MONTEREY COUNTY
RESOURCE MANAGEMENT AGENCY

PUBLIC WORKS - ARCHITECTURAL SERVICES

VOLUME THREE OF THREE

PROJECT MANUAL

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PROJECT NO. 8548
BID NO. 10567

Kitchell CEM
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SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Provide complete design-build fire suppression system.

B. Related Sections
   1. Section 03 30 00 - Cast-in-Place Concrete.
   2. Section 07 90 00 - Joint Protection.
   3. Section 08 31 13 - Access Doors and Frames.
   4. Section 09 90 00 - Painting and Coating
   5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   6. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   7. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
   8. Section 22 11 16 –Domestic Water Piping.
   9. Section 22 11 19 - Domestic Water Piping Specialties.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME).
   1. ASME B31.1 - Power Piping.
   2. ASME B31.9 - Building Services Piping.
   3. ASME/ANSI B16.20 - Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
   4. ASME/ANSI B16.10 - Face to Face and End to End Dimensions of Valves.
   5. ASME/ANSI B16.34 - Valves Flanged, Threaded and Welding End.

B. National Certified Pipe Welding Bureau (NCPWB).

C. Standard Procedure Specifications

D. ASME SEC IX - ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.

E. AWWA Standards
   1. AWWA C111/A21.11: Rubber-Gasket Joints for Ductile–Iron Pressure Pipe and Fittings

F. MSS Compliance:
   1. MSS SP-25 - Marking System for Valves, Fittings, Flanges and Unions.
   2. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
   3. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP-67 - Butterfly Valves.
   5. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
   6. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
   7. MSS SP-85 - Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

8. MSS SP-78 - Gray Iron Plug Valves Flanged and Threaded Ends.

G. FCI Compliance:
1. FCI 73-1 - Pressure Rating Standard for “Y” Type Strainers.
2. FCI 78-1 - Pressure Rating Standard for Pipeline Strainers other than “Y Type.

1.3 DEFINITIONS

A. “Piping” includes, in addition to pipe, all fittings, flanges, valves, hangers and other accessories related to such piping.

B. “Wiring” includes in addition to conductors, all raceway, conduit, fittings, boxes, switches, hangers and other accessories related to such wiring.

C. “Concealed” means hidden from sight in chases, furred spaces, shafts, hung ceilings or embedded in construction.

D. “Exposed” means not installed underground or “concealed” as defined above.

E. “Provide” means to furnish and install.

1.4 SUBMITTALS

A. Design Standards
1. The fire protection system shall be designed in accordance with the latest editions of the NFPA 13 and 2010 California Fire Code and designated amendments, and standards required set forth by the Authority Having Jurisdiction (AHJ) and Local Fire Marshal. Sprinkler system shall be hydraulically engineered and calculated. Refer to the following Sections for additional design reference:

B. System Description:
1. The fire protection system shall consist of a fully designed and hydraulically engineered wet pipe fire sprinkler suppression system. The new wet pipe fire sprinkler system will be served by a 2” main sprinkler riser. The fire sprinkler system will consist of (1) tap to serve the entire building. The sprinkler branch tap size shall be hydraulically calculated. The new sprinkler line shall include at a minimum a new double check back flow preventer, a control valve, an alarm check valve, fire department connection, and pressure gauges as required by NFPA standards.

2. Contractor shall confirm with the AHJ the hydraulic most remote area square footage requirements, the density requirements and total hose demand for the hazard zone.

C. Shop Drawings
   1. General: Prepare and submit plans, sections, details and diagrams to required scales for specified areas. Drawings shall be coordinated, dimensioned and indicate equipment, piping, and ductwork in relation to architectural and structural features as well as other building systems. Include Minor piping, drains, air vents, etc. Indicate exact locations and elevations of valves, piping specialties, access doors, dampers etc.
   2. Required Drawings: Prepare and submit drawings for all areas and all mechanical work. Scale shall be minimum 3/8" = 1'-0" in mechanical rooms, fan rooms, and mechanical areas, and minimum 1/4" = 1'-0" elsewhere.

D. Coordination Drawings
   1. General: Coordination drawings are defined as "shop drawings" which also indicate, on the same drawings, the major utilities of all other trades. "Coordination Drawings" shall indicate location and elevations of structural slabs and beams, architectural elements, domestic water piping, plumbing vents, sanitary drains, storm drains, fire protection piping, lighting fixtures, electrical conduits (2-inch and larger), ductwork, penetrations of walls and roof, fire dampers, fire/smoke dampers, automatic dampers, terminal boxes, air outlets, access panels, ceiling mounted equipment and controls, gas piping, flues, fans, air handling equipment, etc.
   2. Submit coordination drawings for the following:
      a. Entire building.
      b. Other areas for which space is limited.
   3. It is the intent of the coordination drawings to ensure coordination of all major utilities, prior to the start of installation. This is a substantial effort which will require careful and detailed coordination and planning to ensure appropriate information is available, from all trades, in a timely manner. The coordination drawing effort shall be integrated into the project schedule and monitored to ensure conformance.
   4. Conflicts between trades, which cannot be resolved through generally accepted practice of coordination between trades, shall be clouded on the coordination drawings and an appropriate description of the problem noted for review by the Owner's Representative.
   5. Nonconforming M/E work installed within designated coordination areas is subject to removal and replacement by installing contractor at no additional cost to Owner.
   6. Coordination drawings shall be signed and dated by individual trade constrictors. By act of signature and submittal of singular combined coordination drawings, each trade contractor acknowledges coordination of their portion of the work with all other mechanical, electrical, architectural, and structural work contractors.

E. Product Data:
   1. Fire service (underground Piping) shall be ductile iron Class 52.
   2. Fire service pipe shall be UL/FM approved, ferrous and shall meet NFPA-13 requirements, and shall be schedule 40.
   3. Grooved couplings and fittings shall be UL/FM approved malleable or ductile iron with rust inhibiting coating. Coupling gasket shall be Elastomer (EPDM). Manufacture shall be Gruvlok, Victaulic, or approved equal
   4. Threaded fittings shall be cast iron rated for 175 psi cold water working pressure.
   5. Butterfly valves shall be UL/FM approved for fire service, gear operator with crank handle, indicator dial plate, integral supervisory switch with contacts as required and conduit connection for wiring to fire alarm system if applicable. Manufacturer shall be Grinnell, Nibco, or approved equal.

6. Check Valves shall be UL/FM approved for fire service, iron body bronze trimmed suitable for 175 PSI water working pressure. Manufacturer shall be Grinnell, Nibco or approved equal.
7. Pipe supports and hangers shall be UL/FM approved. Manufacturer shall be Grinnell, Nibco, or approved equal.
8. Pressure gauges shall be rated from 0-300 psig. Manufacturer shall be Weksler, Ashcroft, or approved equal.
9. Fire sprinklers heads shall be quick response type UL/FM approved pendant type with fire sprinkler head guards. Provide extra heads, wrench as required by NFPA. Temperature classifications shall be per NFPA 13 requirements. Manufacturer shall be Tyco, Reliable or approved equal.
10. Water flow switch shall be UL/FM approved with tamperproof cover, conduit connection and contacts as required for wiring to fire alarm system if applicable. Manufacturer shall be Potter Electrical Signal Co, Notifier, or approved equal.
11. Supervisory switch shall be UL/FM approved with tamperproof cover, conduit connection and contacts as required for wiring to building fire alarm system if required. Manufacture shall be Potter Electric Signal Co, Notifier, or approved equal.

F. Record Documents
1. Comply with the Conditions of the Contract and the requirements of Section 23 05 53.
2. Indicate mains, branches, and sprinkler heads of fire protection systems, with valves and control devices located and numbered per valve schedule, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, vents, etc.). Indicate actual inverts and horizontal locations of underground piping.
3. Indicate equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Identify approved substitutions, Contract Modifications, and actual equipment and materials installed.

G. Samples: When specified under applicable Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Conform to the requirements specified in Division 1.

B. Provide factory-applied plastic end-caps on each length of pipe. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe.

C. Where possible, store pipe inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

D. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.6 SUBSTITUTIONS

A. General:
1. Base manufacturer is indicated in equipment schedules.
2. In Specification, additional acceptable manufacturer(s) may be indicated.

3. Other manufacturers, materials, or methods shall not be used unless approved in writing by the Owner's Representative.
4. The burden of proof as to the equality of any proposed substitute manufacturer, material**,** or method shall be upon the Contractor.
5. The Owner's Representative's decision shall be final.

B. Requests for substitution review and acceptance shall be accomplished by table of comparison listing pertinent features of both specified and proposed materials, such as materials of construction, performance, dimensions, weights, replacement or maintenance access, motor type, horsepower, voltage, phase, service factor. Review of proposed substitutions will not be made until receipt of satisfactory comparison tabulation.

C. Submittal of substitutions shall be limited to one proposal for each type or kind of item, unless otherwise permitted by the Owner's Representative. If first proposed product submittal is rejected, Contractor shall then submit the first-named or scheduled product.

D. Contractor shall be responsible for all costs and coordination due to the substitution, such as impacts on electrical requirements, weight, openings in slabs and roofs, structural framing, housekeeping pad size, etc.

1.7 JOB CONDITIONS

A. Cause as little interference or interruption of existing utilities and services as possible. Schedule Work which will cause interference or interruption in advance with Construction Manager.

B. Examine Contract Documents to determine how other Work will affect execution of mechanical Work.

C. Arrange for, coordinate, and pay costs incidental to providing utility company services indicated.

D. Establish lines and levels for each system and coordinate with other systems to prevent conflicts and maintain proper clearances and accessibility.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Refer to individual Division 23 piping sections for pipe, and fitting materials joining methods. Comply with governing regulations.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Provide welding materials to comply with installation requirements.
1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Gaskets for Flanged Joints: ASME/ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

2.3 PIPE ESCUTCHEONS

A. General: Provide solid (not split-hinged) pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. All escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid brass or solid sheet brass pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid sheet metal escutcheons.

D. Manufacturer: Chicago Specialty, Producers Specialty, Sanitary-Dash.

2.4 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.

C. Manufacturer: Thunderline Link Seal, Metraflex Metraseal, or approved equal.

2.5 FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges:
      a. 3-inch and smaller: 0.040-inch/20 gauge thick.
      b. 4 to 6-inch: 0.064-inch/16 gauge thick.
      c. Over 6-inch: 0.079-inch/14 gauge thick.
   2. Steel Pipe: See “Mechanical Sleeve Seals” article.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Hold piping close to walls, overhead construction, columns and other

clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1 inch clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

C. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

D. Comply with ASME B31.1.

E. Pressures: Do not install piping, valves or piping specialties where exposed to system pressures greater than their rated working pressures.

F. Sloping, Air Venting and Draining:
   1. Slope piping as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in direction of flow as follows:

G. Install piping free of sags and bends. Support requirements are specified in Section 23 05 29.

H. Fittings:
   1. Provide standard, manufactured fittings in all cases. Field fabricated fittings are prohibited. Bushings are prohibited on pressure piping.
   2. Weld-O-Lets and Thread-O-Lets may be used for non-galvanized steel piping if main pipe size is at least three standard pipe sizes larger than branch pipe, e.g. 2-inch main and 1-inch branch.
   3. Provide insulating couplings at connections of ferrous piping to non-ferrous piping.

3.2 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

D. Fluid Control: Except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ASME B31.9.

E. Installation of Check Valves:
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow. Provide silent type wafer check valves at pump discharge locations.
3. Lift Check Valve: Install in piping line with stem vertically upward, position for proper direction of flow.

F. Install globe valves to close against pressure.

G. Install plug valve with seat toward equipment to be isolated.

3.3 TESTING

A. General: Provide labor and test equipment including test pumps, gauges, instruments and other equipment required. Use test quality pressure gauges, instruments and other equipment required. Use test quality pressure gauges with range of approximately twice test pressure. Use calibrated gauges and instruments.

B. Piping:
1. General: Remove from systems, during testing, equipment which would be damaged by test pressure. Replace removed equipment after testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system.
2. Correct leaks by remaking joints with new material; makeshift remedies will not be permitted. Test time accrues only while full test pressure is on system. Test before backfilling, concealing, insulating or making connections to potable water system.
3. Test Schedule: Test each section of systems at one and one-half times the maximum working pressure of that section, but at not less than scheduled test pressure. Obtain maximum working pressures from the Owner's Representative if not indicated on Drawings. Unless indicated otherwise, scheduled tolerance is "no pressure loss", except that due to temperature change, in 24 hour period.

C. Valves:
1. General Service Valves: Test bonnets for tightness. Test operate from closed-to-open-to-closed position while under test pressure.
2. Automatic Valves: Test, including solenoid valves, water regulating valves, pressure reducing valves, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.
3. Safety Valves: Test relief valves, safety relief valves, safety valves and temperature and pressure relief valves 3 times.

D. Piping Specialties: Test pressure gauges and other specialties for proper performance.

E. Hangers and Supports: With systems in normal operation, test hangers, supports and rods to insure they are plumb and supporting proper share of load. Additionally support systems and equipment that sway, crawl, or vibrate.

F. Buried Pipe and Equipment Wrapping and Coating: Test surfaces with standard 8,000 to 10,000 volt electrical holiday detector.

G. Other Materials and Equipment:
1. Rotation: Verify.

2. Motor Amperage: Verify operating motor amperage does not exceed motor nameplate rating.
3. Test as specified; as recommended by equipment manufacturer; and as otherwise necessary or directed to assure they are complete, operable, and ready for use.

3.4 ADJUSTING AND CLEANING

A. Inspect all equipment and put in good working order.

B. Equipment and Materials: Remove foreign materials including dirt, grease, splashed paint, and plaster, etc. Restore damaged finishes to original condition.

C. Piping: Flush clean interior of piping. Upon completion of flushing, completely drain systems at low points; remove, clean, and replace strainer baskets and refill systems.

D. Adjusting: Adjust equipment and system components as indicated or as otherwise required to result in intended system operation. Thereafter, as a result of system operation, or as directed, make readjustments as necessary to refine performance and to effect complete system tune-up.

3.5 SPECIAL TOOLS

3.6 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush clean interior of piping. Inspect each run of each system for completion of joints, supports and accessory items. Upon completion of flushing, completely drain systems at low points; remove, clean and replace strainer baskets and refill systems.
1. Inspect pressure piping in accordance with procedures of ASME B31.

3.7 ADJUSTING AND CLEANING OF VALVES

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

C. Valve Identification: Tag each valve in accordance with Section 23 05 53.

3.8 ADJUSTING AND CLEANING OF PIPING SPECIALTIES

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 211000

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe Wrap for Below Ground Fire Water Service.
2. Materials – General.
3. Pipes and Fittings.
4. Fittings.
5. Sprinklers.
6. Flexible Sprinkler Hose Fittings.
7. Dielectric Fittings.
8. Sprinkler Specialty Fittings.
9. Listed Fire Protection Valves.
10. Specialty Valves.
11. Fire Department Connections.
12. Alarm Devices.
13. Fire Hoses.
14. Pressure Gauges.
15. Hangers and Supports.
16. Sleeves for Wall/Floor Penetrations.
17. Signs.
18. Pipe Escutcheons.
19. Fire Barrier Penetration Seals.

B. Related Sections:
1. Section 01 31 00 - Coordination.
2. Section 09 90 00 - Painting and Coating.
3. Section 10 44 00 - Fire Protection Specialties.
4. Section 21 05 00 – Common Work Results for Fire Suppression.
5. Section 22 05 19 - Meters and Gauges for Plumbing Piping.
6. Section 28 31 00 - Fire Detection and Alarm.
7. Section 31 23 33 - Trenching and Backfill.

1.2 REFERENCES

A. National Fire Protection Association (NFPA)
1. NFPA 13 - Installation of Sprinkler Systems.
2. NFPA 14 - Installation of Standpipe and Hose Systems.
3. NFPA 15 - Water Spray Fixed Systems for Fire Protection.
4. NFPA 20 - Installation of Stationary Pumps for Fire Protection.
5. NFPA 24 - Installation of Private Fire Service Mains and their Appurtenances.
6. NFPA 25 - Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

7. NFPA 72 - National Fire Alarm Code.
8. NFPA 230 - Fire Protection of Storage.
9. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants.

B. Factory Mutual Systems (FM) Publications
1. Approval Guide

C. Underwriter's Laboratories, Inc. (UL) Publications
1. Fire Protection Equipment Directory

D. ASME/ANSI
1. B1.20.1 - Pipe Threads, General Purpose
2. B16. - Malleable Iron Threaded Fittings
3. B16.4 - Gray Iron Threaded Fittings Class 125 and 250.
4. B16.5 - Pipe Flanges and Flanged Fittings
5. B16.9 - Factory-Made Wrought Buttwelding Fittings
6. B16.11 - Forged Steel Fittings, Socket-Welding and Threaded
7. B16.25 - Buttwelding Ends
8. B36.10 - Welded and Seamless Wrought Steel Pipe

E. ASTM International
1. A47- Ferritic Malleable Iron Castings
2. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. A135 - Electric-Resistance-Welded Steel Pipe
4. A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
5. A536-84 - Ductile Iron Castings
6. C635 - Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
7. C636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

F. Underwriter's Laboratories (UL)
1. UL 193 - Warm Valves for Fire-Protection Service
2. UL 194 - Gasketed Joints for Ductile-Iron Pipe and Fittings for Fire Protection Service
3. UL 213 - Rubber Gasketed Fittings for Fire Protection Service
4. UL 262 - Gate Valves for Fire-Protection Service
5. UL 312 - Check Valves for Fire-Protection Service
6. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems
7. UL 393 - Indicating Pressure Gauges for Fire-Protection Service
8. UL 405 - Fire Department Connections
9. UL 464 - Audible Signal Appliances
10. UL 753 - Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service
11. UL 1091 - Butterfly Valves for Fire-Protection Service
12. UL 1468 - Direct Acting Pressure Reducing and Pressure Restricting Valves
13. UL 1474 - Adjustable Drop Nipples for Sprinkler Systems
14. UL 1726 - Automatic Drain Valves for Standpipe Systems

G. AWWA C105 - Polethylene Encasement for Ductile-Iron Pipe Systems

H. AWWA C151/ ANSI A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water

I. AWWA C110/ ANSI A21.1D-[Date] - Ductile-Iron and Gray-Iron Fittings for Water

J. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

K. ANSI/ ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.

L. AWWA C510 - Double Check Valve Backflow-Prevention Assembly

M. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly.

1.3 DEFINITIONS

1. Working plans as used in this Section refer to Contract Documents (including Drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
2. Other definitions for fire protection systems are included in referenced NFPA standards.

1.4 SYSTEM DESCRIPTION

A. Design Requirements

1. Wet Pipe Sprinkler System Description: This system shall be installed in conformance with NFPA 13. All materials utilized shall be UL listed and approved. All materials installed shall adhere to the manufacturer's installation guidelines. System devices shall include the following:
   a. Sprinkler Heads: As indicated in Part 2 of this Section.

B. Performance Requirements

1. Work provided under this Section shall include, but not be limited to, complete automatic sprinkler system as outlined in this Section, including all labor, materials and shop drawings needed to provide an operating system, and all of the following:
   a. Connection to fire service mains.
   b. Backflow preventer.
   c. Automatic sprinklers and appropriate escutcheons.
   d. Flexible sprinkler hose fitting.
   e. Control and check valves.
   f. Drain and test valves.
   g. Pipe, fittings, and auxiliary drains.
   h. Hangers and supports including seismic restraints, and any required calculations.
   i. Sleeves including firestopping and watertight sealants.
   j. Ceiling and wall plates.
   k. Cutting and patching.
   l. Signs, pipe identification, and flow arrows.
   m. Fire department connection.
   n. Waterflow alarms (paddle type and pressure-type).
   o. Supervisory devices.
   p. Coordination with all other trades including the subcontractor providing the detection and actuation system.
   q. Shop drawings, hydraulic calculations, device manufacturer's literature, samples.
   r. Air tests, hydrostatic tests, Contractor's Material and Test Certificates and as-built drawings.
   s. Training and operating instructions.
   t. Spare parts/sprinklers in cabinet with special wrenches.

u. All permits and fees for this work.

2. The design shall conform to NFPA 13 and the requirements specified in this Section. Design of the automatic wet pipe sprinkler system shall be for Light Hazard.
3. The fire protection system includes fire water service from a point approximately 5-feet outside each Building to all spaces as indicated on the Fire Protection Plans and as required by NFPA 13. The underground piping design shall be in accordance with NFPA 24. The system shall include all materials, accessories and equipment inside and outside the building to provide a system complete and ready for use. Design and provide each system giving full consideration to HVAC and plumbing piping, electrical equipment, ductwork and other construction and equipment in accordance with detailed drawings to be submitted for approval. Equipment for fire protection service shall be UL listed or FM approved for use in a wet pipe sprinkler system.
4. Sprinkler System Protection Limits: All spaces within each building except as noted on the Fire Protection Plans.
    a. Exception: Areas with other fire extinguishing systems and areas indicated to be without sprinkler protection.
    b. Commercial sprinklers shall be provided in areas as indicated on the Fire Protection Plans. Part 2 of this Section contains detailed sprinkler requirements.
    c. The type of sprinkler head to be used in each room is indicated on the Fire Protection Plans. Contractor shall submit in writing to the Owner's Representative the type of sprinkler heads used in each room for each building.
5. Water Distribution: Distribution shall be uniform throughout each Building, which it is assumed the sprinkler heads will open. Variation in discharge from individual heads in the hydraulically most remote area shall be between 100 and 200 percent of the specified density.
6. Clearance from Electrical Equipment: Piping and automatic sprinklers are prohibited directly over:
    a. Transformers.
    b. Substations.
    c. Switchboards.
    d. Motor Control Centers.
    e. Emergency Generators.
    f. Bus Ducts.
    g. Electrical Panels.
    h. If installing pipe over electrical equipment is unavoidable, provide a galvanized drip pan under piping to protect electrical equipment. Provide 1/2-inch drain pipe from pan and terminate 6-inches above floor.
7. Location of Sprinkler Heads: Heads in relation to the ceiling and the spacing of sprinkler heads shall not exceed their linked area coverage for Light Hazard and Ordinary Hazard Group 1, as indicated. Uniformly space sprinklers on the branch piping. Locate sprinkler heads in a consistent pattern with ceiling grid, lights and supply air diffusers. Locate sprinkler heads in center of tiles in areas as shown on the Drawings. Part 2 of this Section contains detailed sprinkler requirements.
8. Sprinkler Discharge Area: The sprinkler discharge area shall be the hydraulically most remote areas as defined in NFPA 13 and 230.
9. Hose Allowances: System design shall include an allowance of 250 gpm for inside hose stream.
10. Hydraulic Calculations shall be performed in accordance with NFPA 13 and 15. A minimum 10 psi cushion or safety factor/margin, between the available pressure and the calculated required pressure shall be incorporated into all hydraulic calculations.

11. The Contractor shall provide system demands at base of risers. Available water supply at risers shall be coordinated with the Civil Engineer. As stated above, confirm pressure with Civil Engineer prior to performing calculations.
12. Hydraulic Calculations: Hydraulic calculations for each building shall be in conformance with NFPA 13 and the following requirements:
    a. The Contractor shall conduct an up-to date fire flow test indicating the static and residual pressure in the water mains used for fire service with certified flow volumes at time of test. Tests must be conducted at or near peak demand of day.
    b. The Contractor shall coordinate with Civil Engineer fire service water pressures for the entire site, as specified in Number 13 above.
    c. Densities listed below are for the most hydraulically remote areas plus hose streams.

Occupancy	Density GPM/Sq.Ft.	Remote Area Sq.Ft.
Light Hazard Corridors and Vestibules Offices Toilets	0.10	1500

1.5 TOLERANCES

A. The Contractor shall furnish on a design/build basis, all equipment, materials, tools, labor, engineering, drawings, and accessories, necessary for complete fire protection systems, with said systems being made ready for operation. The purpose of the Specifications and Drawings is to convey to the Contractor the scope of design/build work required, all of which the Contractor shall furnish, install, adjust, and make operable, and to meet the requirements of the California State Fire Marshal.

B. The omission of any necessary system component shall not relieve the Contractor of the responsibility for providing such necessity, without additional cost to the OWNER. Any case of error, omission, discrepancy or lack of clarity shall be promptly identified to the Owner's Representative for clarification prior to the bid due date.

C. The Contractor shall provide all devices and equipment required by these Specifications and Drawings and the Local Fire Marshal. Under no circumstances shall the Contractor delete any equipment or devices without written directive of the State of California Fire Marshal.

D. Authority Having Jurisdiction: Any reference in the Specifications or applicable to the "authority having jurisdiction" (AHJ) shall be interpreted to mean the State of California Fire Marshal.

E. Installation of the fire suppression system shall not be started until all plans and specifications have been approved by the Office of the State of California Fire Marshal.

1.6 SUBMITTALS

A. Partial submittals will not be acceptable. Before any work is commenced, submit manufacturer's data (with listing or approval), system calculations, water supply data, and complete sets of working drawings.

B. Manufacturer's Data: Annotate descriptive data to show the specific model, type and size of each item the Contractor proposes to furnish. Where any devices which are provided or furnished involve work by another trade, submit additional data copies directly to the subcontractor. Where manufacturer's data sheets show multiple equipment or model numbers, indicate with an arrow the equipment to be provided.
   1. Pipe, fittings and seismic supports.
   2. Alarm valves.
   3. Gate and check valves.
   4. Globe valves.
   5. Backflow preventers.
   6. Sprinklers and escutcheons.
   7. Pipe hangers and supports.
   8. Pressure and waterflow switches.
   9. Tamper switches.
   10. Inspector's test station.
   11. Retard chamber.
   12. Ball drip.
   13. Fire department connections.
   14. Lubricating compound / PTFE tape.
   15. Signs.
   16. Caps, Chains.
   17. Cabinets.
   18. Hose Valves.
   19. Drip pans.
   20. Dielectric unions.
   21. Underground piping support, anchoring methods, and pipe wrap.
   22. Corrosion protection and coating materials for underground pipe rodding.
   23. Signs, pipe identification, and flow direction.
   24. Flexible sprinkler hose fittings.

C. Shop Drawings:
   1. Submit to the Owner's Representative: Shop drawings, hydraulic calculations and manufacturer's data as required to obtain approval of all applicable local, state, federal and insurance authorities in accordance with Section 01 33 23.
   2. After obtaining approval of shop drawings from the Owner's Representative, submit to the Local Fire Marshal one (1) set of shop drawings, hydraulic calculations and manufacturer's data as required to obtain approval.
   3. Submit to the Owner's Representative: One set of shop drawings and manufacturer's data bearing the review stamp of all applicable local, state, federal and insurance authorities.
   4. Hydraulic calculations shall include a water supply graph and hydraulic cover sheet. The cover sheet shall include the name and location of the calculated area, ceiling height, occupancy, design criteria, sprinkler spacing, system type, sprinkler make, model, size, K factor and temperature rating, flow requirements, C factor used, water supply data and source of information, and commodity storage class, height and configuration.
   5. Prepare shop drawings at minimum scale of 1/8-inch equals 1 foot for plans, and 1/4-inch equals 1 foot for details. Show all piping, sprinklers, hangers, type of pipe, tube connections, outlets, roof construction, and occupancy of each area, including ceiling and roof heights as required by NFPA 13. When welding is planned, shop drawings shall indicate the sections to be shop welded and the type of welded fittings to be used.

6. Shop drawings shall include details of earthquake sway bracing with any required calculations, sealed by a Professional Structural Engineer licensed in the State of California.

D. Changes:
   1. Make no changes in installation from layout as shown on the approved Drawings unless change is specifically approved by the Owner's Representative. This does not include minor revisions for the purpose of coordination.
   2. Any pipe fabricated and/or installed before all approvals are obtained are at the Contractor's own expense and responsibility. Any changes made to the approved drawings other than as stated above are at the Contractor's own expense and responsibility.

E. As-Built and Project Record Drawings:
   1. In accordance with Section 01 78 23, maintain at the site an up-to-date set of as-built drawings which shall be corrected daily and delivered to the OWNER upon completion of the Work.
   2. The Contractor shall utilize the marked up drawings to produce a set of Project Record Drawings. Upon completion furnish the Owner's Representative with four (4) sets of prints and one set in electronic AutoCAD 2009 "DWG" format of each approved shop drawing, revised to show "as-built" conditions in accordance with Section 01 78 00.

F. Fire Zone Sprinkler Head Identification:
   1. The Contractor shall prepare AutoCAD drawings identifying (by zone and number) each sprinkler head associated with each fire zone. These drawings are to be framed in tamperproof glass and mounted on the wall or as per the direction of the Owner's Representative.

G. Final Inspection and Test:
   1. Upon completion of final inspections and tests, as required by appropriate NFPA Standards and these Specifications, submit documentation of all test results and copies of the Standard Contractor's Material and Test Certificates to the Owner's Representative.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

C. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in "California Electrical Code," Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Comply with requirements of authority having jurisdiction for submittals, approvals, materials, hose threads, installation, inspections, and testing.

E. Comply with requirements of OWNER's insurance underwriter for submittals, approvals, materials, installation, inspections, and testing.

F. Licensed Fire Sprinkler Contractor: Submit design drawings, Fire Protection design calculations, and installation inspection reports, sealed by a Fire Sprinkler Contractor licensed in the State of California, certifying compliance with specifications.

G. Installer's Qualifications: Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment. A qualified firm is one that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction. Submit evidence of qualifications to the Owner's Representative upon request. Refer to Division 1.

H. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
   1. NFPA 13.
   2. California Electrical Code (CEC), latest edition.
   3. NFPA 230.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

B. Provide temporary protective coating on cast iron and steel valves.

C. Certificates: Submit mill certificates indicating steel pipe for use in above-ground sprinkler piping conforms to specified requirements.

1.9 SEQUENCING AND SCHEDULING

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment and ductwork, all plumbing systems, and partition assemblies.

B. MAINTENANCE SERVICE Initial Maintenance Service: Beginning at Project completion, provide one year emergency repair service by skilled employees of sprinkler system Installer.
   1. Include 24-hour-per-day, 7-day-per-week emergency callback service.
      a. Response Time: Four hours or less.

1.10 EXTRA MATERIALS

A. Provide spare sprinkler cabinets, complete with sprinklers of assorted temperature ratings of the type necessary and in use throughout the installation as required by NFPA 13. Each cabinet shall be equipped with one special sprinkler wrench required for each type of sprinkler installed.
   1. Confer with the Owner's Representative for exact locations for sprinkler cabinets.

PART 2 PRODUCTS

2.1 PIPE WRAP FOR BELOW GROUND FIRE WATER SERVICE

A. General: Provide pipe wrap for all pipe installed below ground.
   1. Cleaning: Remove loose scale, rust, dirt, oil and grease before wrapping. Wire brush as required; use solvent for removal of oil and grease.
   2. Encase in two (2) layers of an AWWA C105, 8-mil polyethylene jacket, all ductile iron pipe installed below ground. Install jacket per AWWA C105.

2.2 MATERIALS - GENERAL

A. All components shall be UL listed or FM approved for the intended purpose. Components shall be used in accordance with the manufacturer's recommendations and its UL listing and/or FM approval.

2.3 PIPES AND FITTINGS

A. Underground Piping Systems:
   1. General: Provide outside-coated, ductile-iron, cement-mortar lined pipe and fittings conforming to NFPA 24, and AWWA C151/A21.51 for piping, and AWWA C110/ANSI A21.10 for fittings. Anchor joints in accordance with NFPA 24. Provide concrete thrust blocks or other suitable means of thrust restraint in accordance with NFPA 24. Restrain the pipe riser with steel rods from the elbow where the pipe turns up toward the floor, to the flange above the floor. Minimum pipe size shall be as shown. Minimum depth of cover shall be such that the top of the pipe is not less than 36-inches below finished grade.
   2. Mechanical Joints: Dimensional and material requirements for pipe ends, gland bolts and nuts, and gaskets shall conform to AWWA C111. Mechanical joints shall also meet the requirements of UL 194.
   3. Back-fill Materials:
      a. Granular Fill: Granular fill for filling over excavations and for bedding of pipes dial consist of approved, uniformly graded, sand, stone, gravel, or stone screening. free from an excess of soft or unsound particles or other objectionable material.
      b. Soil Materials: Soil materials used as backfill for trenches shall consist of approved native material that is free from debris, wood roots, scrap materials and other vegetable matter and refuse.
   4. Buried Utility Warning and Identification Tape: Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warming and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3-inch minimum width, color coded for the utility involved with warning and identification imprinted in bold black lettering continuously and repeatedly over the entire tape length. Warning and identification shall be CAUTION BURIED WATER PIPING BELOW or similar. Use permanent code and letter coloring unaffected by moisture and or the substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12-inches below the top surface of the earth or the top surface of the subgrade under pavements.

B. Above Ground Piping:
   1. General: Provide fittings for changes in direction of piping and for all connections. Arrange piping so that it can be drained at the main riser. Make changes in piping sizes through standard tapered, reducing pipe fittings; the use of bushings will not be permitted. Perform welding in the shop; field welding will not be permitted. Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape ONLY; apply on male threads. Lubricant used on gaskets for mechanical fittings must

be non-petroleum based and approved by the Owner's Representative. Run piping concealed in areas with suspended ceilings, except as otherwise noted on the Drawings.

2. Pipe shall be new, designed for 175 psi, non-shock, cold water working pressure, conforming to ASTM specifications, and have the manufacturer's name and brand along with the applicable ASTM standard marked on each length of pipe.
    a. Steel: Steel piping shall be black or galvanized.
        1) Standard Wall: Overhead pipe used shall be black steel and shall comply with ASTM A135. Galvanized pipe shall be used where exposed to atmosphere and for dry systems. Dimensions for all overhead pipe must be in accordance with the American Standard for Wrought Steel and Wrought Iron Pipe ASME B36.10M for pressure up to 300 psi. Schedule 40 pipe is considered "standard wall" pipe. Schedule 30 pipe is, acceptable in sizes 8-inch and larger. Standard wall pipe ends shall be welded, threaded, cut grooved or plain end.
        2) Thin Wall: Overhead pipe of the Welded and Seamless Type specified in ASTM A53 used in welded systems shall have a minimum pipe wall thickness for pressures up to 300 psi as follows: Schedule 10 in sizes up to 5-inch; 0.134 inches for 6-inch; and 0.188 inches for 8-inch pipe. Pipe ends shall be roll grooved or welded in accordance with NFPA 13.
        3) Threadable light wall piping shall not be used.
        4) Pipe and preparation shall conform to the fitting manufacturer's recommendations.

2.4 FITTINGS

A. Piping connections for steel pipe shall be threaded, flanged or grooved, and rated for 175 psi working pressure. Piping connections for stainless steel shall be stainless steel. Plain end fittings and couplings are not permitted. All fittings shall be suitable for use in sprinkler and standpipe systems in accordance with NFPA 13 and 14.
    1. Steel Pipe:
        a. Threaded fittings shall be cast iron, 125 pound class, black, and in accordance with ASME B16.4; or malleable iron, 150 pound class, black and in accordance with ASME B16.3. Bushings shall not be used unless written approval is obtained from the Owner. Threaded fittings on deluge system located outside shall be malleable.
        b. Welded fittings shall be steel, standard weights, black, and in accordance with ASME B16.9, ASME B16.25, ASME B16.5, ASME B16.11 and ASTM A234.
        c. Grooved fittings shall be malleable or ductile iron joined with rigid or flexible couplings with approved gaskets. Groove-type fittings shall be UL listed or FM approved for fire protection: Fittings shall be manufactured by Victaulic, Gustin-Bacon, or approved equal.
        d. Grooved couplings and reducers shall be malleable or ductile iron conforming to ASTM A47. Grooved couplings to be malleable or ductile iron having clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; composition sealing gaskets recommended by the manufacturer, steel bolts, nuts, and washers. Use hot-dipped galvanized couplings for galvanized pipe. Coupling gasket shall be molded Elastomer (EPDM) Victaulic grade "E" (TYPE A), Gustin-Bacon Type W or as otherwise recommended by the manufacturer for dry pipe systems, or equal. Grooved couplings and reducers shall be of the same manufacturer as used for the grooved fittings. Grooved couplings may be of flexible or rigid type.
        e. Flanged fittings shall be Class 150 steel, rated at 200 psi working pressure and provided to match adjacent equipment or fittings. Where using bolt connections, the

length of the bolts shall not protrude as to prevent the use of a socket wrench on associated nuts. Flanged bolts shall be hexagon head machine bolts with heavy semi-finished hexagon head nuts, cadmium plated, having dimensions in accordance with ANSI B18.2.1 and ANSI B18.2.2. Bolted connections shall be hot-dipped galvanized; or stainless steel bolts, nuts, and washers where exposed to outside air. Gaskets shall be full-faced of 1/16-inch minimum thickness red sheet rubber.

B. Drain, trim, and test valves shall be approved.
   1. Main drain, auxiliary drain and inspectors test valves shall be globe valves, bronze body, rising stem, inside screw, renewable composition disc manufactured by Nibco, Stockham or equal. Globe valves up to 1-inch to be Nibco KT-65, Stockham or equal. Globe valves 1-1 /4-inches to 3-inches to be Nibco KT-211-W, Stockham or equal.
   2. Gate valves shall not be used for dry pipe system inspectors test connections.

C. Check Valves:
   1. Check valves for water supply, fire department connections, and risers shall have removable covers for maintenance without removing the valve from the system.
   2. Check valves in the trim shall be approved.

2.5 SPRINKLERS

A. Fire Sprinkler Heads:
   1. Sprinklers shall be quick response type and have a temperature classification per NFPA 13. Fire sprinklers shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted. Sprinklers shall be of all brass body construction with a metal Belleville spring seal, coated on both sides with Teflon film. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Institutional sprinklers shall have a quick response solder link. Commercial sprinklers shall have a quick response frangible bulb type fusible element. Sprinklers to be installed in areas with no ceilings shall be of a brass finish and shall be of adequate temperature for the hazard. Sprinklers shall have a standard or large orifice and a 5.6 or 8.0 nominal K Factor. Sprinklers shall be UL Listed or FM Approved. Quick response sprinklers shall be listed for installation in an Ordinary Hazard occupancy if installed in an Ordinary Hazard occupancy.
   2. Sprinkler head types are indicated on the Fire Protection Plans. Contractor shall review types of heads with the Owner’s Representative prior to drawing submittal. The Contractor shall submit in writing to the Owner’s Representative the types of heads for each room in each building based on the meeting.

B. Commercial Quick Response Sprinklers:
   1. Microfast Quick Response Pendent Sprinkler: Sprinklers to be installed through a ceiling shall be chrome finish pendent sprinklers (or finish as specified elsewhere) with a Viking model “E-1 or F-1” adjustable semi-recessed escutcheon of same specified finish. Sprinklers shall have a quick response frangible bulb type fusible element. Sprinklers shall have a standard or large orifice and a 5.6 or 8.0 nominal K Factor. Sprinklers shall be UL Listed or FM Approved. Quick response sprinklers shall be listed for installation in an Ordinary Hazard occupancy if installed in an Ordinary Hazard occupancy. Quick Response Sprinklers (formerly Model M) shall be Viking SIN: VK302 (5.6K Standard Orifice Pendent) or SIN: VK352 (8.0K Large Orifice Pendent) Data Page 41a. (No Substitutions Allowed).

2. Microfast Quick Response Upright Sprinkler: Sprinklers to be installed through a ceiling shall be chrome finish pendent sprinklers (or finish as specified elsewhere) with a Viking model "E-1 or F-1" adjustable semi-recessed escutcheon of same specified finish. Sprinklers shall have a quick response frangible bulb type fusible element. Sprinklers shall have a standard or large orifice and a 5.6 or 8.0 nominal K Factor. Sprinklers shall be UL Listed or FM Approved. Quick response sprinklers shall be listed for installation in an Ordinary Hazard occupancy if installed in an Ordinary Hazard occupancy. Quick Response Sprinklers (formerly Model M) shall be Viking SIN: VK300 (5.6K Standard Orifice Upright) or SIN: VK350 (8.0K Large Orifice Upright). (No Substitutions Allowed).
3. Quick Response High Pressure Concealed Pendent Sprinkler: Concealed sprinklers shall be UL Listed as quick response for working pressures up to 250 PSI (17 BAR). Sprinklers shall have a quick response frangible bulb type fusible element. Quick response high-pressure concealed pendent sprinklers shall be listed for installation in an Ordinary Hazard occupancy if installed in an Ordinary Hazard occupancy. Concealed sprinklers shall have a white finish (or painted to match enclosure finish) cover plate that is a push-on, thread-off assembly with a 2-3/4-inch diameter or a 3-5/16inch diameter. Concealed sprinklers shall have a 1/2-inch NPT, a standard orifice, and a nominal K Factor of 5.6. High-Pressure QR Concealed Pendent Sprinklers (formerly Model B-2) shall be Viking Horizon Mirage SIN: VK454 (Base Part Number 12292). (No Substitutions Allowed).
4. Quick Response Concealed Horizontal Sidewall Sprinkler: Quick response concealed horizontal sidewall sprinklers shall be listed for installation in an Ordinary Hazard occupancy if installed in an Ordinary Hazard occupancy. Sprinklers shall have a quick response frangible bulb type fusible element. Concealed horizontal sidewall sprinklers shall have a white finish (or painted to match enclosure finish) cover plate that is a push-on, pull-off assembly with a cover diameter no greater than 2-3/4-inch. Concealed sprinklers shall have a 1/2-inch NPT, a standard orifice, and a nominal K Factor of 5.6. Quick response horizontal sidewall sprinklers shall be UL Listed for Light Hazard and Ordinary Hazard occupancies. Concealed Horizontal Sidewall Sprinklers shall be Viking SIN: VK408 (Base Part Number 11451). (No Substitutions Allowed).

C. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and one wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.

2.6 DIELECTRIC FITTINGS

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180-degree F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
1. Available Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.
   d. Hart Industries International, Inc.
   e. Watts Industries, Inc.; Water Products Div.

f. Zurn Industries, Inc.; Wilkins Div.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig minimum working-pressure rating as required for piping system.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.

D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.
   1. Available Manufacturers:
      a. Advance Products and Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.

E. Dielectric Couplings: Galvanized steel with inert and noncorrosive thermoplastic lining and threaded ends and 300-psig working-pressure rating at 225-degree F.
   1. Available Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

F. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig working-pressure rating at 225-degree F.
   1. Available Manufacturers:
      a. Perfection Corporation.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Co. of America.

2.7 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:
   1. Available Manufacturers:
      a. Anvil International, Inc.
      b. Central Sprinkler Corp.
      c. Ductilic, Inc.
      d. JDH Pacific, Inc.
      e. National Fittings, Inc.
      f. Shurjoint Piping Products, Inc.
      g. Southwestern Pipe, Inc.
      h. Star Pipe Products; Star Fittings Div.
      i. Victaulic Co. of America.
      j. Ward Manufacturing.

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
1. Available Manufacturers:
a. Central Sprinkler Corp.
b. Fire-End and Croker Corp.
c. Viking Corp.
d. Victaulic Co. of America.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
1. Available Manufacturers:
a. Elkhart Brass Mfg. Co., Inc.
b. Fire-End and Croker Corp.
c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
1. Available Manufacturers:
a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
1. Available Manufacturers:
a. CECA, LLC.
b. Merit.

2.8 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:
1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Available Manufacturers:
a. Grinnell Fire Protection.
b. McWane, Inc.; Kennedy Valve Div.
c. NIBCO.
d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.

3. NPS 3: Ductile-iron body with grooved ends.
4. Available Manufacturers:
    a. NIBCO.
    b. Victaulic Co. of America.

D. Globe or Angle Valves
1. NPS 2 and smaller: Bronze body, bronze trim, rising stem and handwheel inside screw, renewable composition disc, solder or screwed ends, with backseating capacity repackable under pressure.
2. Over NPS 2: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.
3. Available Manufacturers:
    a. NIBCO
    b. Grinnell Fire Protection
    c. Stockham

E. Butterfly Valves: UL 1091.
1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Available Manufacturers:
        1) Global Safety Products, Inc.
        2) Milwaukee Valve Company.
2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
3. Available Manufacturers:
    a. Central Sprinkler Corp.
    b. Global Safety Products, Inc.
    c. McWane, Inc.; Kennedy Valve Div.
    d. Mueller Company.
    e. NIBCO.
    f. Pratt, Henry Company.
    g. Victaulic Co. of America.

F. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Available Manufacturers:
    a. Central Sprinkler Corp.
    b. Clow Valve Co.
    c. Crane Co.; Crane Valve Group; Crane Valves.
    d. Grinnell Fire Protection.
    e. Mueller Company.
    f. NIBCO.
    g. Potter-Roemer; Fire Protection Div.
    h. Reliable Automatic Sprinkler Co., Inc.
    i. Star Sprinkler Inc.
    j. Stockham.
    k. Victaulic Co. of America.
    l. Watts Industries, Inc.; Water Products Div.

G. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Available Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
   a. Available Manufacturers:
      1) Clow Valve Co.
      2) Crane Co.; Crane Valve Group; Crane Valves.
      3) Crane Co.; Crane Valve Group; Jenkins Valves.
      4) Hammond Valve.
      5) Milwaukee Valve Company.
      6) Mueller Company.
      7) NIBCO.
      8) Red-White Valve Corp.
      9) United Brass Works, Inc.

H. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
   1. Indicator: Electrical, 115-Vac, prewired, single-circuit, supervisory switch.
   2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
      a. Available Manufacturers:
         1) Milwaukee Valve Company.
         2) NIBCO.
         3) Victaulic Co. of America.
   3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
      a. Available Manufacturers:
         1) Central Sprinkler Corp.
         2) Grinnell Fire Protection.
         3) McWane, Inc.; Kennedy Valve Div.
         4) Milwaukee Valve Company.
         5) NIBCO.
         6) Victaulic Co. of America.

I. Double Check Valve Assemblies: ANSI/ASSE 1012, AWWA C510 and AWWA C511, bronze body with corrosion resistant internal parts and stainless steel springs, two independently operating check valves: Febco Model 805YD. Use iron body assembled for 2-inch and above.

2.9 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
   1. Available Manufacturers:
      a. Central Sprinkler Corp.
      b. Globe Fire Sprinkler Corporation.
      c. Grinnell Fire Protection.
      d. Reliable Automatic Sprinkler Co., Inc.
      e. Star Sprinkler Inc.

f. Victaulic Co. of America.
g. Viking Corp.

2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
   a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

B. Pressure-Regulating Valves: UL 1468, brass or bronze, NPS 1-1/2 and NPS 2-1/2, 400-psig minimum rating. Include female NPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as indicated.
   1. Finish: Rough metal.
   2. Available Manufacturers:
      a. AFAC Inc.
      b. Elkhart Brass Mfg. Co., Inc.
      c. Fire-End and Croker Corp.
      d. GMR International Equipment Corporation.
      e. Grinnell Fire Protection.
      f. Potter-Roemer; Fire Protection Div.
      g. Zurn Industries, Inc.; Wilkins Div.

C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
   1. Available Manufacturers:
      a. AFAC Inc.
      b. Grinnell Fire Protection.

2.10 FIRE DEPARTMENT CONNECTIONS

A. Available Manufacturers:
   1. AFAC Inc.
   2. Central Sprinkler Corp.
   3. Elkhart Brass Mfg. Co., Inc.
   4. Fire-End and Croker Corp.
   5. Fire Protection Products, Inc.
   6. GMR International Equipment Corporation.
   7. Guardian Fire Equipment Incorporated.
   8. Potter-Roemer; Fire-Protection Div.
   9. Reliable Automatic Sprinkler Co., Inc.
   10. United Brass Works, Inc.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."
   1. Type: Flush, with four inlets and square or rectangular escutcheon plate.
   2. Finish: Polished chrome-plated.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 6-inch- minimum- 8-inch- minimum- 10-inch-diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
   1. Available Manufacturers:
      a. Potter Electric Signal Company.
      b. System Sensor.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   1. Available Manufacturers:
      a. ADT Security Services, Inc.
      b. Grinnell Fire Protection.
      c. ITT McDonnell & Miller.
      d. Potter Electric Signal Company.
      e. System Sensor.
      f. Viking Corp.
      g. Watts Industries, Inc.; Water Products Div.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
   1. Available Manufacturers:
      a. Grinnell Fire Protection.
      b. Potter Electric Signal Company.
      c. System Sensor.
      d. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
   1. Available Manufacturers:
      a. McWane, Inc.; Kennedy Valve Div.
      b. Potter Electric Signal Company.
      c. System Sensor.

2.12 PRESSURE GAUGES

A. Available Manufacturers:
   1. AGF Manufacturing Co.
   2. AMETEK, Inc.; U.S. Gauge.
   3. Brecco Corporation.
   4. Dresser Equipment Group; Instrument Div.
   5. Marsh Bellofram.
   6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2 to 4-1/2 inch diameter, dial pressure gauge with range of 0 to 300-psig.

1. Water System Piping: Include caption “WATER” on dial face.

2.13 HANGERS AND SUPPORTS

A. Swivel rings and building attachments shall be UL listed/approved.
   1. Trapeze/hanger component station module shall meet or exceed values listed in NFPA 13.
   2. Earthquake sway bracing compartments shall meet or exceed sizes listed in NFPA 13.

2.14 SLEEVES FOR WALL/FLOOR PENETRATIONS

A. Sleeves through walls and floors, where provided, shall be of a type that can be made watertight and fire stopped. Sleeve sizes shall be as required by NFPA 13 and 14 for Earthquake Protection.

2.15 SIGNS

A. Valve signs shall indicate purpose and system of each control, test, trim, and drain valve. Hydraulic information sign shall meet requirements of NFPA 13 and 14.

2.16 PIPE ESCUTCHEONS

A. General: Provide solid, (not hinged or split type) pipe escutcheons as specified with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. Escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid cast brass or sheet brass escutcheons, solid pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid sheet metal escutcheons.

D. Manufacturer: Chicago Specialty, Producers Specialty, Sanitary-Dash.

PART 3 EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test in accordance with NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 “Quality Assurance” Article.

B. Report test results promptly and in writing to Owner’s Representative.

3.2 EARTHWORK

A. Refer to Section 31 20 00, “Earthmoving” for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 FIRE DEPARTMENT CONNECTION INSTALLATIONS

A. Install fire department connections of types and features indicated in locations indicated.

B. Install ball drip valves at each check valve for fire department connection to mains and where indicated. Drain to floor drain.

3.5 CONNECTIONS

A. Connect to specialty valves, specialties, fire department connections, and accessories.

B. Connect water supplies to sprinkler systems. Include backflow preventers.

C. Electrical Connections: Power wiring is specified in Division 26.

D. Connect alarm devices to fire alarm system.

3.6 FIELD QUALITY CONTROL

A. Perform field acceptance tests of each fire protection system.
   1. Flush, test, and inspect sprinkler piping systems according to NFPA 13.

B. Replace piping system components that do not pass test procedures specified, and then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
   1. Report test results promptly and in writing to the Owner's Representative.
   2. Report test results promptly and in writing to authority having jurisdiction when required.

C. Report test results promptly and in writing to the Owner's Representative and authority having jurisdiction.

3.7 CLEANING

A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.8 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.9 STARTUP SERVICES

A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:
   1. Verify that specialty valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.
   2. Verify that excess pressure pumps and accessories have been installed correctly and operate correctly.
   3. Verify that specified tests of piping are complete.
   4. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
   5. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
   6. Check that potable water supplies have correct type of backflow preventer.
   7. Check that fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
   8. Fill wet-pipe sprinkler systems with water.
   9. Energize circuits to electrical equipment and devices.
   10. Adjust operating controls and pressure settings.

3.10 DEMONSTRATION AND TRAINING

A. In accordance with Section 01 78 23, the Contractor shall conduct two training sessions of four hours each to familiarize the facility personnel with the features, operation, and maintenance of the fire protection systems. Training sessions shall be scheduled by the Owner's Representative at a mutually agreeable time to the Contractor and the Owner's Representative.

B. Operating Instructions:
   1. Furnish three (3) copies of printed operating and maintenance instructions to the Owner's Representative, and adequately instruct the maintenance personnel in proper operation and test procedures of all fire protection components provided, furnished, or installed.

C. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

D. Schedule demonstration with at least 7 days' advance notice.

E. Upon completion of the system it shall be tested in the presence of the Local Fire Marshal.

END OF SECTION

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Pipe, tube, and fittings
2. Miscellaneous piping materials/products.
3. Valves.
4. Piping specialties.
5. Pipe escutcheons.
6. Mechanical sleeve seals.
7. Fire barrier penetration seals.
8. Fabricated piping specialties.
9. Motors and drives.

B. Related Sections
1. Section 03 30 00 - Cast-in-Place Concrete.
2. Section 07 90 00 - Joint Protection.
3. Section 08 31 13 - Access Doors and Frames.
4. Section 09 90 00 - Painting and Coating.
5. Section 22 05 19 - Meters and Gauges for Plumbing Piping.
6. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
9. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
10. Section 22 07 19 - Plumbing Piping Insulation.
11. Section 23 05 19 - Meters and Gauges for HVAC Piping.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME).
1. ASME B31.1- Power Piping.
2. ASME B31.9- Building Services Piping.
3. ASME B16.20- Metallic Gaskets for Pipe Flanges; Ring-Joint, Spiral-Would, and Jacketed
4. ASME B16.21- Nonmetallic Flat Gaskets for Pipe Flanges.
5. ASME B16.10- Face-to-Face and End-to-End Dimensions of Valves.
6. ASME B16.34-[2004] - Valves Flanged, Threaded and Welding End.

B. National Certified Pipe Welding Bureau (NCPWB) - Standard Procedure Specifications.

C. ASME SEC IX - ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.

D. ANSI Standards.
   1. ANSI B16.20.1- Metallic Gaskets for Pipe Flanges - Ring Joint, Spiral-Wound, and Jacketed.

E. AWWA Standards
   1. AWWA C111- Rubber - Gasket Joints for Ductile - Iron Pressure Pipe and Fittings.

F. MSS Compliance:
   1. MSS SP-25- Marking System for Valves, Fittings, Flanges and Unions.
   2. MSS SP-72- Ball Valves with Flanged or Butt-Welding Ends for General Service.
   3. MSS SP-80- Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP-67- Butterfly Valves.
   5. MSS SP-70- Gray Iron Gate Valves, Flanged and Threaded Ends.
   6. MSS SP-85- Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   7. MSS SP-78- Gray Iron Plug Valves, Flanged and Threaded Ends.
   8. MSS SP-71- Gray Iron Swing Check Valves, Flanged and Threaded Ends.

G. FCI Compliance:
   1. FCI 73-1- Pressure Rating Standard for "Y" Type Strainers.
   2. FCI 78-1- Pressure Rating Standard for Pipeline Strainers Other than "Y Type.

1.3 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, flanges, valves, hangers and other accessories related to such piping.

B. "Wiring" includes in addition to conductors, all raceway, conduit, fittings, boxes, switches, hangers and other accessories related to such wiring.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings or embedded in construction.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Provide" means to furnish and install.

1.4 SUBMITTALS

A. General
   1. Comply with the requirements of Division 1 and the specific requirements of the Sections of Division 22.
   2. Submit all similar equipment together as part of the same submittal. For example:
      a. All water heaters shall be contained in the same submittal.
   3. Contractor shall review all submittals prepared by each supplier and mark all copies as acceptable to the Contractor. This acceptance shall signify that all required service connections are shown and in the proper location to meet the installation requirements and that the equipment can fit in the space allowed.
   4. Do not order equipment until submittals have been reviewed and approved by the Owner's Representative.
   5. Each item submitted shall be labeled or identified the same as on the drawings.

6. Mark submittal “Exactly as Specified” or accompanied by a letter from the supplier explaining in detail what difference, if any, exists between the submitted item and the specified item. Failure to point out the differences will be considered cause for disapproval. The Owner’s Representative will not assume any responsibility for differences concealed or otherwise not brought to their attention, and the Contractor will be required to correct any deficiencies or differences discovered at a later date, and assume responsibility for any delays, damage, and/or expenses incurred by others due to such action.
7. Brands or trade names are mentioned to set standards of quality only; use no substitute materials, however, unless approved in writing by the Owner’s Representative. Approval of substitute materials does not relieve the Contractor of responsibility for providing a workable and functioning system as specified.
8. Submittals will be checked for general conformance with the design concept but acceptance by the Owner’s Representative in no manner is meant to verify that dimensions, quantities, or location of services are as necessary to meet the job requirements. This remains the responsibility of the Contractor.

B. Shop Drawings
1. General: Prepare and submit plans, sections, details and diagrams to required scales for specified areas. Drawings shall be coordinated, dimensioned, indicate equipment and piping in relation to architectural and structural features as well as other building systems. Include minor piping, drains, air vents, etc. Indicate exact locations and elevations of valves, piping specialties, access doors, etc.
2. Required Drawings: Prepare and submit drawings for all areas and all plumbing work. Scale shall be minimum 3/8” = 1’-0” in mechanical rooms, fan rooms, and mechanical areas, and minimum 1/4” = 1’-0” elsewhere.

C. Coordination Drawings
1. General: Coordination drawings are defined as “shop drawings” which also indicate, on the same drawings, the major utilities of all other trades. “Coordination drawings” shall indicate location and elevations of structural slabs and beams, architectural elements, domestic water piping, plumbing vents, sanitary drains, storm drains, fire protection piping, lighting fixtures, electrical conduits (2-inch and larger), ductwork, penetrations of walls and roof, fire dampers, fire/smoke dampers, automatic dampers, terminal boxes, air outlets, access panels, ceiling mounted equipment and controls, gas piping, flues, fans, air handling equipment, etc.
2. Submit coordination drawings for the following:
    a. Building.
    b. Other areas for which space is limited.
3. It is the intent of the coordination drawings to ensure coordination of all major utilities, prior to the start of installation. This is a substantial effort which will require careful and detailed coordination and planning to ensure appropriate information is available, from all trades, in a timely manner. The coordination drawing effort shall be integrated into the project schedule and monitored to ensure conformance.
4. Conflicts between trades, which cannot be resolved through generally accepted practice of coordination between trades, shall be clouded on the coordination drawings and an appropriate description of the problem noted for review by the Owner’s Representative.
5. Nonconforming M/E work installed within designated coordination areas is subject to removal and replacement by installing contractor at no additional cost to Owner.
6. Coordination drawings shall be signed and dated by individual trade constructors. By act of signature and submittal of singular combined coordination drawings, each trade

contractor acknowledges coordination of their portion of the Work with all other plumbing, mechanical, electrical, architectural, and structural work contractors.

D. Product Data
   1. General: Manufacturer's specifications, data sheets, certified drawings, and installation instructions. Include physical and performance data such as weights, sizes, capacities, required clearances, performance curves, acoustical characteristics, finishes, color selection, location and size of field connections, and accessories. Include certified drawings on major equipment such as boilers, water chillers, cooling towers, controls, pumps, and tanks.
   2. Motors: Submit manufacturer's name, type, RPM, HP (KW), full load amps, efficiency, and power factor.
   3. Part Load Performance: Submit equipment data to indicate performance characteristics throughout ranges of possible load conditions.
   4. Include operating weight and location of center of gravity of each item of equipment in manufacturer's cut sheet for purposes of seismic calculation.
   5. Pipes and Pipe Fittings: Submit schedule showing pipe material data, sizes, fitting valve type k factor, working pressure for each service.
   6. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
   7. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
      a. Strainers: include pressure drop or chart for each type and size.
      b. Meters and gauges: include scale range for each service.

E. Test Reports
   1. Manufacturer's Tests
      a. Factory Tests: As specified for specific equipment.
      b. Field Tests: As specified.
   2. System Pressure Tests: As specified under "Testing" article. Test log of pressure tests on each system. Indicate date of test, scope of test, test pressure, duration, and observers.

F. Certification
   1. Seismic Restraints: As specified under Section 22 05 29 and 22 05 48.
   2. Welding Certificates.
   3. Brazing Certificates.

G. Operating and Maintenance Manuals: Include, but not limited to, the following:
   1. List of all equipment with Manufacturer's name, model number, and local representative, service facilities and normal channel of supply for each item. Include phone number and address of service facilities
   2. System Description: Description of start-up, operating, and shutdown procedures.
   3. Controls: Diagrams and description of operation sequence of each system.
   4. Equipment: Manufacturer's brochures, ratings, certified shop drawings, lubrication charts and data, parts lists with part numbers, and belt and sheave data. Mark each sheet with equipment identification number and actual installed condition.

5. Materials and Accessories: Manufacturer's brochures parts lists with part numbers and lubrication data where applicable. Mark each sheet with equipment identification number or system and location of installation; and to specifically identify which options are provided (in case where data sheet shows multiple options).
6. Certificate of factory tests, field tests and code compliance as specified.
7. Wiring and controls schematics.
8. Trouble shooting directions.
9. Maintenance procedures and frequencies.
10. Description of special tools.
11. Copies of warranties.
12. Safety precautions.
13. Emergency contingencies.

H. Record Documents
1. Comply with the Conditions of the Contract and the requirements of Section 22 05 53.
2. Indicate mains and branches of piping systems, with valves and control devices located and numbered per valve schedule, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, vents, etc.). Indicate actual inverts and horizontal locations of underground piping.
3. Indicate equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Identify approved substitutions, Contract Modifications, and actual equipment and materials installed.

I. Samples: When specified under applicable Sections.

1.5 QUALITY ASSURANCE

A. Perform all work in accordance with following rules (codes, standards and regulations):
1. Codes
a. California Building Code, Latest Edition: CBC
b. California Fire Code, Latest Edition: CFC
c. California Electrical Code, Latest Edition: CEC
d. California Plumbing Code, Latest Edition: CPC
e. California Mechanical Code, Latest Edition: CMC
f. California Occupational Safety Health Act: OSHA
g. California Code of Regulations: CCR
h. CCR Title 24 California Energy Code: CEC
i. Applicable Local Codes and Ordinances.
2. Standards
a. Air Conditioning and Refrigeration Institute: ARI
b. Air Movement and Control Association, Inc.: AMCA
c. Canadian Gas Association: CGA
d. American National Standards Institute: ANSI
e. American Society of Heating, Refrigeration, and Air Conditioning Engineers: ASHRAE
f. American Society of Mechanical Engineers: ASME
g. American Society of Plumbing Engineers: ASPE
h. American Society of Testing and Materials: ASTM
i. American Water Works Association: AWWA
j. American Welding Society: AWS

k. Associated Air Balance Council: AABC
l. Factory Mutual: FM
m. International Association of Plumbing and Mechanical Officials: IAPMO
n. Institute of Boiler and Radiator Manufacturers: IBR
o. Manufacturer's Standardization Society of the Valves and Fittings Industry: MSS
p. National Electrical Manufacturers Association: NEMA
q. National Electrical Testing Association: NETA
r. National Environmental Balancing Bureau: NEBB
s. National Fire Protection Association: NFPA
t. Plumbing and Piping Industry Council: PPIC
u. Sheet Metal and Air Conditioning Contractors National Association, Inc.: SMACNA
v. Underwriters' Laboratories: UL

3. Regulations
   a. California State Fire Marshal: CSFM
   b. California State Department of Public Health: CSDPH
   c. Safety Orders of Division of Industrial Safety: SODIS
4. Where standards of Contract Documents for materials and/or workmanship are higher than those of applicable rules, Contract Documents shall take precedence; otherwise the rules shall govern.
5. Nothing in the Contract Documents is to be interpreted as permitting the Work not conforming to the rules.
6. Should there be any direct conflict between the rules and the Contract Documents, the rules shall govern.
7. Charges for all materials and labor required for the compliance with rules and regulations shall be included in the Contract Price.

B. Certifications: Provide proof of code compliance for equipment as follows:
1. Gas Fired Equipment and Safety Devices: Per applicable standards and bear label of CGA.
   a. Fuel-burning heating appliances shall bear permanent and legible factory-applied nameplate on which shall appear: manufacturer's name; approved fuel input rating, expressed in Btu/hr.; model and serial numbers; instructions for lighting, operation, and shutdown; type fuel approved for use; and symbol of approved agency certifying compliance of equipment with recognized standards.
2. Electrical Equipment and Safety Devices: Per applicable standards of NEC; UL listed or classified.
3. Pressure Vessels and Pressure Safety Devices: Per applicable standards and bear label of ASME.
4. Energy Conservation: Comply with applicable codes. Provide equipment and materials certified by manufacturer per California energy code as applicable.
5. Equipment: Provide UL listed or classified equipment where required by code officials. Verify such requirements.

C. Repair or replace, to the satisfaction of the Owner, any damage to Work of this Section and damage caused by Work of this Section.

D. Workmanship shall be first class throughout and performed only by competent and experienced workmen in a manner satisfactory to the Owner. Constant supervision of the Work, either by the Contractor or his competent representative, shall be maintained.

E. Work shall be installed so as not to delay the progress of construction and shall be properly coordinated with other trades.

F. Use only new materials in perfect condition. Inspect all materials upon arrival at job site and immediately remove defective items from site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.7 SUBSTITUTIONS

A. General
1. Base manufacturer is indicated in equipment schedules.
2. In Specification, additional acceptable manufacturer(s) may be indicated.
3. Other manufacturers, materials, or methods shall not be used unless approved in writing by the Owner's Representative.
4. The burden of proof as to the equality of any proposed substitute manufacturer, material**,** or method shall be upon the Contractor.
5. The Owner's Representative's decision shall be final.

B. Requests for substitution review and acceptance shall be accomplished by table of comparison listing pertinent features of both specified and proposed materials, such as materials of construction, performance, dimensions, weights, replacement or maintenance access, motor type, horsepower, voltage, phase, service factor. Review of proposed substitutions will not be made until receipt of satisfactory comparison tabulation.

C. Submittal of substitutions shall be limited to one proposal for each type or kind of item, unless otherwise permitted by the Owner's Representative. If first proposed product submittal is rejected, Contractor shall then submit the first-named or scheduled product.

D. Contractor shall be responsible for all costs and coordination due to the substitution, such as impacts on electrical requirements, weight, openings in slabs and roofs, structural framing, housekeeping pad size, etc.

1.8 JOB CONDITIONS

A. Cause as little interference or interruption of existing utilities and services as possible. Schedule Work which will cause interference or interruption in advance with Construction Manager.

B. Examine Contract Documents to determine how other Work will affect execution of plumbing Work.

C. Determine and verify locations of all existing utilities.

D. Arrange for, coordinate, and pay costs incidental to providing utility company services indicated.

E. Establish lines and levels for each system and coordinate with other systems to prevent conflicts and maintain proper clearances and accessibility.

PART 2 PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping sections for pipe, tube, fittings materials joining methods. Comply with governing regulations.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Provide welding materials to comply with installation requirements.
   1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Gaskets for Flanged Joints: ASME B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

2.3 VALVES

A. General: Refer to Section 22 05 23.

2.4 PIPING SPECIALITIES

A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or, if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Dielectric Unions and Flanges
   1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion. Pressure rating equal to or greater than that of nearby valves.
   2. Manufacturers
      a. B & K Industries, Inc.
      b. Capital Mfg. Co.; Div. of Harsco Corp.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Perfection Corp.
      f. Rockford-Eclipse Div.
      g. Victaulic/Clearflow.
      h. Calpico.

C. Thermometers: Refer to Section 22 05 19.

D. Thermometer Wells: Refer to Section 22 05 19.

E. Pressure Gauges: Refer to Section 22 05 19.

F. Pressure Gauge Cocks: Refer to Section 22 05 19.

G. Test Fittings: Refer to Section 22 05 19.

2.5 PIPE ESCUTCHEONS

A. General: Provide solid (not split-hinged) pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. All escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid brass or solid sheet brass pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid solid sheet metal escutcheons.

D. Manufacturers
   1. Chicago Specialty.
   2. Producers Specialty.
   3. Sanitary-Dash.

2.6 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.

C. Manufacturers
   1. Thunderline Link Seal.
   2. Metraflex Metraseal.
   3. Others.

2.7 FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges:
      a. 3-inch and smaller: 0.040-inch/20 gauge thick.
      b. 4 to 6-inch: 0.064-inch/16 gauge thick.
      c. Over 6-inch: 0.079-inch/14 gauge thick.
   2. Steel Pipe: See Section “Mechanical Sleeve Seals”.

2.8 MOTORS AND DRIVES

A. Motor controls and power wiring
   1. Provided as part of Division 26 work, unless indicated otherwise, including motor control switches, starters, disconnects, conduit and wiring, except for low voltage control wiring required for temperature controls.
   2. Where equipment is specified with factory pre-wired controls and is furnished instead with components shipped loose, plumbing contractor shall be responsible for coordinating the complete installation and assume any additional costs.

B. Motors
   1. Ball or roller bearing type, high efficiency type, with starting and running characteristics consistent with torque and speed requirements of driven machine.
   2. Use motors rated in accordance with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 72 degrees F above ambient with service factor of 1.15.
   3. Motors driven by variable frequency drives shall be rated for inverter duty and shall meet the requirements of NEMA MG-1 part 31.4.4.2.
   4. Where substitute manufacturers are provided with different control panels, starters, or electrical characteristics from scheduled equipment, contractor shall coordinate complete installation and assume any additional costs.
   5. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
   6. Do not include service factor when selecting motor horsepower.
   7. Motors exposed to moisture or rain shall be totally enclosed, fan cooled (TEFC). Others may be open drip proof (ODP), unless otherwise indicated.

C. Motor electrical power characteristics: 460 V, 3-phase, 60 Hz for 1/2 HP and larger; 115 V, 1-phase, 60 Hz for smaller than 1/2 HP, unless noted otherwise.

D. Efficiency
   1. Requirements apply to all motors, 1/2 HP and larger.
   2. Ratings in accordance with IEEE 112b Rating Method.

a. Motors shall be labeled as NEMA "Premium" Efficient, with efficiencies as follows, based on 1750 RPM.;

	% Efficiency	
HP	ODP	TEFC
1/2	80.5	78.5
3/4	82.5	80.0
1	85.5	85.5
1-1/2	86.5	86.5
2	86.5	86.5
3	89.5	89.5
5	89.5	89.5
7-1/2	91.0	91.7
10	91.7	91.7
15	93.0	92.4
20	93.0	93.0
25	93.6	93.6
30	94.1	93.6
40	94.1	94.1
50	94.5	94.5
60	95.0	95.0

3. Motors with other than 1750 RPM shall be same type motor as would meet requirements for 1750 RPM motors.

E. Belt Drives
1. Manufacturers
   a. Browning.
   b. Gates.
   c. Woods.
   d. Dayton.
2. Belts: V-belt drives rated at 1-1/2 times the motor horsepower. High quality commercial-grade rubber with polyester reinforcing.
   a. Provide two belts minimum for motor sizes 2 HP and larger.
3. Spare Parts: Provide one complete set of spare belts for all equipment items. When two or more pieces of equipment require identical belts, provide quantity of spare belts sufficient to serve two pieces of equipment.
   a. Obtain receipt from Owner.
   b. Identify each belt by equipment ID.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2-inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

C. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

D. Electrical and Elevator Equipment Spaces: Do not run piping through transformer vaults, electrical rooms and other electrical or electronic equipment spaces and enclosures, unless piping or ductwork is for equipment serving that electrical space.

E. Comply with ASME B 31.1.

F. Pressures: Do not install piping, valves or piping specialties where exposed to system pressures greater than their rated working pressures.

G. Sloping, Air Venting and Draining:
   1. Slope piping as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in direction of flow as follows:

Service	Inclination	Min. Slope
Cooling Coil Condensate Drain	Down	1/8” per foot (1-percent)

H. Install piping free of sags and bends. Support requirements are specified in Section 22 05 29.

I. Fittings
   1. Provide standard, manufactured fittings in all cases. Field fabricated fittings are prohibited. Bushings are prohibited on pressure piping.
   2. Weld-O-Lets and Thread-O-Lets may be used for non-galvanized steel piping if main pipe size is at least three standard pipe sizes larger than branch pipe, e.g. 2-inch main and 1-inch branch.
   3. Provide insulating couplings at connections of ferrous piping to non-ferrous piping.

3.2 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

D. Fluid Control: Except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ASME B31.9. Where throttling is indicated or recognized as principal reason for valve, install globe valves.

E. Installation of Check Valves
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
   2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow. Provide silent type wafer check valves at pump discharge locations.
   3. Lift Check Valve: Install in piping line with stem vertically upward, position for proper direction of flow.

F. Install globe valves to close against pressure.

G. Install plug valve with seat toward equipment to be isolated.

H. Valve Discharge Piping: Provide discharge pipe to atmosphere from all relief and safety valves, sized with area equal to sum of outlet areas of all valves connected thereto, unless indicated larger.

3.3 INSTALLATION OF PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surfaces.

B. Dielectric Unions and Flanges: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer’s installation instructions.

C. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

D. Fire Barrier Penetration Seals: Fill entire opening with sealing compound. Adhere to manufacturer’s installation instructions.

3.4 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs.
   1. Do not install sleeves through structural members, except as detailed on Drawings, or as reviewed by the Owner’s Representative.
   2. Install sleeves accurately centered on pipe runs.

3. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two pipe sizes larger than piping run.
4. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation.
5. Pack 100 percent of annular space between sleeve and pipe or pipe insulation. Provide acoustical sealant at each end of pipe sleeve to seal packing in place.
    a. At fire-rated walls, partitions, floors, roofs, and ceilings: Packing shall be through-penetration firestop.
    b. At non-fire-rated walls, partitions, floors, roofs, and ceilings: Packing shall be fiberglass insulation, with density of 1.5 pcf.
6. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves.
7. Extend floor sleeves 1 inch above level floor finish.
8. Provide temporary support of sleeves during placement of concrete and other work around sleeves.
9. Provide temporary closure to prevent concrete and other materials from entering sleeves.

B. Type of Sleeves
1. Install sheet-metal sleeves at walls and partitions.
2. Install schedule 40 pipe sleeves in concrete slabs.
3. Install mechanical sleeve seals at exterior penetrations; below grade, and at slabs-on-grade.

C. Mechanical Sleeve Seals: Install in accordance with the manufacture's instructions.

3.5 PIPING EXPANSION PROVISIONS

A. General: Install domestic hot water piping with at least four elbows or tees at following locations.
1. Between piping mains and risers.
2. Between equipment and pump or tank.
3. Between piping main and equipment.

B. Expansion Loops: Fabricate expansion loops as indicated, and elsewhere as determined by Installer for adequate expansion of installed piping system. Provide pipe anchor and pipe alignment guides as indicated, and elsewhere as determined by Installer to properly anchor piping in relationship to expansion loops.
1. At Contractor's option, pipe anchors may be insulated lugged anchors; [Pipe Shields, Inc.; Model #C4000 Series]. Comply with requirements for insulated pipe supports in Section 22 05 29.
2. At Contractor's option, pipe guides may be guided insulated pipe supports; [Pipe Shields, Inc.; Model #B3000 or B7000 Series]. Comply with requirements for insulated pipe supports in Section 22 05 29.

3.6 INSTALLATION OF EQUIPMENT AND DEVICES

A. Install all equipment in accord with manufacturer's recommendations and in accordance with the equipment's listing (if applicable).

B. Access
1. Install all equipment and devices to permit easy access for maintenance.

2. Maintain easy access to all equipment and devices installed as part of Division 22 Work, including but not limited to, motors, drives, valves, actuators, etc.
3. Proper access shall include:
    a. Valves may be operated.
    b. Control devices may be adjusted.
    c. Equipment access panels may be opened.
    d. Normal maintenance work such as lubrication of bearings, etc., may be performed readily within arm's reach of access opening.
4. Relocate items which interfere with access.
5. When possible, install Work in accessible locations to avoid the need for access panels.
6. Coordinate with the Owner's Representative to achieve acceptable locations of access panels.
7. Coordinate all access panel locations with other trades and the Contractor.
8. Where possible, avoid locating access panels in secure areas.
9. Provide stainless steel access panels in areas subject to moisture.

C. Provide all necessary anchoring devices and supports.
1. Use structural supports suitable for equipment, or as indicated.
2. Check loadings and dimensions of equipment with shop drawings.
3. Do not cut or weld to building structural members, unless specifically indicated.
4. Provide all required equipment supports, including those not detailed on architectural and mechanical Drawings.
5. Comply with Section 22 05 29 and 22 05 48.

D. Verify that equipment will fit support layouts indicated.
1. Where substitute equipment is used, revise indicated supports to fit, at no additional cost to the Owner.

E. Coordinate size and location of roof penetrations, floor penetrations, and wall openings with Work of other Sections.

F. Install rain hoods and metal counter flashings as indicated and as required to make all penetrations of plumbing work through walls and roofs, water and weather-tight. Furnish all clamps, waterproofing material and labor necessary.

G. Install floor mounted equipment on 6-inch high concrete pad, 6 inches larger on each side than base of unit, unless otherwise specified, indicated, or equipment manufacturer's recommendation calls for. Coordinate size and location of equipment pads and curbs with Work of other Sections.

H. In areas other than mechanical rooms, do not install piping, or equipment in exposed manner unless indicated otherwise.

3.7 ADJUSTING AND CLEANING OF VALVES

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Valve Identification: Tag each valve in accordance with Section 22 05 53.

3.8 ADJUSTING AND CLEANING OF PIPING SPECIALTIES

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

3.9 EQUIPMENT VIBRATION

A. Mechanical Balance: Pumps, motors, and drives, when equipment is installed and in normal operation, shall be within the following maximum limits, unless specified more restrictively for individual equipment items:
   1. 600 RPM and Less: 0.003-inch displacement, peak-to-peak.
   2. Over 600 RPM: 0.10-inch per second velocity, peak.

B. Pulley Run-Out: When equipment is installed and in normal operation, pulley run-out in radial and axial directions not to exceed 0.001 inches.

C. Field Tests: If requested, test equipment to determine compliance with specified requirements. Measure vibration displacement and velocity in vertical direction relative to floor. Make measurements on bearing housings (not end caps), or other heavy structural element directly connected to bearing housing, at each end of equipment.

D. Field Balancing: Balance and retest equipment as required for compliance with specified requirements.

3.10 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush clean interior of piping. Upon completion of flushing, completely drain systems at low points; remove, clean and replace strainer baskets and refill systems. Inspect each run of each system for completion of joints, supports and accessory items.
   1. Inspect pressure piping in accordance with procedures of ASME B31.1.

END OF SECTION

SECTION 220510

BASIC PIPING INSTALLATION REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Basic requirements to furnish and install site piping.
2. Special tools.
3. Tape wrap.
4. Coal Tar Epoxy Coating.
5. Heat Shrink Wrap.
6. Pipe locating wire.
7. Closure sections.
8. Joint lubricant.
9. Feeler gauge.
10. Couplings.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete.
2. Section 22 40 00 - Plumbing Fixtures.
3. Section 33 11 00 - Water Utility Distribution Piping.
4. Section 33 31 00 - Sanitary Utility Sewerage Piping.

1.2 REFERENCES

A. ANSI/NSF 60 - Standard for Drinking Water Treatment and Chemicals - Health Effects.

B. AWWA/ANSI C104/A21.4-90 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

C. AWWA/ANSI C110/A21.10-87 - Ductile-Iron and Gray-Iron Fittings for Water.

D. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 inch through 12 inch (100 mm through 300 mm) for Water Transmission and Distribution.

E. AWWA C210 - Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

F. AWWA C651 - Disinfecting Water Mains.

G. NFPA 25 - Standards for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

1.3 DESCRIPTION

A. Provide all materials as required that will result, upon completion, in a functioning system in compliance with performance requirements specified, and any modifications resulting from reviewed shop and field coordination drawings.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Group shop drawings and product data of related systems, products, and accessories in a single complete submittal.

C. Submit complete data on pipe, fittings, linings, coatings, and any manufacturer's installation instructions for pipelines assembled in the field from standard pieces.

D. Color, DVD, log sheets and written report detailing CCTV inspection of gravity pipelines.

1.5 REGULATORY REQUIREMENTS

A. Fire Protection: Conform to National Fire Protection Association.

B. Plumbing: Conform to UPC with California Amendments, 2010 California Plumbing Code.

C. Mechanical: Conform to UMC with California Amendments, 2010 California Mechanical Code.

D. Seismic: Conform to Chapter 23 of CCR Title 24.

E. Structural: Conform to IBC with California Amendments, 2010 California Building Code.

F. Electrical: Conform to NEC with California Amendments, 2010 California Electrical Code.

G. Fire: Conform to IFC with California Amendments, 2010 California Fire Code.

1.6 PROJECT/SITE CONDITIONS

A. Install work at locations shown on Drawings. If prevented by project conditions, prepare drawings showing proposed rearrangement of work. Include changes to Work specified in other sections. Obtain permission of Owner's Representative before proceeding with rearrangement.

B. Examine related work and surface before starting work on any section
   1. Report to Owner's Representative, in writing, conditions which will prevent proper provision of this work.
   2. Beginning work of any section without reporting unsuitable conditions to Owner's Representative constitutes acceptance of conditions.
   3. Cause as little interference or interruption of existing utilities and services as possible. Notify Owner's Representative of any interruption.
   4. Keep roads clear of materials and debris.

1.7 PRODUCT STORAGE AND PROTECTION

A. Storage
   1. Exercise care in handling and storing of materials and equipment to avoid damage.
   2. Store materials and equipment onsite in enclosures or under protective coverings.
   3. Do not store materials and equipment directly on the ground.
   4. Store equipment containing electrical motors, controls, and wiring in indoor, heated, clean, dry locations.

B. Protection
   1. Protect all work and materials and equipment against loss or damage.
   2. Close all pipe openings with caps or plugs.
   3. Clean and deliver all work and equipment in an unblemished, new conditions.

1.8 FIELD QUALITY CONTROL

A. Repair or replace defective or damaged work, as directed by Owner's Representative.

B. Perform indicated tests to demonstrate satisfactory workmanship, operation, and performance.
   1. Conduct tests in presence of Owner's Representative and, if requested, inspectors of agencies having jurisdiction, including local State Fire Marshall Representative.
   2. Arrange date of tests in advance with Owner's Representative, manufacturer, and installer.
   3. Give all inspectors minimum of 48 hours notice.
   4. Furnish or arrange for use of electrical energy, steam, water, air, oxygen, or gas required for tests.

C. Repair or replace equipment and systems damaged, found inoperative, or defective, and continue remedial measures and retests until satisfactory results are obtained.

1.9 DRAWINGS

A. Drawings in general are diagrammatic and indicate sizes and locations only. Detailed connections to equipment and methods of installation for a complete installation are not shown.

B. Scaled dimensions shall be considered approximate.

C. Before proceeding with work check and verify dimensions required for a complete operating system.

1.10 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by Owner's Representative.

B. Advise Owner's Representative that work is ready for review at following times
   1. Prior to backfilling buried work.
   2. Prior to concealment of work in walls and above ceilings.
   3. When all requirements of contract have been completed.

C. Neither backfill nor conceal work without consent of Owner's Representative.

1.11 AS-BUILT DRAWINGS

A. Contractor to maintain current As-Built Drawings and provide same to Owner's Representative at close of construction.

B. Include all change orders, field changes, adjustments, substitutions and deletions.

C. Show sizes, invert elevations, and location of underground piping and related work.

1.12 POINT OF MANUFACTURE

A. Owner's Representative shall have free access to those parts of the manufacturer's plant that are involved in work performed under this Specification. The manufacturer shall afford the inspector, without charge, all reasonable facilities for determining whether the pipe or appurtenances meet the requirements of this Specification.

B. Inspection by Owner's Representative shall not relieve contractor of responsibility to furnish material conforming in all respects to the requirements of this specification.

C. If plant inspection and/or testing is requested by Owner's Representative, manufacturer shall notify Owner's Representative at least 72 hours in advance of date, time, and place of product testing.

PART 2 PRODUCTS

2.1 SPECIAL TOOLS

A. Furnish to Owner's Representative at completion of work:
1. One set of any special tools required to operate, adjust, dismantle, or repair equipment furnished under any section of this Division.
2. "Special Tools": Those not normally found in possession of mechanics or maintenance personnel.

2.2 TAPE WRAP

A. Tape Wrap: 15 mil, butyl rubber adhesive, polyethylene-backed tape as produced by Polyken Division of the Kendall Company, Boston, MA; Royston Laboratories, Inc., Pittsburg, PA.

2.3 COAL TAR EPOXY COATING

A. Coal Tar Epoxy Coating for Protection of Metal: Self-priming coal tar; Tnemec 46N-413, Carboline 300M, Ameron 78HB.

2.4 HEAT SHRINK WRAP

A. Heat Shrink Wrap Pipe Joints: Use Raychem or Canuso of appropriate size and shape for flexible couplings and flange joints.

2.5 PIPE LOCATING WIRE AND MARKER

A. Pipe Locating Wire: Bare AWG No. 10, soft drawn, single-strand copper wire.

B. Provide at least six mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.

C. Pipe marker shall be internal with locating wire color coded for use with different utility pipe systems, and marked with the utility tape every 24 inches. Provide 4 mil thick, 4-inch wide polyethylene marker.

2.6 CLOSURE SECTIONS

A. Furnish and install all necessary closures. Closure sections shall consist of one or more flexible couplings and plain-end pipe of lengths required to effect the closure. Pipe and couplings for closure sections shall conform to the pipe and flexible couplings specified for the principal parts of the pipeline.

2.7 JOINT LUBRICANT

A. Furnish joint lubricant with the pipes as recommended by the pipe manufacturer.

B. Lubricant for Water Pipes: Water-soluble, nontoxic, vegetable soap compound conforming to United States Pharmacopeia No. P39.

2.8 FEELER GAUGE

A. Furnish sufficient feeler gauges of the proper size, type, and shape for checking the rubber gaskets.

2.9 FLEXIBLE COUPLINGS

A. Flexible Couplings for Use With Steel Pipe: Dresser, Style 38; Smith Blair, Style 411. Use transition coupling for connecting steel pipe to PVC pipe, material shall be equal to couplings used for steel pipe, Protecting coat couplings.

B. Flexible Couplings for Use With Ductile Iron Pipe or PVC With Ductile Iron Pipe Sizes: Dresser, Style 38, 40, or 138; Smith Blair, Style 411 or 431. Protecting coat couplings.

C. Bolts and Nuts for Exposed Conditions: Zinc-coated. Bolts, nuts and washers for buried service shall be Type 304 stainless steel.

D. Middle rings and followers shall be fusion epoxy lined and coated.

2.10 TRANSITION COUPLINGS

A. Transition couplings used to connect pipes with small differences in outside diameter shall be Dresser, Style 162; Smith Blair, Style 413 Protecting coat couplings.

B. Bolts, nuts, and middle rings shall be as specified for flexible couplings.

C. Middle rings and followers shall be fusion epoxy lined and coated.

2.11 THRUST TIES

A. Provide thrust ties where shown and where required to restrain the force developed by 1 1/2 times the operating pressures specified.
   1. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.

B. Anchor studs perpendicular to longitudinal pipe axis are unacceptable.

C. Use type 304 stainless steel ties and hardware.

2.12 SERVICE SADDLES

A. Service Saddles: Smith Blair, Series 317; Romac, Model 202S. Service saddles shall be capable of withstanding 200 psi internal pressure without leakage or overstressing. The run diameter shall be compatible with the outside diameter of the pipe on which the saddle is installed. Taps shall have iron pipe threads. Saddles shall have malleable or ductile iron bodies and stainless steel straps, stainless steel hex nuts with washers, and neoprene seals. Service saddles shall be double-strap or wide band design. Saddles for PVC pipe shall be specifically designed for PVC pipe. Service saddles for use on PVC pipe shall provide full support around the circumference of the pipe. The saddle shall have a bearing area of sufficient width along the axis of the pipe so that the pipe will not be distorted when the saddle is tightened. The service clamps shall not have lugs or other protrusions that will dig into the pipe when the saddle is tightened, a U-bolt type of strap that does not provide sufficient bearing area or a clamping arrangement that is not fully contoured to the outside diameter of the pipe. Saddles shall have a wedge or taper type gasket for a watertight installation.

2.13 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters for ductile iron piping shall be Smith Blair, Series 912; Dresser, Style 127.

B. Bolts, nuts, and protective coatings for steel components shall be as specified hereinbefore for flexible couplings.

C. Middle rings and followers shall be fusion epoxy lined and coated.

2.14 SLAB, FLOOR, ROOF, AND WALL PENETRATIONS

A. General: Provide ductile iron wall pipe with thrust collar unless otherwise specified or shown.

B. Ductile Iron Wall Pipe
   1. For penetrations through concrete walls.
   2. Diameter and Ends: Same as connecting ductile iron pipe.
   3. Thickness: Equal to or greater than remainder of pipe in line, pressure rating - 150 psi minimum.
   4. Fittings: In accordance with the applicable Detail Piping Specification.
   5. Provide taps for stud bolts in flanges set flush with wall face.
   6. Thrust Collars
      a. Provide for all wall pipes.
      b. Rated for thrust load developed at 250 psi.
      c. Safety Factor: Minimum of two.

d. Material and Construction
    1) Ductile iron or cast iron, cast integral with wall pipe wherever possible.
    2) Fabricate by welded attachment of ductile iron thrust collar to pipe where casting impossible.
        a) Perform in pipe manufacturer's shop by qualified welders as specified herein.
        b) Welds: Electric arc welds of ductile iron with NI-55 or FC-55, nickel-iron-carbon weld rod.
        c) Continuously weld on each side all around.

C. Pipe Sleeves
1. Fabricate of 3/16 inch minimum thickness steel pipe.
2. Abovegrade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
3. Belowgrade or in Submerged or Damp Environments: Lined and coated after fabrication with System No. 2 as specified in Section 109 96 00 - High Performance.
4. Seep Ring
    a. Provide 3/16 inch minimum thickness center flange for water stoppage on sleeves in exterior or water-bearing walls.
    b. Outside Diameter: Three inches greater than wall pipe outside diameter.
    c. Continuously fillet weld on each side all around.
5. Existing Walls: Holes drilled with a rotary drill may be provided in lieu of sleeves.

D. Modular Mechanical Seal
1. Provide for existing wall penetrations by pipe sleeve.
2. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
3. Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates.
4. Size modular mechanical seals according to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.

2.15 STEEL CASING PIPE

A. Smooth steel pipe fabricated in sections for welded field joints.

B. Conform to AWWA C200.

C. Size and thickness as shown on Drawings or required by Owner's Representatives.

D. Interior and exterior coating - Coal tar epoxy conforming to AWWA C210 20 mils total dry film thickness applied in two or more coats.

PART 3 EXECUTION

3.1 INSERTS, SLEEVES, AND EXPANSION PLUGS

A. Lay out work in advance of pouring concrete slabs or walls, and furnish and set inserts and sleeves necessary to complete the work.

B. Size inserts and required reinforcing rod to support the load applied.

C. Expansion plugs shall be selected for at least five times the load applied.

3.2 PREPARATION AND HANDLING

A. Pipe and fittings shall be inspected for dirt, damage, or defects prior to being installed or lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched with material similar to the original whole sections or replaced with new undamaged pipe. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installing.

B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Handle pipe in a manner which avoids damage to the pipe. Do not drop or dump pipe onto the ground or into trenches.

C. When cutting and/or machining the pipe is necessary, use only tools and methods recommended by the pipe manufacturer and approved by the Owner's Representative.

3.3 BURIED PIPE INSTALLATION

A. Laying Buried Pipe
   1. General
      a. Distribute material on the job no faster than it can be used to good advantage. Distribute no more than one day's supply of material in advance of laying, unless otherwise approved by the Owner's Representative.
      b. Pipe shall be prepared as hereinbefore specified and shall be laid on the prepared pipe base and bedded to ensure uniform bearing. No pipe shall be laid in water or when, in the opinion of the Owner's Representative, trench conditions are unsuitable. Joints shall be made as herein specified for the respective types. Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling.
      c. For gravity pipe, do not deviate more than 1 inch from line or 1/2 inch from grade unless otherwise approved. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness.
      d. Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for pipe base when specified or indicated. Remove hard spots that would prevent a uniform bearing. Before laying each section of the pipe, check the grade with a straightedge and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between bell holes, except that the grade may be disturbed for the removal of lifting tackle.
      e. At the location of each joint, dig holes of ample dimensions in the bottom and sides of the trench to permit easy visual inspection of the entire joint.
      f. When the pipe laying is not in progress, including the noon hours, the open ends of pipe shall be closed, and no trench water, animals, or foreign material shall be permitted to enter the pipe.
      g. Where the pipe is connected to concrete structures, the connection shall be made as shown. If the connection is not shown, make connection such that a standard pipe joint is located no more than 24 inches from the structure.
      h. Pipelines intended to be straight shall be so laid, and in no case shall deviation from a straight line exceed 0.10 foot for line and 0.10 foot for grade.
      i. Pipelines laid on a curve may be deflected at the joints provided the deflections do not exceed 75 percent of maximum allowable as recommended by the pipe manufacturer.

j. Where horizontal or vertical curve alignments cannot be installed by joint deflection of standard pipe lengths, the Contractor may select from the following options
   1) Use shorter pipe lengths and allowable joint deflection as specified.
   2) Use standard or special fabricated bends.
   3) In the case of PVC pipe inch deflection coupling.

k. For pressure pipe with indicated operating pressure greater than ten psi, provide thrust blocking at all joint bends or deflections of five degrees or greater.

l. Minimum pipe cover shall be 3 feet unless otherwise approved or shown on the plans. Pipe cover shall be varied as required to avoid high points in pressure pipelines and to avoid conflicts with other underground utilities or facilities. In no case shall non-metallic pipes or conduits that carry water have less than four feet of cover where they cross within 20 feet of either side of the double perimeter fences or other fences having a 24-inch deep concrete grade beam. All other pipes and conduits shall have a minimum of three feet of cover where they cross within 20 feet of either side of the double perimeter fence or other fences having a 24-inch deep concrete grade beam.

m. Lay pipe in accordance with approved laying plan.

2. Bell and Spigot Joint Pipe
   a. Join pipe in strict accordance with the manufacturer's recommendations. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutions will be permitted.
   b. Pipe laying shall proceed upgrade with spigot ends jointing in direction of flow. After a section of pipe has been lowered into the prepared trench, clean the end of the pipe to be joined, the inside of the joint, and the rubber ring immediately before joining the pipe.
   c. The joint gap inside of concrete piping 21 inches in diameter and smaller shall not exceed 3/8 inch in width. If the interior joints on 24 inch and larger pipe are greater than 3/8 inch, they shall be filled and sealed with premixed mortar conforming to ASTM C387 and troweled smooth on the inside surface.
   d. Buried ductile iron piping shall be installed with polyethylene bagging in accordance with ANSI/AWWA C105/A21.5-88. Installation shall be in accordance with Methods A and C of the indicated standard.
3. Mechanical Joint Pipe: Mechanical joint pipe varies slightly with different manufacturers. Install the particular pipe furnished in accordance with the particular manufacturer's recommendations, as approved by the Owner's Representative.
4. Solvent Welded Pipe: Solvent welded pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by manufacturer for the maximum temperature variation between time of solvent welding and final use.
5. Threaded Pipe
   a. Ream ends of cut and threaded metallic pipe.
   b. Apply joint lubricant approved for the intended use by the pipe manufacturer.
6. Fusion Bonded Pipe
   a. Fusion bonded pipe shall be joined using the manufacturers recommendations and recommended equipment.

B. Connecting Dissimilar Pipe Materials
   1. Connect dissimilar pipe materials by means of a flexible coupling. Install couplings in strict accordance with the manufacturer's recommendations.

3.4 INSTALLATION OF EXPOSED PIPING

A. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.

B. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. Boltholes in all flanges shall straddle vertical centerline of pipes.

C. Unions shall be installed where required for piping or equipment installation, even though they are not shown on the drawings.

D. Plastic flanges at any joint with a raised face shall be bolted up using a filler gasket. The filler gasket shall bear the bolt load uniformly and remove the flange moment from that part of the flange protruding beyond the outer edge of the raised face.

E. Pipe taps to the pipe barrel are unacceptable. Pipe tap connections to ductile iron piping shall only be made at a tapping boss of a fitting, valve body, or equipment casting.

F. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

G. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

H. Where valve handwheels are shown, valve orientation shall be as shown. Where valve handwheels are not shown, valves shall be oriented to permit easy access to the handwheels, and to avoid interferences.

I. Paint exposed piping in accordance with Section 09 96 00.

3.5 VENTS AND DRAINS

A. Vent the high points and drain the low points of all pressure pipelines, except gravity flow services, whether shown on the Drawings or not. Unless otherwise shown or directed, use 3/4-inch ball valves on pipelines 2-1/2 inch and larger and 1/2-inch ball valves on pipelines two inches and smaller.

3.6 INSULATED JOINTS

A. Install insulated joints between all connections of metallic pipe with dielectric coatings and metallic pipe with cement-mortar coatings.

B. Insulating joints shall be installed between copper pipe and any other metallic pipe.

C. Insulated joints shall be installed between ductile iron and any other type of metallic pipe or any existing ductile iron pipe unless otherwise shown. Insulated joints are not required between metallic pipe and nonmetallic pipe.

D. Do not insulate joints between steel pipe and iron valves or other appurtenances or vice versa.

E. Insulated joints may consist of flanges, flexible couplings, insulating unions, or other type of joints as specified in these specifications, unless otherwise shown or directed.

F. Cover and protect insulated joint during painting of aboveground adjacent piping to prevent short circuiting.

G. Install insulated joints at all connections of pipes with cathodic protection to equipment and buildings.

3.7 CORROSION PROTECTION OF ATMOSPHERIC EXPOSED ACCESSORIES

A. All atmospheric exposed surfaces of black and hot-dip galvanized steel, brass, copper and bronze piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners shall be painted in accordance with Section 09 96 00.

B. Pipe support systems shall be painted No. 70, light gray, as specified in ANSI Z53.1; Tnemec Co., Inc. No. 2050.

3.8 HEAT SHRINK WRAP

A. Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

3.9 WALL PIPES AND PIPE SLEEVES

A. Wall pipes and pipe sleeves embedded in concrete walls, floors, and on slabs shall be embedded as specified in Section 03 30 00 and as shown. Support all pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

3.10 INSTALLATION OF FLEXIBLE COUPLINGS, FLANGED COUPLINGS ADAPTERS, GROOVED JOINT COUPLINGS, AND SERVICE SADDLES

A. Clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. Flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively on opposite sides a little at a time until all bolts have a uniform tightness. Use torque-limiting wrenches.

3.11 PIPING SYSTEMS TESTING

A. General
   1. Prior to acceptance of work, test piping systems in the presence of the Owner's Representative and authorities having jurisdiction per respective and applicable governing codes and requirements of this section. All water piping shall be tested prior to backfilling per NFPA and the State Fire Marshall requirements.
   2. Provide necessary equipment and materials and make necessary test connections required to properly execute tests.
   3. Use only potable water for hydrostatic testing of potable water lines.
   4. Contractor may use San Lucas Library water system as source for test water. Submit plan to protect water system from contamination prior to use.
   5. Remake leaking gasket joints with new gaskets and new flange bolting. Destroy old bolting. Where welded joints fail, submit proposed method of repair for approval by the

Owner's Representative. Testing shall take place during steady state ambient temperature conditions.

6. Other than standard piping flanges, plugs, caps and valves, use only commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. The safe test pressure rating of any plug shall be not less than two times the actual test pressure being applied. Do not use expandable elastomer plugs for piping which could develop sufficient reactive force to cause damage to a structure, other piping, or cause moving of thrust or anchor provisions in case of blow-out.
7. Remove components from piping systems during testing whenever the component may sustain damage from the test pressure or test media. After completion of the test, reinstall the component and retest at the component pressure rating with suitable media.
8. Check system components such as valves for functional operation under system test pressure.
9. Duration of test shall be as specified per manufacturer.
10. Prepare and maintain records of piping systems tests. Record Owner's Representative and contractor personal responsibilities, dates, test gauge identification numbers, ambient temperature, pressure ranges, rates of pressure drop and leakage rates.
11. The connections between new underground piping and the existing shall not be separately tested. Pressure specified in governing code shall be maintained on the joint for not less than 30 minutes.
12. In the event testing demonstrates leakage rates in excess of specified limits, determine source(s) of leakage, repair or replace defective materials and workmanship and retest installation until compliance with specified requirements.
13. Take necessary precautions to vent the expansion force of compressed air trapped during high pressure hydrostatic pressure testing to preclude injury and damage. The Owner's Representative may require the removal of any system component including plugs and caps to ascertain whether the water has reached all parts of the system if purging or vent valves are not provided during construction.

B. Preparation and Execution
   1. Buried Pressure Piping: Conduct final acceptance tests on buried pressure piping that is to be hydrostatically tested after the trench has been completely backfilled, except water piping shall be tested prior to backfilling. The contractor may, if field conditions permit, partially backfill the trench and leave the joints open for inspection and conduct an initial test, except water pipe tests.

C. Hydrostatic Leak Tests
   1. Equipment: Furnish two graduated containers; two pressure gauges; one hydraulic force pump, and suitable hose and suction pipe as required.
   2. Buried Water Fire Suppression Water Piping.
      a. Water piping shall be tested in accordance with NFPA.
      b. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least five days have elapsed after the thrust blocking is installed. If high-early-strength concrete is used for thrust blocking, the time may be reduced to two days. When testing cement-mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.
      c. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for two hours, reopening the isolation valve only as necessary to restore the test

pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula.

1) $L=SD(P)^2/133,200$
2) In the above formula
3) L=Allowable leakage, in gallons per hour
4) S=Length of pipe tested, in feet
5) D=Nominal diameter of pipe, in inches
6) P=Test pressure during the leakage test, in pounds per square inch

d. Correct any leakage greater than the allowance determined under this formula.

e. Maximum test length shall be the shortest length that can be isolated by closing adjacent valves or the length between a valve and an end cap.

D. Gravity Sewers: Gravity sewers shall be air tested as follows:

1. Time of Testing: Test pipe after backfilling has been completed. The Contractor, at his option and expense, may make other earlier tests to ensure compliance with the tests specified herein.
2. Procedure
   a. After all plugs are in place and securely blocked, introduce air slowly into the pipe section to be tested until the internal air pressure reaches 5.0 pounds per square inch. Allow a minimum of two minutes for the air temperature to stabilize.
   b. Pipe and joints being air tested shall be considered satisfactory when tested at an average pressure of 3.0 pounds per square inch when (1) the total rate of air loss from the section being tested does not exceed 2.0 cubic feet per minute, or (2) the section of lines does not lose air at a rate greater than 0.0030 cubic foot per minute per square foot of internal pipe surface.

3.12 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, etc., within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.13 FLUSHING

A. Following assembly and testing and prior to final acceptance, all potable water pipelines installed under this section shall be flushed with water and all accumulated construction debris and other foreign matter removed. Use only potable water for flushing potable water pipelines. Flushing velocities shall be a minimum of 2.5-feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Owner's Representative. Accumulated debris shall be removed through drains two inches and larger or by dropping spools and valves.

3.14 CORROSION PROTECTION FOR BURIED, SUBMERGED, AND CONCRETE-ENCASED PIPE

A. All ductile iron pipe shall be cement-lined in accordance with ANSI A21.4/AWWA C104, except where otherwise noted.

B. Coat cast and ductile iron pipe and fittings.
   1. Coat with coal-tar epoxy per AWWA C210 and manufacturer's recommendations. Provide two coats minimum. Minimum DFT 20 mils.
   2. All abraded areas of coal-tar epoxy coatings shall be cleaned and repaired to provide a protective covering equal to the original and acceptable to the Owner's Representative.

C. Buried ductile iron piping shall be installed with polyethylene bagging in accordance with ANSI/AWWA C105/A21.5-88. Installation shall be in accordance with Methods A and C of the indicated standard.

D. Tape Wrap - Steel and Other Metal Pipe
   1. Field apply tape wrap on appurtenances and short lengths of buried metallic piping not otherwise protected. Apply in accordance with manufacturer's instructions.
   2. Clean pipe and appurtenances with power brushes to remove rust, scale, or other material. Grind or file smooth any sharp burrs that will damage the wrap and solvent clean to remove oils and greases. Apply primer and spiral wrap with a 50 percent overlap to form a double layer. Apply with enough tension to make wrap conform to the surface without wrinkles, but do not stretch excessively. Roll or press the overlap seams to ensure complete bonding.

E. Heat shrink wrap flange and flexible pipe joints per manufacturer's recommendations.

3.15 DISINFECTION

A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-86 and ANSI/NSF 60, as hereinafter modified or expanded.
   1. Complete flushing before disinfecting.
   2. Disinfecting Mixture
      a. Disinfecting mixture shall be a chlorine-water solution having a free chlorine residual of 40 to 50 ppm. Prepare disinfecting mixture by injecting: (1) a liquid chlorine gas-water mixture; (2) dry chlorine gas; or (3) a calcium or sodium hypochlorite and water mixture into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline. The combined mixture of fresh water and chlorine solution or gas shall be of the specified strength.
      b. Apply disinfecting mixture by means of a standard commercial solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.
      c. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution. The following proportions of hypochlorite to water will be required.

Product	Quantity	Water

Calcium Hypochlorite[a] (65 - 70 percent C1)	1 pound	7.5 gallon
Sodium Hypochlorite[b] (5.25 percent C1)	1 gallon	4.25 gallon

[a]Comparable to commercial products known as HTH, Perchloron, and Pittchlor.
[b]Known as liquid laundry bleach, Clorox, Purex, etc.

3. Point of application: Inject disinfecting mixture into the pipeline to be treated at the beginning of the line through a valve and a suitable connection to the top of the pipeline. Clean water from the existing system or another source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.
4. Retention Period
   a. Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 ppm of chlorine.
   b. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the disinfecting mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
   c. Do not place concentrated quantities of commercial disinfectant in the line before it is filled with water.
   d. After chlorination, flush the water from the pipeline until the water through the line is equal chemically and bacteriologically to the permanent source of supply.
5. Dispose of disinfecting water in an acceptable manner that will protect receiving waters from harmful or toxic concentrations of chlorine. The disinfecting water shall be retained onsite in open detention basins or other methods approved by the Owner's Representative.

3.16 VALVES

A. Install valves in accordance with the manufacturer's recommendations. Operating stems shall be vertical unless otherwise indicated or approved by Owner's Representative.

3.17 LOCATING WIRE AND MARKER TAPE

A. Pipe locating wire shall be provided for the entire length of all pressure pipelines except for metallic piping.

B. Install locating wire by strapping to the pipe or tubing with PVC tape, polyethylene backed tape, or tie locks. Test pipe locating wire with pipe locator equipment prior to final acceptance of pipeline.

C. Stub the locating wire up inside each valve box. Sufficient excess length shall be provided at terminal connections to allow continuation of locating wire to the terminal connection.

D. Wire splices shall be made with compression fittings or soldering; wrapped with Tac-Tape, Aqua-Seal; and wrapped with electrical tape. Prevent bare copper wire from contacting metallic appurtenances including, but not limited to, pipe, buried valves, or fittings.

END OF SECTION

SECTION 220513

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Single Phase Electric Motors.
2. Three Phase Electric Motors.
3. Variable Frequency Drives.

B. Related Sections
1. Section 22 05 00 - Common Work Results for Plumbing
2. Section 22 05 48 - Vibration and Seismic Control for Plumbing Piping and Equipment.

1.2 REFERENCES

A. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

D. NEMA MG 1 - Motors and Generators.

E. California Electrical Code, Latest Edition.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data including complete motor data, motor enclosures.

C. Test results verifying nominal efficiency and power factor for motors larger than 1/2 horsepower.

D. Manufacturer’s installation instructions.

E. Operation and maintenance data.

F. Assembly Drawings: Include bearing data with replacement sizes and lubrication instructions.

G. Warranty: Sample of special warranty.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for Plumbing System use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.5 REGULATORY REQUIREMENTS

A. California Electrical Code, Latest Edition.

B. Conform to State Energy Code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective variable frequency drives within specified warranty period.
   1. Include parts and labor.
   2. Warranty Period: Five years from date of Project completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers
   1. Westinghouse.
   2. General Electric.
   3. Allis-Chalmers.
   4. Others.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: Refer to Section 260500 for required electrical characteristics.

B. Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over-temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, Service Factor, Power Factor, efficiency, ambient temperature.

E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame. Provide grounding lug in conduit boxes.

F. Capacity: Minimum horsepower indicated and able to operate driven devices under all conditions without overload.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Up to five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between one and one and one-half times full load torque.

B. Starting Current: Up to six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.

G. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13 - Enclosed Controllers.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Part Winding Start (Where Indicated): Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings double shielded with waterproof non-washing grease.

M. Nominal Efficiency: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

N. Nominal Power Factor: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

PART 3 EXECUTION

3.1 APPLICATION

A. Motors drawing less than 250-Watts and intended for intermittent service may be integral with manufactured equipment and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors 2-HP and larger or when indicated in the individual Section shall be the energy efficient type.
   1. The minimum efficiency of energy efficient motors shall be:

Motor HP	Efficiency, Percent
0.5	79

0.75	81
1.0	83
1.5	84
2.0	85
3.0	87.5
5.0	87.5
7.5	89.5
10.0	89.5
15.0	91
20.0	91.7
25.0	92.5
30.0	93

D. Single phase motors for centrifugal pumps: split phase type.

E. Single phase motors for pumps: capacitor start, capacitor run type.

F. Motors located in exterior locations: totally enclosed weatherproof epoxy-sealed type.

G. Belt connected motors: With slide bases and shaft as required for aligning pulleys.

H. In finished areas mount motor protection switches flush and install suitable cover plates.

I. In inmate accessible areas: exposed electric motor cases assembled with tamper proof screws under provisions of Section 05 05 23.

3.2 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: SINGLE PHASE - OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/6	1200	48	41	48
1/4	1200	48,56	41	51
1/3	1200	48,56	56	55
1/2	1200	56	62	60
3/4	1200	56,143T	68	68
1	1200	184	65	62
1-1/2	1200	215	67	60
2	1200	215	68	65
3	1200	215	75	80
1/8	1800	48		
1/6	1800	48	49	58

1/4	1800	48,56	53	52
1/3	1800	48,56	56	55
1/2	1800	48,56	64	65
3/4	1800	56	63	64
1	1800	56,143T,182T	68	72
1-1/2	1800	56,145T,184T	70	64
2	1800	56,145T,182T	73	72
3	1800	184T	78	78
5	1800	184T,213T	74	76
7-1/2	1800	215T	77	85
10	1800	215T	84	90
1/3	3600	48,56	55	68
1/2	3600	48,56	57	71
3/4	3600	56	62	75
1	3600	56	63	69
1-1/2	3600	56,143T	68	77
2	3600	56,145T	71	75
3	3600	56,182T	76	88
5	3600	184T	76	88
7-1/2	3600	213T	81	82
10	3600	215T	83	86

3.4 PERFORMANCE SCHEDULE: SINGLE PHASE - TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/6	1200	48	41	48
1/4	1200	48,56	44	50
1/3	1200	48,56	57	56
1/2	1200	56	59	63
3/4	1200	56,143T	68	68
1	1200	184	67	67
1-1/2	1200	215	71	69
2	1200	215	82	84
3	1200	215	80	82
5	1200	256	82	
1/12	1800	42		
1/8	1800	42	47	55
1/6	1800	42,48	49	58
1/4	1800	48,56	53	52
1/3	1800	48,56	56	55
1/2	1800	48,56	63	67
3/4	1800	56	66	68
1	1800	56,143T	68	72
1-1/2	1800	56,145T	73	77
2	1800	182T	75	81
3	1800	184T	78	87
5	1800	213T	82	87
7-1/2	1800	215T	84	
10	1800	215T	84	

1/8	3600	42	45	62
1/6	3600	42	52	57
1/4	3600	42	53	60
1/3	3600	48,56	55	68
1/2	3600	48,56	57	71
3/4	3600	56	66	74
1	3600	56	66	81
1-1/2	3600	56,143T	70	82
2	3600	145T	74	78
3	3600	182T	76	87
5	3600	184T	84	96
7-1/2	3600	213T	82	89
10	3600	215T	86	98

3.5 PERFORMANCE SCHEDULE: SINGLE PHASE - EXPLOSION PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/3	1200	56	54	56
1/2	1200	56	59	63
3/4	1200	56	65	67
1	1200	184	67	68
1-1/2	1200	215	71	69
1/3	1800	56	56	58
1/2	1800	56	65	65
3/4	1800	56	66	68
1	1800	56,143T	66	67
1-1/2	1800	184	70	70
2	1800	182T	75	81
3	1800	215	79	77
5	1800	215	74	81
1/2	3600	56	55	69
3/4	3600	56	62	75
1	3600	56	66	81
1-1/2	3600	143T	70	82
2	3600	145T	74	82
3	3600	182T,184T	76	87

3.6 PERFORMANCE SCHEDULE: THREE PHASE - OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/2	900	56,143T	71	57
3/4	900	145T	74	56
1	900	182T	71	66
1-1/2	900	184T	74	67
2	900	213T	73	63
3	900	215T	76	60
5	900	254T	80	60

7-1/2	900	256T	85	62
1/4	1200	48,56		
1/3	1200	48,56	70	
1/2	1200	48,56	71	58
3/4	1200	56,143T	77	67
1	1200	56,145T	77	69
1-1/2	1200	56,145T,182T	78	77
2	1200	184T	78	72
3	1200	213T	79	72
5	1200	215T	83	76
7-1/2	1200	254T	85	78
10	1200	256T	86	78
15	1200	284T	87	82
20	1200	286T	87	81
25	1200	324T	88	84
1/4	1800	48		
1/3	1800	48,56	74	
1/2	1800	48,56	74	63
3/4	1800	48,56	74	60
1	1800	56,142T,143T	75	64
1-1/2	1800	56,145T	79	69
2	1800	56,145T	80	70
3	1800	56,145T,182T	81	77
5	1800	184T	84	82
7-1/2	1800	213T	86	76
10	1800	215T	87	78
15	1800	254T	87	77
20	1800	256T	89	86
25	1800	284T	89	83
1/3	3600	48,56		
1/2	3600	48,56	74	63
3/4	3600	48,56	75	73
1/3	3600	48,56		
1/2	3600	48,56	74	63
3/4	3600	48,56	75	73
1/2	3600	56	67	63
1	3600	56	75	64
1-1/2	3600	56,143T	78	82
2	3600	56,145T	80	86
3	3600	56,145T	81	84
5	3600	56,182T	81	88
7-1/2	3600	184T	84	85
10	3600	213T	87	89
15	3600	215T	87	91
20	3600	254T	89	86
25	3600	256T	89	87

3.7 PERFORMANCE SCHEDULE: THREE PHASE - TOTALLY ENCLOSED, FAN COOLED

	RPM	NEMA	Percent	Percent Power

HP	(Syn)	Frame	Efficiency	Factor
1/4	900	56		
1/3	900	56		
1/2	900	56,143T	68	48
3/4	900	145T	73	57
1	900	182T	68	64
1-1/2	900	184T	74	65
2	900	213T	75	66
3	900	215T	75	60
5	900	254T	80	60
7-1/2	900	256T	81	63
10	900	284T	88	67
15	900	286T	89	66
20	900	324T	90	68
25	900	326T	88	69
1/6	1200	48		
1/4	1200	48,56		
1/3	1200	56		
1/2	1200	56	71	58
3/4	1200	56,143T	76	68
1	1200	56,145T	77	67
1-1/2	1200	56,145T,182T	77	71
2	1200	184T	80	73
3	1200	213T	79	73
5	1200	215T	83	73
7-1/2	1200	254T	85	75
10	1200	256T	86	82
15	1200	284T	88	79
20	1200	286T	88	81
25	1200	324T	90	80
1/8	1800	42		
1/6	1800	42		
1/4	1800	48		
1/3	1800	48,56	72	
1/2	1800	48,56	74	63
3/4	1800	48,56	74	60
1	1800	56,143T	77	62
1-1/2	1800	56,145T	79	66
2	1800	56,145T	81	74
3	1800	182T	82	78
5	1800	184T	84	82
7-1/2	1800	213T	86	79
10	1800	215T	88	81
15	1800	254T	90	80
20	1800	256T	90	83
25	1800	284T	90	84
1/6	3600	42		
1/4	3600	42		
1/3	3600	48		
1/2	3600	48,56	67	63

3/4	3600	48,56	75	73
1	3600	56	75	76
1-1/2	3600	56,143T	74	80
2	3600	56,145T	76	89
3	3600	56,145T,182T	81	87
5	3600	84T	85	94
7-1/2	3600	184T,213T	86	85
10	3600	215T	87	92
15	3600	215T,254T	89	92
20	3600	254T,256T	87	89
25	3600	256T,284T	88	87

3.8 PERFORMANCE SCHEDULE: THREE PHASE - EXPLOSION PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/3	1200	56		
1/2	1200	56	71	58
3/4	1200	56,143T	72	70
1	1200	56,145T	77	69
1½	1200	56,145T,182T	78	77
2	1200	184T	84	68
3	1200	213T	80	75
5	1200	215T	82	
7½	1200	254T	84	
10	1200	256T	86	
15	1200	284T	87	
1/3	1800	56		
1/2	1800	56	74	60
3/4	1800	56	76	69
1	1800	56,143T	75	74
1½	1800	56,145T	78	80
2	1800	56,145T	80	80
3	1800	182T	82	75
5	1800	184T	85	80
7½	1800	213T	86	82
10	1800	215T	89	82
15	1800	254T	87	82
20	1800	256T	92	84
25	1800	284T	92	86
1/2	3600	56	68	77
3/4	3600	56	72	79
1	3600	56	74	79
1½	3600	143T	74	80
2	3600	145T	76	89
3	3600	145T,182T	81	87
5	3600	184T	84	94
7½	3600	184T,213T	84	90
10	3600	215T	87	92
15	3600	254T	86	85

20	3600	256T	87
25	3600	284T	85

3.9 PERFORMANCE SCHEDULE: THREE PHASE - TWO SPEED, ONE WINDING, OPEN, DRIP-PROOF, VARIABLE TORQUE.

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/0.25	1800/900	143T	80/86	75/49
1.5/0.37	1800/900	145T	77/61	81/58
2/0.5	1800/900	145T	77/60	85/67
3/0.75	1800/900	184T	81/71	83/60
5/1.2	1800/900	184T	81/61	84/63
7.5/1.9	1800/900	215T	83/75	82/65
10/2.5	1800/900	215T	83/76	87/66
15/3.7	1800/900	254T		
20/5	1800/900	256T		
25/6.3	1800/900	284T		

3.10 PERFORMANCE SCHEDULE: THREE PHASE - TWO SPEED, ONE WINDING, TOTALLY ENCLOSED, FAN COOLED, CONSTANT TORQUE

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/0.5	1800/900	143T	77/59	80/48
1.5/0.75	1800/900	143T	76/61	85/50
2/1	1800/900	184T	75/64	86/52
3/1.5	1800/900	184T	80/66	85/48
5/2.5	1800/900	215T	83/69	82/48
7.5/3.75	1800/900	256T		
10/5	1800/900	254T		
15/7.5	1800/900	256T		
20/10	1800/900	284T		
25/13	1800/900	286T		

3.11 PERFORMANCE SCHEDULE: THREE PHASE - TWO SPEED, TWO WINDING, OPEN, DRIP-PROOF, CONSTANT TORQUE

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/0.44	1800/900	145T	77/59	80/48
1.5/0.7	1800/900	182T	76/61	85/50
2/0.9	1800/900	182T	75/64	86/52
3/1.3	1800/900	184T	80/66	85/48
5/2.2	1800/900	215T	83/69	82/48
7.5/3.3	1800/900	256T		
10/4.4	1800/900	256T		
15/6.7	1800/900	284T		
20/8.9	1800/900	286T		
25/11	1800/900	286T		

3.12 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1	1200	145T	81	72
1-1/2	1200	182T	83	73
2	1200	184T	85	75
3	1200	213T	86	60
5	1200	215T	87	65
7-1/2	1200	254T	89	73
10	1200	256T	89	74
15	1200	284T	91	77
20	1200	286T	91	78
25	1200	324T	92	74
1	1800	143T	82.5	84
1-1/2	1800	145T	85	85
2	1800	145T	86	85
3	1800	182T	87.5	86
5	1800	184T	88	87
7-1/2	1800	213T	89.5	86
10	1800	215T	90	85
15	1800	256T	91	85
20	1800	256T	91.7	86
25	1800	284T	93	85
1-1/2	3600	143T	82	85
2	3600	145T	83	87
3	3600	145T	84	85
5	3600	182T	86	86
7-1/2	3600	184T	87	88
10	3600	213T	88	86
15	3600	215T	90	89
20	3600	254T	90	89
25	3600	256T	90	92

3.13 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1	1200	145T	81	72
1-1/2	1200	182T	84	65
2	1200	184T	86	68
3	1200	213T	87	63
5	1200	215T	88	66
7-1/2	1200	254T	90	68
10	1200	256T	90	75
15	1200	284T	91	72
20	1200	286T	91	76
25	1200	324T	91	71
1	1800	143T	83	84

1-1/2	1800	145T	85	85
2	1800	145T	85	85
3	1800	182T	88	83
5	1800	184T	89	83
7-1/2	1800	213T	90	85
10	1800	215T	91	84
15	1800	254T	92	86
20	1800	256T	93	85
25	1800	284T	93	84
1-1/2	3600	143T	83	85
2	3600	145T	84	87
3	3600	182T	85	87
5	3600	184T	87	88
7-1/2	3600	213T	88	86
10	3600	215T	89	86
15	3600	254T	90	91
20	3600	256T	90	89
25	3600	284T	90	92

END OF SECTION

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SECTION 220516

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Flexible pipe connections.
   2. Expansion joints and compensators
   3. Pipe loops, offsets, and swing joints.

B. Related Sections:
   1. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

1.2 REFERENCES

A. Conform to Standards of Expansion Joint Manufacturer's Association.

B. ANSI B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ANSI B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

1.3 DESIGN CRITERIA

A. Base expansion calculations on 50 degrees F installation temperature to 210 degrees F for hot water heating and 140 degrees F for domestic hot water, plus 30 percent safety factory.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Flexible pipe connector shop drawing data to include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

C. Expansion joint shop drawings to include maximum allowable temperature and pressure rating, and maximum expansion compensation and manufacturers installation instructions.

D. Shop drawings and/or manufacturers descriptive literature for anchors and guides to include method of attachment to pipes and structure and material thickness and dimensions.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTIONS - NEOPRENE

A. Manufacturers:

B. Mason Industries, Inc. Model MENEC, METNC.
   1. Garlock.
   2. Vibration Eliminator Co.

2.2 FLEXIBLE PIPE CONNECTIONS - METAL

A. Manufacturers:
   1. Mason Industries, Inc. Model BBS.
   2. Garlock.
   3. Vibration Eliminator Co.

B. Materials:
   1. For steel piping construct with stainless steel inner hose and braided exterior sleeve.
   2. For copper piping construct with bronze inner hose and braided exterior sleeve.
   3. Use connectors suitable for operating temperatures and pressures with 4:1 minimum safety factor.
   4. 2-inch size and smaller with nipple fittings.
   5. 2-1/2-inch size and larger with fixed flanges.

2.3 EXPANSION JOINTS - PACKLESS TYPE - STEEL 2-1/2-INCH AND SMALLER

A. Manufacturers:
   1. Flexonics Model H.
   2. Hyspan Model 8500
   3. Keflex.

B. Materials:
   1. Stainless Steel bellows type with anti-torque device, flanged or union ends, limit stops, and internal guide.

2.4 EXPANSION JOINTS - PACKLESS TYPE STEEL 3-INCH AND LARGER

A. Manufacturers:
   1. Flexonics Model CSF.
   2. Hyspan Model 3500.
   3. Keflex.

B. Materials:
   1. External ring controlled type with hydraulically formed stainless steel bellows, flanged ends, limit stops, internal sleeve, self-equalizing with reinforcing rings and single end unless noted.

2.5 EXPANSION JOINTS - PACKLESS TYPE - COPPER 2-INCH AND SMALLER

A. Manufacturers:
   1. Flexonics Model L.
   2. ITT Grinnell.

B. Materials:
   1. All bronze type with two-ply bronze bellows, anti-torque device limit stops, internal guides, solder joint end and low pressure compensators.

2. Suitable for minimum of 50 psi pressure, 250 degree F and maximum of 1/2-inch expansion.

2.6 EXPANSION JOINTS - PACKLESS TYPE - COPPER 2-1/2-INCH AND LARGER

A. Manufacturers:
1. Flexonics Model HB.
2. ITT Grinnell.

B. Materials:
1. All bronze type with two-ply bronze bellows, anti-torque device limit stops, internal guides and solder joint end.
2. Suitable for minimum 125 psi and 400 degrees F.

2.7 PIPE ALIGNMENT GUIDES AND ANCHORS

A. Manufacturers:
1. Hyspan Model 9500.
2. Flextronics.
3. ITT Grinnell.

B. Construction:
1. Steel spider fastened to pipe.
2. Steel sleeve secured to structure.
3. Factory fabricated assembly.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine piping layout and notify Owner's Representative of additional anchors or expansion joints required to adequately protect system.

3.2 PROVISIONS FOR EXPANSION

A. Install piping to permit free expansion and contraction without damaging piping or construction.

B. Provide offsets, expansion loops, anchors, guides and supports to permit expansion, within stress limits of ANSI Code for Pressure Piping for temperature ranges specified.

C. Provide expansion joints where pipe loops or changes in direction of piping cannot be employed to absorb expansion and contraction.

D. Use line sized flexible pipe connections and expansion joints suitable to connect to adjoining piping as specified for pipe joints.

E. Where necessary provide pipe guides so that movement takes place along axis of pipe only.

F. Branch connections to terminal heat transfer units shall have strain on when cold, off when hot.

G. Loops, bends, offsets located as indicated.
   1. Corner radii five to six time pipe diameters.
   2. If additional required, because of job required relocation of piping and equipment, design as follows.
      a. Use spring type loop, U-bend or offset U-bend.
      b. Submit design details for approval before fabrication.
   3. Provide AGA approved gas piping system expansion loop per CPC

3.3 EXPANSION JOINTS

A. Install in accordance with manufacturers recommendations.

B. Provide anchors and alignment guides as indicated and as specified.

C. Align expansion joints with alignment guides and supports.

D. Exercise care in cutting pipe for final connection to expansion joint.
   1. Set slip-sleeve in proper position of traverse for cold condition.

E. Where expansion joints are in concealed locations, provide access doors of size to permit inspection, servicing and replacement, as approved.

3.4 ANCHORS AND GUIDES

A. For Piping inside buildings, pipe anchors shall be rigidly fastened to building structure.

B. For piping outside buildings, pipe anchors shall be concrete-encased in soil. Anchors shall not be fastened to building structure.

C. Provide anchor for controlling direction and extent of pipe expansion at locations indicated.
   1. Details of anchor design, manner of fastening to pipe and to building or to independent concrete block shall be per manufacturer's recommendations.
   2. Submit details of anchoring methods for approval before installation.

D. Alignment Guides:
   1. Provide pipe alignment guides to guide expanding pipe to move axially from anchor points to expansion joints, loops or bends.
   2. Locate where indicated and elsewhere if required.

3.5 FLEXIBLE CONNECTORS

A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.

B. Install flexible connectors at right angles to displacement.

C. Install one end immediately adjacent to isolated equipment and anchor other end.

D. Construct spool pieces to exact size for insertion of flexible connection.

END OF SECTION

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SECTION 220519

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section Includes
   1. Thermometers (Water Service and Domestic Water Heating Systems).
   2. Pressure Gauges (Water Service).
   3. Pressure Gauge Toppings (Water Service).
   4. Stem Type Thermometers and Supports.
   5. Test Plugs and Kits.

B. Related Sections
   1. Section 22 11 16 - Domestic Water Piping (for domestic thermometers and gauges inside the building).

1.2 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.3 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: For each type of gauge and fitting specified. Provide manufacturers data which indicates use, construction, operating range, total range, accuracy, and dimensions. Submit a gauge schedule showing manufacturer's figure number, scale range, location and accessories for each gauge.
   1. Provide a Gauge Application Table indicating each different use of gauges and the gauge range to be utilized, including minimum and maximum measurement valves.

C. Product Certificates: For each type of thermometer and gauge, signed by product manufacturer.

1.4 QUALITY ASSURANCE

A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.5 EXTRA MATERIALS

A. Test plugs and kits.

PART 2 PRODUCTS

2.1 DIGITAL THERMOMETERS (DOMESTIC WATER)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. H.O. Trerice Co.
   2. Weiss Instruments, Inc.
   3. Weksler Instruments Corp.

B. Basis of Design: Weiss Vari-angle Digital Thermometer Model #DVU35 with the following:
   1. Accuracy 1 percent of reading or 1 degree, whichever is greater.
   2. Range: -40 to +300 degree F.
   3. Case Hi-Impace ABS.
   4. Display 3/8 inch LCD digits, wide ambient formula.
   5. Resolution 1/10 degree between -19.9 to +199.9 degrees Fahrenheit.
   6. Recalibration internal potentiometer.
   7. Lux rating 10 lux (one-foot candles)
   8. Update every 10 seconds.
   9. Ambient temperature error Zero.
   10. Humidity 100 percent
   11. Sensor glass passivated thermister.

C. Thermometer wells for above: Weiss Instruments, Inc.- Industrial Thermometer Wells (separable socket) as follows:
   1. Brass Construction for copper pipe; stainless steel for steel pipe.
   2. 3/4-inch NPT size.
   3. 3-1/2-inch stem size or 6-inch stem size.
   4. Standard or extension neck to suit installation.
   5. Schedule:

Model	Stem Size
E-35-75BS	3-1/2 inches
ER6-75BS	6 inches
EN6-75BS	6 inches insertion and 2-1/2 inches extension for insulation.

2.2 PRESSURE GAUGES (DOMESTIC WATER)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. H.O. Trerice Co.
   2. Weiss Instruments, Inc.
      Weksler Instruments, Inc.

B. Basis of Design: Weiss Model Solar Powered pressure gauge with the following:
   1. Case: 4-1/2-inches black steel glass reinforced thermo plastic (PBTP), solid front construction, blow out back safety design, weatherproof IP65.
   2. Sensor: Lux Capacitor.
   3. Wetted Materials: Phosphor Brass/Bronze.
   4. Connection: 1/4-inch NPT.
   5. Range: 0 to 400 psi.
   6. Accuracy: 0.5 percent full scale ASME B40.100

7. Ambient Operating: -15 to +150 degrees F.
8. Display: LCD.
9. Lux Rating: <10 (one foot candle).
10. Digits: (4) 5/8-inch high.
11. Update: One Second.

C. Pressure Gauge Accessories:
1. Pressure Snubbers: Weiss Mode PSN-B pressure snubber with the following:
a. 1/4-inch FNPT gauge connection and 1/4-inch MNPT process connection.
b. Corrosion resistant porous metal dampening element/disc.
c. Pressure rating @ 70 degree F is 15,000 psi.
d. Brass construction.

2.3 TEST PLUGS AND KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. H.O. Trerice Co.
2. Texas Fairfax Company
3. Sisco Co., Spedco, Inc.

B. Test Plug Basis of Design: Texas Fairfax Company with the following:
1. 1/4-inch or 1/2-inch NPT brass fitting and cap for receiving 1/8-inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F (natural gas); neoprene core for temperatures up to 350 degrees F (domestic hot and cold); lag extension for pipe insulation.

C. Test Kit Basis of Design: Texas Fairfax Company with the following:
1. Internally padded and fitted carrying case; two (2) 3-1/2-inch diameter pressure gauges-scale range: 0 to 100-psi; two gauge adapters with 1/8-inch type 316 stainless steel probes; two (2) 1-inch dial thermometers with 5-inch stem and external calibration-scale range: 25 to 125 degrees F; two (2) 1-inch dial thermometers with 5-inch stem and external calibration- scale range: 0 to 220 degrees F.

PART 3 EXECUTION

3.1 GENERAL

A. Install in complete conformance with the manufacturer’s instruction.

B. Provide instruments with scale ranges selected according to service with largest appropriate scale.

C. Install pressure gauges and thermometers in locations where they are easily read from normal operating level without crawling or climbing. Install vertical to 45 degrees off vertical.

D. Adjust gauges and thermostats to final angle, clean windows and lenses and calibrate to zero.

3.2 THERMOMETERS

A. Provide thermometers where indicated on the plumbing plans, piping diagrams, and details. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller

than 2-1/2 inches for installation of thermometer sockets 24 inches on each side of the thermometer. Ensure sockets allow clearance from insulation.

3.3 GAUGES

A. Provide pressure gauges where indicated on the plumbing plans, piping diagrams, and details.

B. Install pressure gauges with snubbers. Provide ball valve to isolate each gauge. Extend nipples to allow clearance from insulation.

3.4 TEST PLUGS AND KITS

A. Provide temperature and pressure test plugs where indicated on the plumbing plans, piping diagrams, and details.

B. Turn over test kit to OWNER at project closeout.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Gate valves.
2. Globe valves.
3. Ball valves.
4. Butterfly Valves.
5. Angle Valves.
6. Swing Check Valves.
7. Spring Loaded Check Valves.
8. Trap Primer valves.
9. Drain valves.
10. Water pressure reducing valves.
11. Non-Lubricated Plug Valves.
12. Lubricated Plug Valves.
13. Self-Contained Automatic Valves.
14. Valve Operators.
15. Accessories

B. Related Sections
1. Section 03 30 00 - Cast-In-Place Concrete.
2. Section 22 05 00 - Common Work Results for Plumbing.
3. Section 22 05 10 - Basic Piping Installation Requirements.
4. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
5. Section 22 11 16 - Domestic Water Piping.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
1. Domestic Water Piping, Below Ground: 160 psig.
2. Domestic Water Piping, Above Ground: 125 psig.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 and 01 33 23.

B. Product Data for each valve type include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application. Include pressure drop curve or chart for each type and size of valve.

C. Maintenance Data for valves to include in the operating and maintenance manuals as specified in Division 1 for the following:
   1. Trap primers.
   2. Strainers.
   3. Hot water return balancing valve assemblies.
   4. Water pressure reducing valves.
   5. Temperature and Pressure Relief valves.
   6. Gas Pressure Regulators.

D. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing. Submit spare parts list for each type of valve. Include this data in Maintenance Manual.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1.

B. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials and installation.

C. ASSE Compliance: Comply with ASSE Standards for mixing valve applications.

D. MSS Compliance: Comply with the various MSS Standard Practice documents as follows:
   1. MSS SP-67 - Butterfly valves
   2. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
   3. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
   4. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends.
   5. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
   6. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   7. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

E. ANSI Compliance:
   1. ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
   3. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.
   4. ANSI Z21.41 - Quick Disconnect Devices for Use with Gas Fuel Appliances.

F. ASTM Compliance:
   1. ASTM A276 - Stainless Steel Bars and Shapes.
   2. ASTM A351 - Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
   3. ASTM B61 - Steam or Valve Bronze Castings.
   4. ASTM B62 - Composition Bronze or Ounce Metal Castings.
   5. ASTM B98 - Copper-Silicon Alloy Rod, Bar, and Shapes.
   6. ASTM B127 - Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
   7. ASTM B139 - Phosphor Bronze Rod, Bar, and Shapes.
   8. ASTM B164 - Nickel-Copper Alloy Rod, Bar, and Wire.
   9. ASTM B194 - Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
   10. ASTM B584 - Copper Alloy Sand Castings for General Applications.
   11. ASTM D429 - Rubber Property - Test for Adhesion to Rigid Substrates.

12. ASTM D1784 - Rigid PolyVinyl Chloride (PVC) Compounds and Chlorinated PolyVinyl Chloride (CPVC) Compounds.

G. AWWA Compliance:
   1. AWWA C502 - Dry Barrel Fire Hydrants.
   2. AWWA C504 - Rubber Seated Butterfly Valves.
   3. AWWA C506- Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
   4. AWWA C509 - Resilient Seated Gate Valves for Water and Supply Service.
   5. AWWA C800 - Underground Service Line Valves and Fittings.

H. Valves: Manufacturer's name and pressure rating marked on valve body.

I. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state regulations.

J. Welders Certification: In accordance with ASME SEC IX.

K. NSF Compliance:
   1. Comply with NSF/ANSI 61, Drinking Water System Components - Health Effects, for potable domestic water plumbing specialties.

L. Valve Identification: Comply with MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

M. Valve Types; Provide valve of 'same type' by 'same manufacturer.'

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set bail and plug valves open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Strainers:
      a. Furnish stainless steel screens of quantity of identical units not less than 10 percent of amount of each type and size installed.

2. Furnish gasket material of quantity of identical units not less than 10 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Gate Valves:
      a. Crane.
      b. Jenkins.
      c. Lunkenheimer.
   2. Globe Valves:
      a. Crane.
      b. Jenkins.
      c. Lunkenheimer.
   3. Ball Valves:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   4. Butterfly Valves:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   5. Angle Valves:
      a. Crane.
      b. Jenkins.
      c. Lunkenheimer.
   6. Check Valves:
      a. Kitz Corporation of America.
      b. NIBCO Inc.
      c. Stockham Valves & Fittings, Inc.
      d. Walworth.
   7. Strainers:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   8. Hot water return balancing valve assemblies:
      a. Griswold “Isolator Y”.
      b. No other balancing valves acceptable.
   9. Trap Seal Primer Valves:
      a. Sloan Valve Co.
      b. Precision Plumbing Products.
   10. Drain valves:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   11. Water pressure reducing valves:
      a. Conbraco Industries, Inc-: Apollo Division.

b. Watts Industries, Inc., Water Products Div.
c. Flomatic, Danfoss Flomatic Corporation.

12. Temperature and Pressure Relief Valves:
    a. Watts.
    b. Wilkens.
    c. Bell and Gossett.
13. Plug Valves (Non-Lubricated):
    a. Kitz Corporation of America.
    b. Canbraco Industries Inc: Apollo Division
    c. NIBCO Inc.

2.2 VALVES - BASIC, COMMON FEATURES

A. General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, the Contractor shall confirm selection of the valve with the OWNER Representatve. Valves shall be of same make for all these services.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators (If Applicable): Use specified operators and handwheels, except provide the following special operator features:
    1. Handwheels: For valves other than quarter turn.
    2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
    3. Chain-wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation. Furnish and install chain-wheel operators on valves located more than 3 feet above accessible ceiling or access doors with the chain extended to within 6 inches of the ceiling.
    4. Gear-Drive Operators: For quarter-turn valves 8 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. Threads: ASME B16.4 for cast iron and ASME B16.15 for bronze valves

H. Flanges: ASME B16.24 for bronze valves.

I. Solder Joint: ANSI/ASME B16.18.
    1. Caution: Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.

2.3 GATE VALVES

A. Up to and including 2-inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge threaded ends.

B. Over 2-inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.

2.4 GLOBE VALVES

A. Up to and including 2-inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, renewable composition disc, screwed ends, with back seating capacity repackable under pressure.

B. Over 2-inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.5 BALL VALVES

A. Ball Valves, 2-inches and Smaller: MSS SP-110 compliant; ANSI B1.20.1 (threaded end) and ANSI B16.18 (soldered end); Class 150 SWP and 600 psi non-shock CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; true adjustable packing; soldered end or threaded connection. (Note: Standard and reduced port and hollow ball design not acceptable). Ball shall be vented to allow relief of any trapped media between body and ball. 1/4-inch through 2-inch valve shall be CSA approved for gas service of 1/2 psi at the appliance, and 5 psi from appliance to the meter.
   1. Operator: Vinyl-covered steel lever handle.
   2. Operator: Lever operators with lock.
   3. Stem Extension: For valves installed in insulated piping provide 2 inches extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation
   4. Memory/Balancing Stop: For operator handles.

B. Ball Valves, 2-1/2 inches through 4 inches: MSS SP-110; ANSI B1.20.1; Class 150 SWP and 600 psi non-shock CWP, ASTM B 283 bronze body and bonnet, 3-piece or 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; adjustable packing; soldered end or threaded connection. (Note: Standard and reduced port and hollow ball design not acceptable).
   1. Operator: Vinyl-covered steel lever handle.
   2. Operator: Lever operators with lock.
   3. Stem Extension: For valves installed in insulated piping provide 2 inch extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation
   4. Memory/Balancing Stop: For operator handles.

2.6 BUTTERFLY VALVES

A. Butterfly Valves: 4 inches thru 12 inches: MSS SP-67 and API 609, 200 psi CWP,150 psi maximum pressure differential (except 14 inches through 24 inches which shall be rated at 150 psi), ASTM A536.84 ductile-iron body and bonnet, extended neck, stainless-steel stem, molded-in or bonded-in EPDM or Buna N seat, EPDM or Buna N stem seals, wafer, lug, or grooved style; valve shall be bi-directional and suitable for dead-end service in either

direction at the full working pressure of the valve with the downstream flange removed for up to 96 hours.

1. Disc Type: Nickel-plated ductile iron.
2. Disc Type: Aluminum bronze.
3. Disc Type: Elastomer-coated ductile iron.
4. Disc Type: Epoxy-coated ductile iron.
5. Operator for Sizes 2 inches to 6 inches: Standard lever handle with memory stop.

2.7 ANGLE VALVES

A. Up to and including 2-Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, renewable composition disc, screwed ends, with back seating capacity repackable under pressure.

B. Over 2-Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.8 CHECK VALVES (SWING)

A. Swing Check Valves, 3 inches and Smaller: MSS SP-80; Class 125, 200psi CWP and Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B62 cast-bronze body and cap, rotating bronze disc with integral seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 inches and Larger: MSS SP-71, Class 125, 200psi CWP, ASTM A126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

2.9 STRAINERS (Y-TYPE)

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64 inch round perforations, unless otherwise indicated.
   1. Pressure Rating: 125 psig minimum steam working pressure, unless otherwise indicated.
   2. 2 inches and Smaller: Bronze body, with female threaded ends.
   3. 2-1/2 inches and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
   4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
      a. Drain: Factory installed, hose-end drain valve.
   5. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.

2.10 TRAP PRIMER VALVES

A. Trap priming of floor drains and floor sinks shall be accomplished in one of the following methods (Comply with plumbing drawings and piping diagrams for type for trap primer specified or depicted):
   1. Trap primer elbow (for concealed flush valves).
   2. Vacuum breaker trap primer.
   3. Automatic trap primer (TP-1).
   4. Sink trap primer.

B. Trap Primer Elbow: Sloan Model VBF-21-A1 or A2 which includes cast brass 1-1/2 inch slip joint elbow; water deflector to control the amount of water diverted from the flush; compression elbow for 3/8 inch tubing to floor drain and two slip joint coupling nuts with gaskets.

C. Vacuum Breaker Trap Primer: Sloan Model VBF-272-A which includes one-piece, chrome plated flush connection; water deflector to control the amount of water diverted from the flush; 3/8 inch elbow and flex-bend tube connection from vacuum breaker to wall; diverter wall flange and fittings; chrome plated wall flange and fitting to connect 1/2 inch NPT pipe. Model VBF-A1 also includes high back pressure vacuum breaker and one-piece bottom hex coupling nut.

D. Automatic Trap Primer Valve (TP-1): ASSE 1018, water-supply-fed type, with the following characteristics
   1. Trap primer shall be pressure drop activated and be of all brass construction including a brass body with 1/2 inch male NPT inlet and 1/2 inch NPT discharge. Internal components shall consist of a stainless steel debris screen, brass piston and brass discharge jet. Lubricated O-rings shall be EPDM and seal O-rings shall be nitrile. Trap primers shall be installed on domestic cold water pipe of 1-1/2 inch diameter or less and shall be located where they will be subject to frequent pressure drops of at least 10 psi. Working pressure shall be 35 to 75 psi. Provide distribution units as required for more than one drain. Trap primers shall be UPC certified and IAMPO listed.
   2. Trap Primer Distribution Units shall be Precision Plumbing Products Model DU-2, DU-3, or DU-4. Distribution units shall consist of a 2 inch diameter copper body with 3/8 inch female NPT brass discharge fittings and 1/2 inch male NPT composite top with nitrile O-ring.
   3. Allow 1 foot of drop for every 20 feet of distance from primer to floor drain.
   4. Flush system prior to installing trap primers.
   5. Cycle primers 6 times to assure proper operation.

E. Sink Outlet: Zurn Model Z1021 to be used in conjunction with 1-1/4 inch sink outlet.
   1. Trap primer, chrome plated polished cast brass body with cleanout, ground joint elbow with 1-1/2 inch NPT outlet, 1-1/2 inch slip nuts and washers, and reducing washer for 1-1/4 inch sink tail piece hookup, escutcheon and rigid polished chrome primer line with 1/2 inch compression fittings.

2.11 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110 compliant; ANSI B1.20.1 (threaded end) and ANSI B16.18 (soldered end); Class 150 SWP and 600 psi non-shock CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; adjustable packing; threaded or soldered end connection. (Note: Standard and reduced port and hollow ball design not acceptable).
   1. Operator: Vinyl-covered steel fever handle.
   2. Operator: Lever operators with lock.
   3. Stem Extension: For valves installed in insulated piping provide 2 inches extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation
   4. Memory/Balancing Stop: For operator handles.
   5. Inlet: Threaded or solder joint.

6. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.
7. Cap: Die cast brass.
8. Chain: Brass.

2.12 WATER PRESSURE REDUCING VALVES

A. General: The valve shall be approved or listed under ASSE 1003, CSA B356; Proposition 65 Compliant and IAMPO standards. The manufacturing facility shall be ISO 9001 registered. Water regulators, rated for initial working pressure of 150 psig (1035 kPa) minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.
   1. 2 inches and Smaller: Bronze body with threaded ends.
      a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
      b. Booster Heater Water Supply: Single-seated, direct operated with integral bypass.
   2. 2-1/2 inches and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA-approved, interior epoxy coating for regulators with cast-iron body.
      a. Type: Single-seated, direct operated.
      b. Type: Pilot-operated, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.
   3. Interior Components: Corrosion-resistant materials.
   4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.

B. Low Flow Rates: Direct acting, spring loaded pressure reducing valve.

C. Higher Flow Rates: Pilot-operated, diaphragm-actuated pressure reducing valve.

2.13 PLUG VALVES (NON-LUBRICATED)

A. 2½-inches and larger:
   1. MSS SP-78, 150 psi, cast iron body and plug, non-lubricated, Teflon packing, flanged ends. Provide lever operator or wrench.\

B. Use ball valves 2 inches and smaller, comply with Article 2.3.

C. Use non-lubricated plugs only when shut off valves are also provided.

D. For below grade polyethylene piping, use thermoplastic plug valves molded from polyethylene resin which conforms to ASTM D1248, Type II, Class B with antioxidants, Category 5, grade P23. Valves shall be plain-end for heat-fusion joining in the pipeline. Valves shall have elastomer seats, plug seals, and ground water seal. Plug shall be retained in body by a plug retainer Valves shall have 2 inch square nut operators.

2.14 PLUG VALVES (LUBRICATED)

A. Up to and including 2 inches: Semi-steel, tapered plug, screwed gald type, threaded body.

B. 2-1/2 inches through 4 inches: Semi-steel, 2-bolt cover, tapered plug, flanged body.

C. 6 inches and Over: Semie-steel, bolted gland type, tapered plug, flanged body.

D. Operator:
   1. Lever operator with memory stop smaller than 6 inches.
   2. Gear operator 6 inches and larger.

2.15 SELF-CONTAINED AUTOMATIC VALVES

A. Combination air release valve: combining operating features of both air and vacuum valve and air release valve.
   1. Air and vacuum portion: automatically exhaust large quantities of air during filling of system and allow air to re-enter during drainage or when vacuum occurs.
   2. Air release portion: automatically exhaust small amounts of entrained air that may accumulate in system.
   3. Designed for 150 psi working pressure.
   4. Cast iron, ductile iron, or semi-steel bodies and covers with stainless steel float and trim.
   5. Suitable for water service.
   6. Single body.
   7. Suitable for highly chlorinated water.
   8. Epoxy line.
   9. Manufacturers.
      a. APCO.
      b. Val-Matic.
      c. Crispin.

2.16 VALVE OPERATORS

A. General
   1. Valve operator types describe only general characteristics of operators.
   2. Provide operators compatible with valve with which it will be used and of same manufacturer, or product that is recommended by valve manufacturer.
   3. Size operator to operate valve for full range of pressures and velocities specified.
   4. Valve operators shall open by turning counterclockwise.

B. Manual Operators
   1. General
      a. Provide manual handwheel operators unless otherwise shown or specified.
      b. Galvanize and paint ferrous handwheels same color as valve and associated pipeline.
      c. When maximum force required to operate valve under full operating head exceeds 40 pounds, provide gear reduction operators.
      d. Gear operators totally enclosed and lubricated.
      e. Quarter-turn valve operators: self-locking type to prevent disc or plug from creeping and provide with position indicators to show position of valve disc or plug.
      f. Worm and gear type operators: self-locking worm-gears, one-piece design, of gear bronze material, accurately machine cut. Worm hardened alloy steel, with thread ground and polished.
      g. Geared traveling nut type operators: threaded steel reach rods with internally threaded bronze or ductile iron nut.
      h. Provide safety isolation valves and lockout valves with handles, handwheels, or chain wheels painted “safety yellow.” Equip handles to take padlock and wheels, chain and padlock. Isolation valves are valves that shut off source of stored energy (such as compressed air or water pressure) and that, if opened, could endanger safety or life.
   2. Exposed Operators

a. Furnish with geared operators, extension stems, floor stands, and other elements to permit operation from normal operating level.
b. Lever type operators: means of being fixed in any given position to prevent accidental movement; rugged, noncorrosive construction; fully compatible with valve.

3. Buried Operators
   a. Provide buried service operators on valves larger than 2½ inches with 2 inch AWWA operating nut.
   b. Provide buried operators on valves two inches and smaller with cross handle for operation by forked key.
   c. All moving parts of valve and operators enclosed in housing to prevent contact with soil.
   d. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at FULLY OPEN or FULLY CLOSED positions without damage to valve or operator and grease pack and gasket to withstand submersion in water to 10 psi.
   e. Install valves with extension stems, as required, and valve boxes.

2.17 ACCESSORIES

A. Valve Operator Tags
1. Provide valve operator with 1-1/2 inch minimum diameter heavy brass or stainless steel tag.
2. Tag shall bear valve number.
3. Attach tags to operator with key rings so that ring and tag cannot be removed.
4. Numbers and letters block type, 1/4 inch high.

B. T-Handled Operating Wrenches: Provide two galvanized operating wrenches, four feet long. Provide two galvanized operating keys for cross handled valves.
1. Manufacturers:
   a. Mueller.
   b. Clow Corp.
   c. Others.

C. Valve Boxes
1. Provide Buffalo two-piece sliding type, cast iron, with five 1/4 inch shaft valve boxes of appropriate length for installation. Cast word WATER, or SEWAGE into top of lid, as appropriate for service.
   a. If required, provide extension pieces of manufacturer’s standard type.
2. Covers: bolt-down type with Type 304 stainless steel removable screws conforming to Section 05 05 23 - Tamper Proof Metal Fasteners.
3. Complete with all necessary bases and accessories.
4. Manufacturers
   a. Mueller.
   b. Clow Corp.
   c. Kennedy Valve.

D. Extension Stems for Valve Operators
1. Where depth of valve is such that centerline is more than three feet below grade, provide operating extension stems to bring operating nut six inches below surface of ground and/or box cover.

2. Construct extension stems of steel, complete with two inch square operating nut.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 APPLICATION

A. Provide unions on both sides of all valves except valves that have flanged connections. Provide unions at piping connections to all equipment or apparatus unless equipment or apparatus have flanged connections.

B. Provide brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Provide ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers. Note: Ball valves shall be limited to pipe sizes 4 inches and smaller.

D. Provide ball or butterfly valves for throttling, bypass, or manual flow control services.

E. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment, for pressure reducing valves as indicated on Drawings.

F. Provide spring loaded check valves on discharge of water pumps.

G. Provide listed has shutoff valves in natural vas systems for shut-off service.

H. Provide hot water return balancing valves in domestic hot water recirculating systems where indicated on the Plumbing Drawings and Piping Diagram.

I. Provide butterfly valve for main domestic water shutoff.

J. Provide isolation shutoff valves and unions at inlet and outlet sides of all water pressure reducing valves, water/gas solenoid valves and gas pressure regulators.

3.3 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/4 inch/foot, 2 percent, minimum unless indicated otherwise on Drawings. Maintain gradients.

B. Install piping so that entire system is drainable. Provide drain valves with hose connections at low points.

C. Connect branch piping to top of mains.

3.4 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:
   1. Swing Check Valves: Horizontal position with hinge pin level.

3.5 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open ball valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

H. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
   1. Use soft solders having a maximum melting point of 570 degrees F (299 degrees C).
   2. E.G.: 95-5 tin-antimony = 460 degrees F (238 degrees C); 96-4 tin-silver = 430 degrees F (221 degrees C).

I. Do not use hard solder with a melting point of 840 degrees F (449 degrees C) or higher, because resultant crack on a valve surface may cause fluid leakage.

J. Prepare copper tubes conforming to ASTM B88, Seamless Copper Water Tubes.

K. The maximum service pressure and temperature of solder jointed valves are limited by the properties of solder and tube materials. Information on typical solder materials are provided below:

	Max.	Maximum Working Pressure					
	Temp.	Size 1/4~1-inch		Size 1¼~2-inch		Size 2½~3-inch	
Solders	Degree F	MPa	psi	MPa	psi	MPa	psi
95-5 TA	100	3.45	500	2.76	400	2.07	300
(H95 Sb-5A)	150	2.76	400	2.41	350	1.90	275
96-4TA	200	2.07	300	1.72	250	1.38	200
(H96 Ag-3.5A)	250	1.38	200	1.12	175	1.03	150

3.6 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

E. Do not apply an excessive force when threading pipes into valve bores. It will cause seat deformation and operational difficulty. Adequate threading torques are given below:

Valve Size	1/4~1/2-inch	3/4-inch	1-inch	1¼-inches	1½-inches	2-inches	2½-inches	3~4-inches
Threading Torque (Nm)	20~29	39~49	49~59	59~69	69~78	78~88	108~118	127~137

3.7 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.8 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:
   1. Copper Tube Size, 2-1/2 inches and Smaller: Solder ends.
   2. Copper Pipe Sizes, 3 inches and Larger: Flanged end.

3.9 APPLICATION SCHEDULE

A. General Application: Use ball and butterfly valves for shutoff duty; and ball for throttling duty. Comply with the requirements of piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:
   1. Ball Valves: Class 150, 600 psi CWP, with stem extension,
   2. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
   3. Bronze Swing Check: Class 125, with rubber seat.

C. Non-Potable Water Systems: Use the following valve types:
   1. Ball Valves: Class 150, 600 psi CWP, with stem extension,
   2. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
   3. Bronze Swing Check: Class 125, with rubber seat.

3.10 PROTECTION AND CLEANING

A. Clean interior and exterior of valves prior to installation. Remove dirt and debris as work progresses.

B. Protect valves during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted valves at end of day and when work stops.

3.11 STARTUP SERVICES

A. Before operating systems, perform these steps:
   1. Remove all plugs used during testing of piping systems and plugs used for temporary sealing of piping and valves during installation.
   2. Open all valves.
   3. Remove and clean all debris from inside and outside of valves.
   4. Replace all strainer screens with new.

B. Check valves and verify proper settings, adjustments, and operation. Verify drain grates are secure to drain body using detention type screws.

3.12 ADJUSTING

A. Adjust valves and correct deficiencies discovered during startup services.

3.13 PLUMBING VALVE SCHEDULES

A. Provide valves as scheduled on the following “Data Sheets.” Each Data Sheet begins with a new page.

BALL VALVE DATA SHEET

Ball Valves: 2 inches and smaller (two-piece):

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	77-204 thru 208
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	77-204 thru 208
Nibco	S-585-70

Ball Valves: 2-1/2 inch (three piece and two piece):

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	82-209-01
Nibco	S-595Y
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Ball Valves - 3 inch (three piece and two piece)

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	82-240-01
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Ball Valves - 4 inch (three piece and two piece):

MANUFACTURER	SOLDER ENDS
Kitz	#68 (use threaded with C x MIP adapters)
Conbraco (Apollo)	82-24A-01
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Comply with Article 2.2 and 2.5 for valve description and accessories.

BUTTERFLY VALVE DATA SHEET

Butterfly Valves: 2 inches and larger.

The following are model numbers for wafer-type, with nickel-plated ductile-iron disc;

MANUFACTURER	LEVER	GEAR
Kitz	5112-E-L	5112-E-G
Conbraco (Apollo)	6X13X-01	6W13X-02
Nibco	WD-20103	WD-20105

The following are model numbers for lug-type, with nickel-plated ductile-iron disc:

MANUFACTURER	LEVER	GEAR
Kitz	6112-E-L	6112-E-G
Conbraco (Apollo)	6L13X-01	6L-13X-02
Nibco	LD-20103	LD-20105

The following are model numbers for wafer--type, with aluminum-bronze disc:

MANUFACTURER	LEVER	GEAR
Kitz	5122-E-L	5112-E-G
Conbraco (Apollo)	6W 14X-01	6VW14X-02
Nibco	WD-20003	WD-20005

The following are model numbers for lug-type, with aluminum-bronze disc:

MANUFACTURER	LEVER	GEAR
Kitz	6122-E-L	6122-E-L
Nibco	LD-2000-3	LD-2000-5
Conbraco	6L14X-01	6W14X-02

Comply with Article 2.6 for valve description and accessories.

SWING CHECK VALVE DATA SHEET

Swing Check Valves - 2 inch and Smaller--

MANUFACTURER	CLASS125 THREADED ENDS	CLASS 125 SOLDER ENDS	CLASS 150 THREADED ENDS	CLASS 150 SOLDER ENDS
Kitz	22	23	29	30
Crane	37	1342	137	
Nibco	T-413	S-413	T-433	

Swing Check Valves - 2-1/2 inch and Larger:

MANUFACTURER	CLASS 125	CLASS 175
Kitz	78	x
Crane	373	x
Nibco	F-918	x
Stockham	G-931	G-940

x means not available.

Comply with Article 2.8 for valve description and accessories.

DRAIN VALVE DATA SHEET

Drain Valves:

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Kitz	68C	69C
Conbraco (Apollo)	77-101 thru 109	77-204 thru 209
Nibco	T-585-70-HC	S-585-70-HC

Comply with Article 2.13 for valve description and accessories.

STRAINER DATA SHEET

Strainers: 2 inches and smaller.

MANUFACTURER	THREADED ENDS	SOLDERED ENDS
Kitz	#15	#16
Spirax Sarco	BT/TBT	
Mueller	351/352	

Strainers: 2-1/2 inches and 3 inches.

MANUFACTURER	THREADED ENDS	FLANGED ENDS
Kitz	#15 (2-1/2" & 3")	

Strainers: 2 inches through 12 inches.

MANUFACTURER	THREADED ENDS	FLANGED ENDS
Kitz	(see above)	#80

Comply with Article 2.10 for valve description and accessories.

END OF SECTION

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SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Pipe hangers and supports.
2. Vertical piping clamps.
3. Hanger-rod attachments.
4. Building attachments.
5. Pipe shields.

B. Related Sections
1. Section 22 05 00 - Common Work for Plumbing.
2. Section 22 05 48 - Vibration and Seismic controls for plumbing piping and equipment.

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP 90, Guidelines on Terminology for Pipe Hangers and Supports.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.
1. Shop drawings for each type of hanger and support, indicating dimensions weights, required clearances, and methods of component assembly.

B. Product Data
1. Product data for products and materials indicated.
2. Manufacturer's technical bulletins and installation/application instructions.
3. Material Safety Data Sheets (MSDS).
4. Manufacturer's data (catalog cuts and data sheets), for each manufactured component including hangers, attachments, inserts, thermal shields anchors and guides, auxiliary framing and wall seals. Provide a project specific hanger and support schedule indicating all devices, manufacture and model, where used. Cross reference to product data and specification paragraph. Data shall demonstrate that components comply with Specifications.

C. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual in accordance with requirements of Division 1.

D. Certificates
1. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.

E. Licensed Engineer's hanger and support installation report specified in the "Field Quality Control" Article.

F. Qualification Data
   1. For manufacturer as specified in the “Quality Assurance” Article.

1.4 DESIGN REQUIREMENTS

A. Where not fully called for in the Contract Documents, design of plumbing hangers and supports shall be the plumbing contractor’s responsibility. Design shall conform to accepted engineering practice using a safety factor of 2-1/2.

B. Vibration Isolation: Comply with the requirements of Section 22 05 48.

C. Seismic Restraints: Comply with the seismic design criteria outlined in Section 22 05 48.

1.5 QUALITY ASSURANCE

A. Manufacturer’s qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards
   1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports and anchors.
   2. Qualify welding processes and welding operators according to AWS D1.1.
      a. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
   3. Qualify welding processes and welding operators according to ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
   4. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
      a. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems
      b. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
   5. MSS Standard Compliance:
      a. Provide pipe hangers and supports of which materials design and manufacture comply with MSS SP-58. Select and apply pipe hangers and supports, complying with MSS SP-69.
      b. Fabricate and install pipe Local and supports, complying with MSS SP-89.
      c. Terminology used in this Section is defined in MSS SP-90.

1.6 COORDINATION

A. Coordinate resiliently supported Work with other trades to avoid rigid contact with the building. Inform other trades such as drywall, plastering, or electrical, to avoid any contact which would reduce the vibration isolation.

1.7 CONFLICTS AND DISCREPANCIES

A. Bring to the Owner's Representative's attention prior to installation any conflicts with other trades which will result in unavoidable contact to equipment, piping, etc., described herein, due to inadequate spaces, etc. Corrective work necessitated by conflicts after installation shall be at Contractor's expense.

B. Bring to the Owner's Representative's attention prior to installation any discrepancies between the Contract Documents and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective Work necessitated by discrepancies after installation shall be at Contractor's expense.

PART 2 PRODUCTS

2.1 GENERAL

A. Corrosion Resistance: Provide hot-dip galvanized steel, cadmium plating, or other approved corrosion resistant materials for exterior Work and for Work which will be subject to outdoor exposure during construction.

2.2 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
   1. Superstrut, Gold Gal V.
   2. B-Line Systems, lnc.
   3. Elcen Metal Products Co.
   4. Fee & Mason Mfg.Co.; Div. Figgie International ITT Grinnel Corp
   5. Hubbard Enterprises / HOLDRITE.
   6. Tolco.

2.3 MANUFACTURED HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide felt-lined hangers and supports for copper piping systems in direct contact with copper piping components including galvanized coatings where installed for piping and equipment that will not have a field applied finish. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper piping.

B. Thermal-Hanger Shield Inserts: 100 psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Shield Insert shall cover entire circumference of pipe and be of length indicated by manufacturer for pipe size and thickness of insulation by CSS Pre-Insulated Supports.

C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

D. Adjustable Steel Clevises Hangers: MSS Type 1.

E. Yoke Type Pipe Clamps: MSS Type 2.

F. Steel Double Bolt Pipe Clamps: MSS Type 3.

G. Steel Pipe Clamps: MSS Type 4.

H. Pipe Hangers: MSS Type 5.

I. Adjustable Swivel Pipe Rings: MSS Type 6.

J. Adjustable Steel Bond Hangers: MSS Type 7.

K. Adjustable Band Hangers: MSS Type 9.

L. Adjustable Swivel Rings, Band Type: MSS Type 10.

M. Split Pipe Pings: MSS Type 11.

N. Extension Split Pipe Clamps: MSS Type 12.

O. U-Bolts: MSS Type 24.

P. Clips: MSS Type 26.

Q. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   1. Plate: Unguided type.
   2. Plate: Guide type.
   3. Plate: Hold-down Clamp type.

R. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast-iron floor flange.

S. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

T. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.

U. Single Pipe Rolls: MSS Type 41.

V. Adjustable Roller Hangers: MSS Type 43.

W. Pipe Roll Stands: MSS Type 44.

X. Pipe Rolls and Plates: MSS Type 45.

Y. Adjustable Pipe Roll Stands: MSS Type 46.

Z. Makeshift, field devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42.

2.4 VERTICAL PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide felt-lined or copper-plated clams for copper-piping systems.

B. For vertical mid-span supports of piping 4 inch and under, use Hubbard Enterprises/HOLDRITE Stout Brackets with Hubbard Enterprises/HOLDRITE Stout Clamps or two-hole pipe clamps (MSS Type 26).

C. Two-Bolt Riser Clamps: MSS Type 8.

D. Four-Bolt Riser Clamps: MSS Type 42.

2.5 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.6 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods.

B. Concrete Inserts
   1. Cast-in-Place Concrete Inserts: MSS Type 18.
   2. Post-Installed Anchors: Proprietary type, designed for intended uses, and ICC ESR evaluated.
      a. Manufacturers
         1) ITW Ramset/Red Head.
         2) Simpson.
         3) Hilti Co.

C. Top Beam C-Clamp: MSS Type 19.

D. Side Beam or Channel Clamps: MSS Type 20.

E. Center Beam Clamps: MSS Type 21.

F. Welded Beam Attachments: MSS Type 22.

G. C-Clamps: MS Type 23.

H. Top Beam Clamps: MSS Type 25.

I. Side Beam Clamps: MSS Type 27.

J. Steel Beam Clamps with Eye Nut: MSS Type 28.

K. Linked Steel Clamps with Eye Nut: MSS Type 29.

L. Malleable Beam Clamps: MSS Type 30.

M. Steel Brackets: One of the following for indicated loading:
   1. Light Duty: MSS Type 31.
   2. Medium Duty: MSS Type 32.
   3. Heavy Duty: MSS Type 33.

N. Side Beam Brackets: MSS Type 34.

O. Plate Lugs: MSS Type 57.

P. Horizontal Travelers: MSS Type 58.

Q. Powder-Actuated Fasteners: Not allowed.

2.7 INSULATED PIPE SUPPORTS (PIPE SHIELDS)

A. All insulated lines shall be protected at the point of support by insulated pipe supports provided and installed by the pipe erector.

B. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes:
   1. ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

C. Manufacturers
   1. Pipe Shields Incorporated (PSI).
   2. Michigan.
   3. B-Line.

D. Insulated Pipe Supports
   1. Pipe supported on rod hangers.
   2. Pipe supported on Flat Surfaces.
   3. Pipe supported on pipe rolls.
   4. Pipe Guides.

5. Anchors Riser Pipe Supports.

E. Insulation
   1. 360-degree insulation, encased in 360-degree sheet metal shield.
   2. Provide assembly of same thickness as adjoining pipe insulation.
   3. Insulating Material:
      a. Cold Piping (below 50 degrees F): Urethane foam, 100 psi compressive strength.
      b. Hot piping (above 50 degrees F): Calcium silicate, 100 psi compressive strength, treated with water repellent.

2.8 MISCELLANEOUS MATERIALS

A. Auxiliary Steel
   1. Provide auxiliary structural steel as required for supports, anchors, guides, seismic restraints and vibration isolators.
   2. All structural steel systems to be designed in accordance with AISC Steel Handbook.
   3. All systems to be secured to building structure in a method acceptable to and approved by the Owner's Representative.
   4. Steel Work: Fabricate neatly. Grind off excess burrs and welding spatter. Paint with rust inhibitive primer.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A36.

C. Cement Grout: Portland cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No.2). Mix at a ratio of 1.0 part cement to 2.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

E. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
   1. Manufacturers
      a. Hyspan.
      b. Metraflex.
      c. Others.

F. Plenum Rated Pipe Clamps: ASTM E84 25/50 plastic clamps from Hubbard Enterprises/Holdrite.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive the Work. Notify the Owner's Representative, in writing, of any conditions requiring corrective action.

B. If unsatisfactory conditions exist, do not commence the installation until such conditions have been corrected. Beginning of installation means acceptance of existing conditions.

3.2 GENERAL

A. Install devices in accordance with manufacturer's recommendations and approved shop drawings.

B. Support of pipe tubing and equipment shall be accomplished through means of engineered products specific to each application. Makeshift field devised methods will not be allowed.

C. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.3 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated Work, Installer shall meet at Project site with Contractor, Installer of each component of associated Work, Inspection and testing agency representatives (if any), Installers of other Work requiring coordination with Work of this Section and the Owner's Representative for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.4 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69, or per schedules below, whichever is more severe. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.
   1. For plumbing piping, support spacing shall be per California Plumbing Code (CPC).
   2. For fire protection piping, support spacing shall be per code and NFPA 13.

B. Loading on Steel Beams
   1. Do not place eccentric loads on steel beams for loads greater than 50 pounds.
   2. For loads greater than 50 pounds, use attachments which create concentric loading.

3. Maximum load per insert in slabs shall be 200 pounds, with a minimum spacing of 5 feet in any direction. For loads greater than 200 pounds, or where spacing cannot be maintained, make attachment to building structure or auxiliary steel, rather than to slab.

C. Post-Installed Concrete Anchors: Maximum tension load per insert shall not exceed ICC ESR published values.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports of smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping. Install in accordance with Seismic Restraint manual Guidelines for Mechanical Systems (SMACNA).
   1. Materials, design and type numbers per MSS-58.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Support fire protection piping independently of other piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, felt-lined.

E. Provisions for Movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.1 Power Piping Codes are not exceeded.

H. Insulated Piping: Comply with the following installation requirements:
   1. Provide insulated pipe support (pipe shield) at each support of insulated piping.
   2. Select model of insulated pipe support according to published recommendations of insulated pipe support manufacturer, based on pipe size, pipe material, fluid medium, fluid temperature, support spacing, and type of support.
   3. Submit tabulation showing proposed uses of insulated pipe supports for different applications.

I. Provide pipe supports on all DWV vertical piping penetrating floor slabs.

J. All hanger components shall be Superstrut Gold Galv.

1. Vertical Piping: Superstrut C720 clamps attached to the pipe above each floor to rest on the floor. Provide copperplate on copper tubing. Provide additional support at base of cast iron risers. Provide intermediate support for vertical piping greater than 12 feet in length.
2. Individually Suspended Piping: Superstrut, J-Hanger or Clevis, complete with threaded rod. Copper pipe will be used in conjunction with felt lined hangers.

Pipe Size	Rod Size
2-inch and smaller	3/8 inch
2-1/2 to 3-1/2-inch	1/2 inch
4 to 5-inch	5/8 inch
6-inch	3/4 inch
8-inch and up	7/8 inch

3. Provide 3/8 inch or support of PVC and CPVC and provide continuous support.
4. Trapeze Suspension: Superstrut 1-5/8-inch width channel in accordance with manufacturers published load ratings. No deflection to exceed L/180 of a span.
5. Trapeze Supporting Rods: Shall have a safety factor of 5; securely anchor to building structure.
6. Pipe Straps: Superstrut 702 isolate copper pipe with two layers of 2-inch wide 10 mil polyvinyl tape (Cush-A-Strip or Cush-A-Clamps). Where used for seismic support systems, provide Superstrut 702 or C708 series pipe straps.

K. Concrete Inserts: Superstrut C302 continuous insert or 452-TB spot insert. Do not use actuated fasteners for support of overhead piping unless approved by the Owner's Representative.
1. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
2. Install concrete inserts in new construction prior to placing concrete. Superstrut 452-TB, C745, or C302.
3. Install post-installed concrete anchors after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

L. Steel Connectors: Beam clamps with retainers.
1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts washers, and other accessories

M. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

N. Support to Structure
1. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the Owner's Representative.

O. Rubber Neoprene Pipe Isolators

1. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls as indicated on the Drawings.
2. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. Superstrut S716 or A716.

P. Pipe Hangers and Support Spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and space at or within following maximum limits. Note that spacing listed are recommended maximums; increased spacing requirements due to California Building Code requirements, CCR Title 24, or other regulations in force and applicable for this contract shall be adhered to.

Pipe Diameter	Steel Fluid	Steel Vapor	Copper Fluid
1/2 to 1-inch	6	8	6
1-1/4 to 1-1/2-inch	8	10	6
Over 2-inch	10	10	10

Q. For cast iron soil piping.
1. Support piping at every other joint for piping length of less than 4 feet.
2. For piping longer than 4 feet, provide support on each side of the coupling, within 18 inches of each joint.
3. Hanger shall not be installed on the coupling.
4. Provide support at each horizontal branch connection.
5. Provide [Superstrut] Seismic Manual Stamped OPA-0003 using Seismic Restraint Manual tables.

R. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.

S. Provide rigid insulation and a 12-inch long, 18-gauge galvanized sheet metal shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering or CSS Pre-Insulated Calcium Silicate Support.

T. Insulate copper tubing from ferrous materials and hangers with felt lined hangers.

U. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.

V. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power actuated inserts will not be allowed.

3.6 ADJUSTING AND CLEANING

A. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.

B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

3.7 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint and exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA1 requirements for touching up field-painted surfaces.
   1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Section 09 90 00, Painting and Coding.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.8 INSPECTION AND INSTRUCTION

A. Obtain inspection and approval from the Owner's Representative of any installation to be covered or enclosed prior to such enclosure.

3.9 FIELD QUALITY CONTROL

A. Licensed Engineer's Report: Prepare hanger and support installation report. Include seal and signature of Registered Structural Engineer, licensed in the State of California, certifying compliance with Specifications.

END OF SECTION

SECTION 220548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Vibration Isolators.
2. Seismic restraints.
3. Flexible Connectors.

B. Related Sections
1. Section 22 05 00 - Common Work Results for Plumbing.
2. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

1.2 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves.

B. SMACNA “Guidelines for Seismic Restraints of Mechanical Systems”.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. Shop Drawings:
1. Concrete and steel details for equipment.
2. Welds or anchor bolt locations.
3. Reinforcing and template steels.
4. Number and locations of seismic restraints for each piece of equipment; specific details of restraints including anchor bolts for mountings and maximum load at each location.
5. Spring O.D., free operation, and solid height of springs and ratio of horizontal to vertical stiffness.
6. Number and location of vibration isolators for each piece of equipment including actual operating load for each vibration isolator.

C. Product Data
1. Product data for products and materials indicated.
2. Manufacturer’s technical bulletins and installation instructions.
3. Material Safety Data Sheets (MSDS).
4. Vibration isolation devices: Catalog cuts, isolation efficiencies and rated static deflections.

D. Manufacturer’s Installation Report as specified in the “Field Quality Control” Article.

1.4 DESIGN REQUIREMENTS

A. General

1. Provide seismic restraints for pipes and equipment, including pipes above roofs, supported from below in accordance with the requirements of the California Code of Regulations, Title 24, Parts 2, 3, 4, and 5.
2. Where designs are neither indicated nor referenced, submit such designs, together with supporting calculations.
3. Supplementary steel to be sized for maximum deflection of 0.08 inches at center span.

B. Seismic Restraint
1. Provide seismic restraints for pipes and equipment per CBC, CMC, and CPC, including pipes above roofs, supported from below.
2. Provide seismic restraint for pipe sizes covered by SMACNA:
   a. In equipment room.
   b. On roofs.
   c. In shafts and in ceiling of occupied spaces.
3. Design and provide restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift.
4. Provide approved resilient restraining devices as required to prevent equipment and piping motion in excess of 1/4 inch.
5. Provide capability of safely accepting external forces without failures.
6. Do not short circuit vibration isolation systems or transmit objectionable vibration or noise.
7. Seismic restraint spacing shall be in accordance with specified hanger spacing.
8. Rigidly Supported Piping
   a. Where required for all systems, except sprinkler piping system, restrain per SMACNA seismic standards.
9. Flexibly Supported Piping
   a. Provide and locate restraints to allow normal operation of systems without transmitting vibrations to building structure.
   b. Locations of Restraints: Per SMACNA and Factory Mutual where applicable.
   c. Construction of Restraint: Steel cables, installed slack, may be used.
10. Isolate piping outside of shafts as follows:
   a. Water piping 1-1/4 inch and larger in mechanical equipment rooms: Within 50 feet or 100 pipe diameters whichever is smaller, of connected rotating equipment and pressure reducing stations.
      1) Piping where exposed on roof.
11. Provide spring isolators on piping connected to isolated equipment as follows:
   a. Up to 4 inches in diameter, first 3 points of support.
   b. 1.5 to 8 inches in diameter, first 4 points of support.
   c. 10 inches and over in diameter, first 6 points of support.
   d. Static deflection of first point shall be twice deflection of isolated equipment.
12. Locate Isolators as follows:
   a. Close to building structure.
      1) Hanger boxes butted to ceiling structure.
   b. Between building structure and supplementary steel if required.

1.5 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

B. All items of a given type shall be the product of the same manufacturer.

C. Provide necessary design for avoidance of excessive noise and vibration in building due to operation of machinery or equipment, or due to interconnected piping or conduit.

D. Installation of all vibration isolation units, and associated hangers and bases, shall be under direct supervision of vibration isolation manufacturer's representative.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers
1. Mason Industries, Inc.
2. Vibration Mountings and Controls, Inc.
3. Vibration Eliminator Company.
4. Peabody Noise Control, Inc.

B. Manufactured Units.
1. Isolator Type "PN"; three layers of 1/4-inch neoprene waffle pad bounded between 16 gauge sheet metal shims or 3/4-inch thick neoprene waffle pad consisting of 2 inch square modules separated by thin web. Load distribution top plate utilized as required with additional 1/5 inch thick washer and bushing when pads are anchored to structure.
2. Isolator Type "NM": Double deflection neoprene mountings having a minimum static deflection of .35 inch. Metal surfaces neoprene covered to avoid corrosion. Friction pads top and bottom.
3. Isolator Type "NML": Neoprene mountings with integral seismic restraints and consisting of captive steel insert embedded in neoprene. Mountings may be used in tension and shear as well as compression. Neoprene pad may be bonded to base plate for additional deflection as required.
4. Isolator Type "MS": Spring type, free standing and laterally stable without any housing, complete with 1/4 inch neoprene acoustical friction pad or neoprene cup between base plate and support. Provide leveling height and solid spring height in submittals.
5. Isolator Type "MSL": Spring type mountings designed to resiliently resist seismic forces in all directions. Snubbing in all modes with adjustment to limit upward, downward and horizontal travel to a maximum of 1/4 inch before contacting snubbers. Provide spring with same characteristics as described in Type MS mountings. Provide mountings with leveling bolts that must be rigidly bolted to equipment, and with ports or openings to verify possible overload conditions. In submittals include spring diameter, deflections, compressed spring height and solid spring height.
6. Isolator Type "HN": Vibration hangers which contain minimum .35 inch static deflection neoprene element. Neoprene rod isolation bushing shall pass through hanger box lower hole to prevent metal to metal contact.
7. Isolator Type "HS": Vibration hangers which contain steel spring seated in 1/4 inch thick neoprene cup with integral rod isolation bushing. Bushing shall pass through lower hanger box hole to prevent metal-to-metal contact. Provide spring diameters and hanger box lower hole sizes large enough to permit hanger rod to swing through 30 degree arc. Provide minimum additional travel to solid equal to 50 percent of rated deflection.

2.2 SEISMIC RESTRAINTS

A. Manufacturers
   1. Midland-Ross Superstrut.
   2. Pipe Shields, Inc.
   3. B-Line.

B. Restraint Types
   1. Type R-1: Provide directional seismic restraints with interlocking steel members restrained by replaceable, minimum 1/4-inch thick bridge bearing neoprene bushing, capable of rotation after installation to verify isolation system is out of contact with restraints. Incorporate minimum air gap of 1/8 inch in snubber design in all directions before contact is made between rigid and resilient surfaces.
   2. Type R-2: Restraints of all isolated suspended piping, ductwork and equipment using steel cables arranged to achieve required all-directional restraint and sized to resist seismic loads. Indicate proposed method of achieving sufficient slack to avoid short circuiting vibration isolators in submittal drawing.

C. General Requirements
   1. Provide seismic restraints for all vibration isolated equipment, ductwork and piping.
   2. Restrain supported and suspended equipment and piping by devices capable of restraint in all three mutually orthogonal directions.
   3. For suspended equipment, utilize stranded steel aircraft cable plus modifications to isolators to prevent excessive vertical motion.
   4. Seismic restraints must be installed and adjusted so equipment and piping vibration isolation is not degraded by utilization of restraints.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers
   1. Mason Industries, Inc.
   2. Amber Booth.
   3. Others.

B. Neoprene Connectors
   1. Use flexible EPDM connectors on equipment as indicated on drawings or on equipment schedule, manufactured of multiple layers of frictioned nylon cord with EPDM cover and liner. Do not use steel wire or rings as internal pressure reinforcement. Provide straight connectors with two spheres with a centered molded external ductile iron ring to maintain two spherical shapes. Two inch and smaller sizes may have threaded ends. Provide floating flanges with recess to lock bead wire in raised face EPDM flanges. Use tapered twin sphere connectors as described above where line size changes are required in straight piping runs.
   2. Flanged equipment may be directly connected to neoprene elbows in size range 2-1/2 to 12 inches, if piping makes 90 degree turn and flanges are equal sized. Long radius reducing EPDM elbows may be used in place of steel or cast iron elbows at pump connections.
   3. When pressure would cause connector to extend beyond its rated elongation, employ control rods using 1-1/2-inch thick bridge-bearing neoprene washer bushings designed for maximum loading of 1000 psi.

4. Provide twin sphere connectors with minimum rating of 250 psi at 170 degree F and 165 psi at 250 degree F. Provide elbows and reducing twin spheres with minimum pressure rating of 220 psi at 170 degree F and 145 psi at 250 degree F. Limit neoprene materials to 220 degree F. Certified safety factors shall be a nominal 4 to 1 with minimum acceptable test results of 3.6 to 1. Tests shall cover burst, flange leakage, extension without control rods and flange retention at 50 percent of burst pressure without control rods.
5. Include in submittals test reports by independent consultants showing minimum reduction of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies.

C. Flexible Stainless Steel Hose
1. Provide flexible stainless steel hose with stainless steel braid and carbon steel fittings. Provide flanged fittings for sizes 3-inch and larger, and make nipples for smaller sizes. Use bronze braided flexible hose with female sweat ends for copper lines. Install hoses on equipment side of shut-off valves horizontally and parallel to equipment shafts whenever possible. Flexible metal hose shall be Type BSS or BFF.

PART 3 EXECUTION

3.1 GENERAL

A. Isolate plumbing equipment from building structure by means of noise and vibration isolators.

B. Install isolators in accordance with manufacturer's written instructions and approved shop drawings.

C. Vibration isolators must not cause change of position of equipment or piping resulting in piping stresses or misalignment.

D. Make no rigid connections between equipment and building structure that degrade noise and vibration isolation system.
1. Loop electrical conduit connections to isolated equipment to allow free motion.

E. Do not use isolator leveling bolts as jacking screws.

F. Verify that installed isolators and mounting systems permit equipment motion in all directions.

G. Install vibration isolators for motor driven equipment.

3.2 EQUIPMENT ISOLATION AND SEISMIC CONTROL

A. Position equipment and structural base on blocks or wedges at proper operating height. Set steel bases for 1-inch clearance between pad and base. Set concrete bases for 2-inch clearance.

B. Provide operating load conditions prior to transferring base isolator loads to springs and remove wedges.

C. Adjust or provide additional resilient restraints to flexibly limit startup equipment lateral motion to 1/4 inch.

D. Prior to startup, clean out all foreign matter between bases and equipment.

E. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

F. Position all corner or side seismic restraints with equipment operating for proper operating clearance.

3.3 FIELD QUALITY CONTROL

A. Provide inspection by manufacturer's representative of all vibration isolating devices after installation of all devices.

B. Submit written report by manufacturer regarding installation error, improper selection of devices, and other faults that could affect performance of system. Include report on steps to properly complete isolation work.

END OF SECTION

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SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Pipe Markers.
2. Valve Tags.
3. Equipment Nameplates.
4. Underground Marking Tape.
5. Chart and Diagram Frames.

B. Related Sections
1. Section 09 90 00 - Painting and Coating.
2. Section 10 14 00 - Signage.
3. Section 22 05 00 - Common Work Results for Plumbing.
4. Section 22 11 16 - Domestic Water Piping.
5. Section 22 13 16 - Sanitary Waste and Vent Piping.

1.2 REFERENCES

A. ASME A13.1- Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Indicate model, type, and application usage.

C. Submit list of wording, symbols, letter size**,** letter style, and color coding for each system and vault cover.

D. Submit valve numbering scheme**,** valve chart and schedule, including valve tag number, location, function type, and valve manufacturer's name and model number.

1.4 COORDINATION

A. Coordinate with Owner's Representative for preferred color schemes and service abbreviations and valve and equipment numbering schemes prior to submittal review.

B. Coordinate installation of identifying devices with completion of covering of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment. If not installed before ceiling is installed, the Contractor shall remove ceiling at no additional cost to the OWNER and install identifying devices.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Seton Name Plate Corp.

B. Brimar.

C. Brady.

2.2 PIPE MARKERS

A. Markers: ASME A13.1.
   1. Pressure sensitive vinyl (self sticking) material.
   2. Mechanically fastened type: Snap on or strap on.
      a. For dirty, greasy, or oily pipe where pressure sensitive markers may not perform satisfactorily.
   3. All weather film for outdoor exposed piping.
   4. Provide 360 degree and pipe flow arrows and fluid being conveyed.
   5. Size of letters legend:

OUTSIDE DIAMETER OF PIPE OR PIPE COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS AND ARROWS
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inches	24 inch	2-1/2 inch
Over 10 inches	32 inch	3-1/2 inch

2.3 VALVE TAGS

A. Tags: Brass or anodized aluminum type.
   1. Brass: Minimum 19 gauge, polished, 2-inch diameter with following lettering:
      a. Service: 1/4-inch stamped black filled letters.
      b. Valve numbers: 3/8-inch stamped black filled letters.
   2. Aluminum: 2 inch diameter, 0.032 inch thick, with following lettering:
      a. Service: 1/4-inch engraved letters.
      b. Valve numbers: 3/8-inch engraved letters.

B. Fasteners: 4 ply 0.018 copper or monel wire meter seals, brass “S” hooks or No. 16 brass jack chain.

2.4 EQUIPMENT NAME PLATES

A. 1/8-inch rigid plastic or bakelite with 4 edges beveled, with black background and white border and letters.
   1. Two 3/8-inch mounting holes.
   2. Minimum 1/2-inch high lettering.
   3. Commercial quality, rust resisting nuts and bolts with backwashers, self tapping screws or rivets.

2.5 UNDERGROUND MARKING TAPE

A. General: Provide underground pipe marking tape on all pipes buried beneath the ground. Provide a continuous length of tape 12 inches below the finished earth surface directly above the buried pipe. Provide a second continuous length of tape 12 inches above the top of the buried pipe if the top of the pipe is lower than 36 inches from the top of the finished earth surface.

B. Tape: 5 mil inert plastic film for underground use.

C. Resistant to alkalis, acids and other destructive agents found in soil; information in Civil Engineers Soils Report.

D. Minimum tensile strength: 120 pounds per 6 inch width.

E. Minimum elongation: 500 percent.

F. Provide detectable underground tape above all buried pipes on the Project. Provide a continuous printed message repeated every 16 to 36 inches warning of pipe buried below similar to (i.e., “CAUTION STEAM LINE BURIED BELOW”).

G. Color code:
   1. Blue: Water systems, domestic and fire.
   2. Green: Sanitary and storm sewer system.

H. Provide tape widths of 2, 3, 6, 9, and 12-inches for lines buried 10, 20, 30, 40, and 50 inches or greater, respectively.

2.6 CHART AND DIAGRAM FRAMES

A. Chart and diagram frames: Extruded aluminum with plexiglass or glass windows.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. All items indicated on equipment schedules and plumbing fixtures.
   2. Designation shall match that indicated.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location, directly on item of equipment or apparatus such as starters and pumps.

E. For unsuitable surfaces, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish four charts.
   1. Mount 1 chart in frame and secure on wall in location directed by Owner's Representative.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals".
   3. Show valve tag numbers on project as-built drawings.

G. Provide safety sign for each piece of exposed mechanical equipment that may start automatically. Comply with the requirements of Section 10 14 00.

3.3 PIPE IDENTIFICATION

A. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take off.
   3. At each passage through walls, floors and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.4 SERVICE ABBREVIATIONS

A. Coordinate with Owner's Representative for preferred color schemes and service abbreviations as indicated below:

CD	Cooling Coil Condensate Drain Piping (Gravity)
PCD	Pumped Cooling Coil Condensate Drain Piping
CW	Domestic Cold Water
F	Fire Protection Water Service

HW (x-degrees F)	Domestic Hot Water Supply (indicate temperature)
HWC (x-degrees F)	Domestic Hot Water Circulating (indicate temperature)
NPW	Non-Potable Water
OD	Overflow Drain
SD	Storm Drain
SS	Sanitary Sewer (in mechanical chases and exposed to view)
SP	Sprinkler System
V	Vent (in mechanical chases and exposed to view)

3.5 INSTALLATION OF UNDERGROUND MARKING TAPE

A. Install underground marking tape directly above all outside utility lines.

B. Allow 12 inches between tape and line, and install as close to grade level as feasible.

END OF SECTION

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SECTION 220719

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Glass fiber (pipe).
2. Cellular foam.
3. Jackets and fitting covers.
4. Aluminum jacket (exterior applications).
5. Inserts and shields.

B. Related Sections
1. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
2. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
3. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
4. Section 22 13 19 - Sanitary Waste Piping Specialties.
5. Section 23 07 00 - HVAC Insulation.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training, with not less than five years of documented experience.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.3 SUBMITTALS

A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

B. Shop Drawings: Show fabrication and installation details for the following:
1. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
2. Insulation application at pipe expansion joints for each type of insulation.
3. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Removable insulation at piping specialties and equipment connections.
5. Application of field-applied jackets.

C. Manufacturer's Color Charts: Show the full range of colors available for each type of field-applied finish material indicated.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

E. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 22 05 29.

B. Coordinate clearance requirements with piping Installer for insulation application.

C. Coordinate installation and testing of electric heat tracing.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

PART 2 PRODUCTS

2.1 GLASS FIBER (PIPE)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Schuller, Micro-Lok, AP-T Plus.
2. Knauf Fiber Glass.
3. Owens-Corning Fiber Glass Corp.

B. Insulation: ASTM C547; rigid model; non-compliant; k factor; 0.24-Btu · in/ (h ·ft^2·°F) at 75 degrees; 350 degrees F maximum service temperature; 0.2 percent maximum moisture absorption by volume.

C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn; bonded to aluminum film with pressure sensitive tape lap sealing system; moisture vapor transmission; ASTM E96; 0.02 perm-inches.

2.2 CELLULAR FOAM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong, Armaflex-AP.
   2. Halstead.
   3. Approved equal.

B. Insulation: ASTM C534; flexible; cellular elastomeric; molded or shed; k factor; ASTM C177, 0.27 Btu · in/ (h ·ft^2·°F) at 75 degrees; -70 degrees minimum service temperature; 220 degrees F maximum service temperature; maximum moisture absorption: ASTM D1056, 5 percent (pipe) by weight; 6.0 percent (sheet) by volume; moisture vapor transmission: ASTM E96, 0.10 perm-inches

C. Connection: Waterproof vapor barrier contact adhesive compatible with the insulation. Armstrong 520 adhesive or approved equal.

2.3 JACKETS AND FITING COVERS

A. PVC Plastic Jacket and Fitting Covers (Interior Applications):
   1. Zeston 2000
   2. Approved equal

B. Jackets and fitting covers: ASTM D1784; one piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 degrees F; maximum service temperature 450 degrees F; thickness: 20 mil.

C. Jackets and fitting covers (vapor barrier jackets): ASTM D1784; one piece molded type fitting covers and sheet material; off-white color; minimum service temperature: 0 degrees F; maximum service temperature 450 degrees F; moisture vapor transmission - ASTM E96 - 0.002 perm-inches; thickness: 20 mil.

D. Connections: Pressure sensitive color matching vinyl tape.

2.4 ALUMINUM JACKET (EXTERIOR APPLICATIONS): ASTM B209

A. Manufacturers:
   1. Childers.
   2. Pabco.
   3. Approved equal.

B. Jacket: Thickness: 0.016-inch sheet; finish: smooth; joining: Longitudinal slip joints and 2-inch laps.

C. Fittings: 0.016-inch thick die shaped fitting covers with factory attached protective liner.

D. Metal Jacket Bands: 3/8-inch wide; 0.015-inch thick aluminum.

2.5 INSERTS AND SHEILDS

A. Inserts: Heavy density insulation which will not crush from weight of pipe. Locate between shield and pipe. Inserts are furnished in this Section and installed in Section 22 05 29.

B. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and insulation. Shields are furnished and installed under Section 22 05 29.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verify that piping has been tested and approved before applying insulation material.

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Comply with schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Comply with special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
   1. Apply insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
   3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced on 4 inches centers.
   3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge on 4 inch centers.
      a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
   4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
   5. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with vapor-retarder mastic.

P. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

Q. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections and expansion joints.

R. On insulated piping without vapor barrier for pipes conveying fluids 180 degrees or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation at such locations.

S. All domestic Pipe Exposed in Mechanical Equipment Rooms, Mechanical Chases and Areas with no ceilings and in Finished Spaces less than 10 feet above finished floor: Finish with PVC jacket and fitting covers.

T. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

U. Insulation on all cold water systems shall be applied with a continuous unbroken vapor seal. Do not allow hangers, supports, anchors etc., to come in direct contact with the pipe.

V. Insulate entire system including fittings, unions and flexible connections, flanges and expansion joints.

W. Insulation shall not be applied until system is tested, cleaned, and approved.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
   1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
   2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
   3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:
   1. Apply preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Apply canvas jacket material with manufacturer’s recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer’s written instructions.
   2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
   3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer’s written instructions.

2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.
6. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
7. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

E. Apply insulation to flanges as follows:
1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

F. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.

G. Apply insulation to valves and specialties as follows:
1. Apply premolded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
3. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
4. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:
   1. Apply pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:
   1. Apply mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:
   1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
   2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
   3. Apply insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
   1. Apply jacket smooth and tight to surface with 2 inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062 inch thick coats of jacket manufacturer's recommended adhesive.
   3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
   1. Draw jacket material smooth and tight.
   2. Apply lap or joint strips with the same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Apply jackets with 1-1/2 inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section, Painting.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.8 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
   1. Flexible connectors.
   2. Vibration-control devices.
   3. Fire-suppression piping.
   4. Drainage piping located in crawl spaces, unless otherwise indicated.
   5. Below-grade piping, unless otherwise indicated.
   6. Chrome-plated pipes and fittings, unless potential for personnel injury.
   7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.9 FIELD QUALITY CONTROL

A. Inspection: Engage a qualified inspection agency to perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:
   1. Inspect fittings and valves randomly selected by Architect.
   2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
   3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.10 INSULATION APPLICATION SCHEDULE, GENERAL

A. Comply with insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.11 INTERIOR INSULATION APPLICATION SCHEDULE

A. General: Materials and thicknesses are specified in schedules at the end of this Section.

B. Interior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
   1. Domestic cold water, except as noted in Schedule at the end of this Section.
   2. Storm and overflow water. Insulate roof and overflow drain bodies, horizontal, and vertical rainwater leaders of storm and overflow drain pipe.
   3. Domestic hot water.
   4. Sanitary drains for fixtures accessible to the disabled.
   5. Cooling coil condensate drain piping.
   6. Non-potable make-up water to evaporative cooling unit.

C. Interior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
   1. Storm water. Insulate roof drain bodies, horizontal, and vertical rainwater leaders of storm and overflow drain piping.
   2. Domestic hot water.
   3. Cooling coil condensate.

D. Mechanical/Plumbing Chases: With regard to pipe insulation, Mechanical/Plumbing chases shall be regarded as interior exposed spaces and domestic cold water not required to be insulated.

3.12 PLUMBING EQUIPMENT APPLICATION SCHEDULE

A. Insulate equipment including valves, tanks, air removal devices, etc.

B. Plumbing equipment shall be insulated under this Section.

C. Expansion tanks and similar equipment not receiving fluid directly from the system do not require insulation.

D. Valves, traps, pressure reducing valves, pumps, etc.: Extend insulation 6 inches beyond flanges.

E. Systems Above Ambient Temperature: 2-inch thick glass fiber insulation with vapor barrier.

F. Systems Below Ambient Temperature: 1/2-inch thick glass fiber insulation with vapor barrier. Exception: Insulate pump bodies on systems below ambient temperature with 1-inch thick cellular foam insulation.

G. All equipment requiring access for maintenance, repair or cleaning shall be insulated with lace-on blankets.

H. All exposed hot water and drain piping at Handicap fixtures shall be insulated with a neatly installed removable type ADA - approved insulation kit equal to Basin Guard, Pro Wrap, or approved equal.

Insulation Schedule					
System	Operating Temperature (degrees F)	Insulation Type	Pipe Size (inches)	Insulation Thickness (inches)	Notes

Domestic Cold Water (above ground)	___	Glass Fiber	Up to 12	1/2	(2) (4)
Domestic Cold Water (below ground)	___	Cellular foam	Up to 8	1/2	___
Storm Drain	___	Glass Fiber	Up to 6	1/2	(2)
Overflow Drain	___	Glass Fiber	Up to 6	1/2	(2)
Notes: Runouts to fixtures which are less than 12 feet in length may have 1/2 inch insulation. Provide PVC jacket and fittings for all piping exposed to view, exposed in water heater rooms, mechanical chases exposed to view in all Dayrooms, mechanical areas, Areas with no ceiling and finished spaces less than 10 feet -0 inches above finished floor. Provide secondary containment pipe as specified in Section 22 13 19. All domestic cold water piping in mechanical and plumbing chases are not required to be insulated.					

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SECTION 220801

COMMISSIONING OF DOMESTIC WATER HEATER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Responsibilities.
      a. Division 01 responsibilities in the commissioning process which consists of:
         1) Commissioning of domestic hot water system.

B. Related Sections
   1. Section 01 91 13 – General Commissioning Requirements.
   2. Section 23 08 00 – Commissioning of HVAC.

C. Related Documents
   1. Commissioning Plan

1.2 Definitions

A. CxA: Commissioning Agent.

B. O&M: Operations and Maintenance.

C. TI: Technical Inspector

D. Refer to Section 019113 for further definitions.

1.3 DESCRIPTION

A. This section describes commissioning requirements applicable to commissioned items and systems specified in Divisions 01 to ensure that all systems are operating in a manner consistent with the Contract Documents.

B. Conform to commissioning requirements and the commissioning plan.

1.4 RESPONSIBILITIES

A. General Commissioning:
   1. Refer to Commissioning Plan and Section 019113.

B. Plumbing System:
   1. Commissioning requirements in Section 01 91 13 and the Commissioning Plan.
   2. Provide submittals as required by A/E and those listed on the prefunctional checklists.
   3. During the startup and initial checkout process, execute the plumbing-related portions of the prefunctional checklists for all commissioned equipment.
   4. Provide all test equipment necessary to fulfill specified testing requirements.
   5. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.

6. Refer to Section 019113 for specific details on non-conformance issues relating to prefunctional checklists and tests and for issues relating to functional performance tests.
7. The training shall consist of a review of the O&M manuals and hands-on training. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment. The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packages controls, not controlled by the central control system. Training shall occur after functional testing is complete, unless otherwise approved by the Owner Representative.

C. Controls system:
1. Sequences of Operation Submittals: The Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
   a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
   b. All interactions and interlocks with other systems.
   c. Detailed delineation of control between any packaged controls and the building automation system (BAS), listing what points the BAS monitors only and what BAS points are control points and are adjustable.
   d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
   e. Start-up sequences.
   f. Warm-up mode sequences.
   g. Normal operating mode sequences.
   h. Unoccupied mode sequences.
   i. Shutdown sequences.
   j. Capacity control sequences and equipment staging.
   k. Temperature and pressure control: setbacks, setups, resets, etc.
   l. Detailed sequences for all control strategies, e.g., optimum start/stop, staging, optimization, demand limiting, etc.
   m. Effects of power or equipment failure with all standby component functions.
   n. Sequences for all alarms and emergency shut downs.
   o. Seasonal operational differences and recommendations.
   p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
   q. Schedules, if known.
   r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers shall not repeat for different sequence sections, unless the sections are numbered.
2. Control Drawings Submittal:
   a. The control drawings shall have a key to all abbreviations.

b. The control drawings shall contain graphic schematic depictions of the systems and each component.

c. The schematics shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

d. Provide a full points list with at least the following included for each point:

1) Controlled system
2) Point abbreviation
3) Point description
4) Display unit
5) Control point or setpoint (Yes / No)
6) Monitoring point (Yes / No)
7) Intermediate point (Yes / No)
8) Calculated point (Yes / No)
9) Control or setpoint: Point that controls equipment and can have its setpoint changed.
10) Intermediate point: point whose value is used to make a calculation which then controls equipment.
11) Monitoring point: point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
12) Calculated point: "virtual" point generated from calculations of other point values.
13) The Contractor shall keep the CxA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the CxA in the following manner:

a. Using a skilled technician who is familiar with the installed systems in this building, execute the functional testing of the controls system. Assist in the functional testing of all equipment. Provide two-way radios during the testing.

b. Execute all control system trend logs.

5. The Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, check-out and adjust the control system prior to functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

a. System name.

b. List of devices.

c. Step-by-step procedures for testing each controller after installation, including:

1) Process of verifying proper hardware and wiring installation.
2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
3) Process of performing operational checks of each controlled component.
4) Plan and process for calibrating valve and damper actuators and all sensors.

5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

e. A description of the instrumentation required for testing.

6. Provide a signed and dated certification to the Contractor upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
7. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points.
8. List and clearly identify on the as-built duct and piping drawings the locations of all monitoring and control sensors.
9. Provide all test equipment necessary to fulfill specified testing requirements.
10. The Contractor shall keep a running log of events and issues. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and TI at least twice a week.
11. Provide the CxA with any updates as a result of A/E review.
12. Provide all test equipment necessary to fulfill specified testing requirements.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. The Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Section.

PART 3 EXECUTION

3.1 SUBMITTALS

A. The Contractor shall provide submittal documentation relative to commissioning as required in this Section, and Division 1.

3.2 STARTUP

A. The Contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA and TI.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the PM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. The Contractor shall compile and prepare documentation for all commissioned systems covered in Division 23.

C. The Contractor shall deliver this documentation to the CxA four months prior to the training of personnel.

3.4 TRAINING OF PERSONNEL

A. The Contractor shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.

B. The CxA shall be responsible for reviewing the content and adequacy of the training of Owner personnel for commissioned equipment or systems. TI will verify compliance.

PART 4 PREFUNCTIONAL CHECKLIST AND FUNCTIONAL TEST FORMS

4.1 TEST FORMS

A. See attached sample.

B. For complete set of test sheets see commissioning plan.

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SECTION 221116

DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Settlement Joints.
   2. Copper pipe and fittings for above and below ground installation.
   3. Pipe wrap for all domestic water piping installed below ground and inside grout-filled block walls.
   4. Insulation for copper pipe through concrete, grade beams and footings.
   5. Electric heat tracing for domestic water temperature maintenance.
   6. Dielectric unions and fittings.

B. This Contractor shall furnish all labor, materials, pipe supports, sleeves, hangers, tools, equipment and perform all work and services necessary for furnishing and installation of a complete domestic water piping system. Although all work is not specifically shown or specified, all valves, appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation shall be furnished and installed as part of this work.

C. Domestic water piping installed below ground and under slab in all [buildings] (i.e. trap primer lines, etc) shall be supported either from the structural slab or direct burial. Scope and direction is indicated on the Plumbing Plans.

D. Related Sections
   1. Section 01 31 13 - Project Coordination.
   2. Section 22 05 00 - Common Work Results for Plumbing.
   3. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
   4. Section 22 05 29 - Hangers and Supports for HVAC Piping and Equipment.
   5. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   6. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
   7. Section 22 07 19 - Plumbing Piping Insulation.
   8. Section 22 11 19 - Domestic Water Piping Specialties.

1.2 REFERENCES

A. ASME B31.9 - Building Services Piping, for materials, products, and installation.

B. NSF 61, Drinking Water System Components-Health Effects: Sections 1 through 9, for potable domestic water piping and components.

C. ASME BPVC - SEC IX: Welding and Brazing Qualifications.

D. ASTM E814 Fire Tests of Through-Penetration Fire Stops.

E. ASTM F708: Design and Installation of Rigid Pipe Hangers.

F. AWWA C651: Disinfecting Water Mains.

G. MSS SP-58: Pipe Hangers and Supports - Materials, Design, and Manufacture.

H. ANSI/MSS SP-69: Pipe Hangers and Supports - Selection and Application.

I. NCPWB: Procedure Specifications for Pipe Welding.

J. ANSI/AWWA C111- Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings/A21.11

K. ANSI/AWWA C153/A21.53 - Ductile Iron Compact Fittings for Water Service, depending on size of piping for settlement joints.

L. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile Iron Pipe Systems, for polyethylene jacket.

1.3 DEFINITIONS

A. Water Service Piping: Water piping outside the building that conveys water to the building.

B. Service Entrance Piping: Water piping approximately 5-feet outside the building, between water service piping and water distribution piping.

C. Water Distribution Piping: Water piping from a point approximately 5-feet outside the building that conveys water to fixtures and equipment throughout the building.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with the following minimum working pressure ratings, unless otherwise indicated:
   1. Domestic Water Service Piping, Below Ground: 160 psig.
   2. Domestic Water Distribution Piping, Above Ground: 125 psig.

1.5 SUBMITTALS

A. Submit in accordance with Sections 01 33 00 and 01 33 23.

B. Product Data for settlement joints, below and above ground pipe, fittings, couplings, hangers, pipe coating and pipe wrap for pipe installed below ground and installed in grout-filled block walls, seismic bracing and thrust and/or restraint or blocking at base of domestic water riser. Provide manufacturer's catalog information.

C. Shop Drawings
   1. For underground and above ground systems, and all mechanical and plumbing chases. Include plans, elevations, sections, and details.
   2. In accordance with Sections 22 05 29 and 22 05 48.

D. Calculations: In accordance with Sections 22 05 29 and 22 05 48.

E. Water Samples: Specified in Disinfection of Domestic Water Piping System Article in Part 3.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Settle joints shall be FM approved.

1.7 RECORDS

A. Provide record of all pipe tests and provide as part of O & M Manual.

B. Include certificate of Tests in O&M Manual.

C. Include certificate of Health Department approval of domestic water quality in O&M Manual.

D. Provide certificate of Domestic water piping system disinfecting and include in O & M Manual.

1.8 DRAWING SCHEDULE

A. Refer to sheet notes and schedule on Drawings for model numbers, symbols, etc. for additional information concerning products specified in this section.

PART 2 PRODUCTS

2.1 SETTLEMENT JOINT

A. General: Provide settlement joint on all domestic water service entrance pipe to each building, as indicated on the Underground Plumbing Plans.

B. Settlement joint shall be manufactured of 65-45-12 ductile iron conforming to the material requirements of ASTM A536.84 and ANSI/AWWA C153/A21.53. Provide foundry certification of material with submittal.

C. Each settlement joint shall be pressure tested prior to shipment against it own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, shall apply. Factory Mutual Approval for the 12-inch and smaller sizes is required.

D. Each settlement joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of 20 degrees, 3-inch to 12-inch; and 4-inches minimum expansion.

E. All internal surfaces (wetted parts) shall be lined with a minimum of 15-mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be holiday tested with a 1500-volt spark test conforming to said specification. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet ANSI/NSF-61.

F. All external surfaces shall be coated with a catalyzed coal tar epoxy conforming to the material requirements of AWWA C210. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

G. Manufacturer's certification of compliance to the above standards and requirements shall be provided with submittal.

2.2 PIPING MATERIALS

A. General: The application of the following pipe, tube, and fitting materials and joining methods required for plumbing piping systems are indicated in Part 3 Article "Pipe Fittings and Applications."

B. Hard Copper Tube: ASTM B88, Type L, water tube, drawn temper for above ground and in wall installation.

C. Set Copper Tube: ASTM B88, Type K, water tube, annealed temper for below ground installation.

1. COPPER PIPE AND FITTINGS
    a. Soft Copper Tube: ASTM B88, Types K (ASTM B88M, Types A and B), water tube, annealed temper.
        1) Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
        2) Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
        3) Copper Unions: MSS SP-123/ASME B16.18, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
            a) Threaded Ends: Threads conforming to ASME B1.20.1.
    b. Hard Copper Tube: ASTM B88, Types L (ASTM B88M, Types B and C), water tube, drawn temper.
        1) Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
        2) Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
        3) Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
            a) Threaded Ends: Threads conforming to ASME B1.20.1.
        4) Copper, Grooved-End Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
            a) Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to ANSI/AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
        5) Alternate Fitting Option: For piping 4-inches and smaller, copper press fittings conforming to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Fittings shall be IAPMO and UPC listed.

2.3 JOINING MATERIALS

A. Solder, brazing, and welding filler metals are specified in Section 22 05 00, Common Work Results for Plumbing.

2.4 VALVES

A. Comply with Section 22 05 03.

2.5 PIPE INSULATION THROUGH CONCRETE AND FOOTINGS

A. General: Provide a minimum 1-inch thick pipe insulation for all copper pipe installed through concrete footings, grade beams, etc.
   1. Cleaning: Remove loose scale, rust, dirt, oil and grease before wrapping.
   2. IMOC, IMCOSHIELD, non-slit pre-lubricated polymer foam insulation.

2.6 DIELECTRIC PIPE FITTINGS

A. General: Provide dielectric pipe fittings, unions and waterways to protect domestic water copper pipe from deterioration caused by galvanic and stray current corrosion. Provide dielectric fitting, union or waterway where dissimilar metals are used in piping systems.
   1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
   2. Insulating Material: Suitable for system fluid, pressure, and temperature.
   3. Dielectric Unions: Factory-fabricated, union assembly for 250 psig minimum working pressure at a 180 degrees F temperature.
      a. Manufacturers: Epco Sales, Inc.; Watts Industries, Inc. - Water Products Division or Zurn Industries, Inc. - Wilkins Division.
   4. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150 or 300 psig minimum pressure to suit system pressures.
      a. Manufacturers: Epco Sales, Inc. or Watts Industries, Inc. - Water Products Division.
   5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      a. Provide separate companion flanges and steel bolts and nuts for 150 or 300 psig minimum working pressure to suit system pressures.
      b. Manufacturers: Advance Products & Systems, Inc.; Calipco, Inc. or Pipeline Seal and Insulator, Inc.
   6. Dielectric Couplings: Galvanized-steel coupling, having inert and noncorrosive, thermoplastic lining, with threaded ends and 300 psig minimum working pressure at 225 degrees F temperature.
      a. Manufacturers: Calpico, Inc. or Lochinvar Corp.
   7. Dielectric Nipples: Electroplated steel nipple, having inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300 psig working pressure at 225 degrees F temperature. Nipples shall be listed by IAPMO/UPC and SBCCI PST and ESI.
      a. Manufacturers: Precision Plumbing Products, Inc.; Sioux Chief manufacturing Co.,Inc, Perfection Corp. or Victaulic Co. of America.

2.7 PIPE ESCUTCHEONS

A. General: Provide solid (not split-hinged) pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. All areas with escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid cast brass or sheet brass escutcheons, solid pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid sheet metal escutcheons.

D. Manufacturer: Chicago Specialty, Producers Specialty, Sanitary-Dash.

PART 3 EXECUTION

3.1 EXCAVATION

A. Comply with the requirements Section 31 23 33.

3.2 SERVICE ENTRANCE PIPING

A. Extend building domestic water piping 5 feet outside building and connect to water service piping. Coordinate invert elevations, pipe sizes and points of connection with the Civil Drawings.

3.3 PREPARATION OF FOUNDATION FOR BURIED PIPING

A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.

B. Remove unstable, soft and unsuitable materials at surface on which piping is to be laid and backfill with clean sand or pea gravel to indicated level.

C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig holes at each end of pipe joint to relieve loads and to ensure continuous bearing of pipe barrel on foundation.

3.4 PIPING AND FITTINGS APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Grooved joints may be used on aboveground grooved-end piping.

D. Underground Domestic Water Service Entrance Piping: Use the following piping materials:
   1. 6 inches and Smaller: Soft copper tube, Type K, cast-copper-alloy, soldered-joint pressure fittings; and soldered joints with Alloy Sn95 solder.
   2. All copper pipe installed below finished grade and slab shall be encased in one layer of an ANSI/AWWA C105, 8-mil polyethylene jacket installed per ANSI/AWWA C105/A21.5.

E. Aboveground Domestic Water Distribution Piping: Use the following piping materials:
   1. 6 inches and Smaller: Hard copper tube, Type L wrought-copper or cast-copper-alloy pressure fittings; copper unions; bronze flanges and soldered joints with Alloy Sn95 solder.

2. Provide transition fitting (C900 PVC-to-Copper) at location indicated outside the building. Coordinate with Civil Drawings.

3.5 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use full port ball or butterfly valves.
   2. Throttling Duty: Use full port ball or butterfly valves.
   3. Hot Water, Balancing Duty: Calibrated balancing valves, comply with the requirements of Section 22 05 23.
   4. Drain Duty: Hose-end drain valves.
   5. Isolation Duty: Use full port ball valves.
   6. Back Flow: Swing check valves.

B. All iron body valves installed below finished grade shall be encased in two layers on an ANSI/AWWA C105, 8-mil polyethylene jacket installed per ANSI/AWWA C105/A21.5.

3.6 PIPING INSTALLATION

A. Contamination Prevention:
   1. Pipe interiors shall be kept free of debris.
   2. Interior surfaces of domestic water pipes, valves and fittings shall be protected against contamination, as well as debris. All openings in pipelines shall be closed with watertight plugs when worked is halted on the system. Sealing and packing materials shall not support growth of bacteria. Trenches that become wet shall be treated with calcium hypochlorite granules to prevent bacterial growth.

B. General:
   1. The installation of the domestic water systems shall conform to the latest edition of California Plumbing Code (CPC) and this specification.
   2. Piping installation shall be coordinated with respect to space available for HVAC, fire protection and electrical installation. In case of conflict in the routing of the piping and ducting, the routing of the ducting shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows; shall not encroach on aisles, passageways and equipment and shall not interfere with the servicing or maintenance of equipment. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Pipe shall not be bent. Cutting or weakening of structural members to facilitate piping installation is not permitted.

3. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers. Piping above ground shall run parallel with the lines of the building unless otherwise noted on the drawings. Service pipe, valves and fittings shall be kept a sufficient distance from other work to permit finished covering not less than 1-inch from such other work and not less than 1-inch between finished covering on the different services.

C. Comply with the requirements of Section 22 05 00.

D. Extend domestic water distribution piping to a point 5 feet outside each building and in sizes and locations indicated. Connect to water service entrance piping, coordinate point of connection with Civil Drawings. Provide transition fitting, C900 PVC-to-copper.

E. Install underground copper tubing according to CDA's "Copper Tube Handbook."

F. Install wall penetration system at service pipe penetration through foundation wall. Make installation watertight. Comply with Section 22 05 00.

G. Install butterfly valve, hose-end drain valve, strainer, pressure gauge, temperature gauge, and test tee with valve, inside building Mechanical Room at water service entrance. Comply with Section, 22 05 19 for temperature and pressure gauges, and with Section 22 11 19 for drain valves and strainers.

H. Install aboveground domestic water piping level without pitch and plumb.

I. Provide and install electric heat trace temperature maintenance on all non-recirculating domestic hot water systems to maintain temperatures indicated on Drawings. Heat trace shall extend from [water heater, mechanical room] to within 15 feet minimum of each fixture. Install per manufacturer's instructions.

3.7 JOINT CONSTRUCTION

A. Comply with Section 22 05 00 for basic piping joint construction.

B. Soldered Joints: Use ASTM B813, water-flushable, lead-free flux; ASTM B32, lead-free-alloy solder; and ASTM B828 procedure, unless otherwise indicated.

C. Grooved Joints: Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

D. Option for fittings: Copper press connections. Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

3.8 VALVE INSTALLATION

A. General: Valves shall be installed at the locations shown on the drawings, as required by code and for isolation of equipment, plumbing fixtures, etc. All valves shall be installed with the stems between the horizontal the 90 degrees vertical. Provide access to all concealed valves by means of access doors furnished and installed by the Contractor.

B. Sectional Valve: Install sectional valves close to water main on each branch and riser serving 2 or more plumbing fixtures or equipment connections and where indicated. Use ball valves for piping 4 inches and smaller. Use butterfly valves for piping 5 inches and larger.

C. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball valves for piping 4-inches and smaller. Use butterfly valves for piping 5 inches and larger.

D. Drain Valves: Install drain valves specified in Section 22 11 19 on each plumbing equipment item located to drain equipment for service and repair. Install drain valves at base of each water riser, at low points in horizontal piping, and where required to drain water distribution piping system.
   1. Install hose-end drain valves at low points in water mains, risers, and branches.
   2. Install stop-and-waste drain valves where indicated.

E. Balancing Valve: Install balancing valve on the hot water and hot water return loops as indicated on the Drawings and Riser Diagrams Comply with Section 22 05 23 for balancing valves.

F. Check Valves: Install swing check valve on discharge side of each pump and elsewhere as indicated. Use MSS SP-80, Class 125, cast-bronze body for 2-inch and smaller piping.

G. Mechanical and Plumbing Chases: Install ball valve on each branch serving each plumbing chase.

3.9 HANGER AND SUPPORT INSTALLATION

A. Comply with the requirements of Section 22 05 48 and Section 22 05 29 for seismic-restraint devices and pipe hanger and supports.

B. Install hangers for horizontal and vertical piping with the following maximum spacing and minimum rod sizes:
   1. Support vertical copper tube at each floor.
   2. Install supports for vertical copper tubing every 10 feet.

C. Conform to Table below for maximum spacing of supports:

Pipe Material	Horizontal In Feet	Vertical In Feet	Rod Size In Inches
Copper Tubing 1-1/4 inches and smaller:	6	10	3/8 inch
Copper Tubing 1-1/2 inches and larger:	10	10	1/2 inch

D. Support horizontal and vertical piping inside each mechanical chase using cold formed metal framing ("Superstrut"), comply with requirements of Section 22 05 48 and Section 22 05 29.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water distribution piping to exterior water service entrance piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to the following:
   1. Plumbing Fixtures: Install cold and hot water supply piping in sizes indicated, but not smaller than required by the latest edition of California Plumbing Code (CPC) and/or authorities having jurisdiction. Refer to Section 22 40 00 and Section 22 11 19.

3.11 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   1. Do not enclose, cover, or put piping into operation until all piping is inspected and approved by local plumbing official and/or authority having jurisdiction.
   2. During progress of the installation, notify local plumbing official and/or authority having jurisdiction at least 24 hours prior to time inspection must be made. Perform tests specified below in presence of the local plumbing official and/or authority having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping system before concealing or closing-in after roughing-in and prior to setting fixtures.
      b. Final Inspection: Arrange for final inspection by local plumbing official and/or authority having jurisdiction to observe tests and to ensure all systems are in compliance with requirements of the latest edition of California Plumbing Code.
   3. Reinspection: When a plumbing official finds that a piping system will not pass test or inspection, Contractor shall make the required corrections and arrange for reinspection by the plumbing official.
   4. Reports: Prepare inspection reports and have them signed by the local plumbing official and/or authority having jurisdiction. A copy of all inspection reports to be included in the O & M Manuals.
   5. Provide written report to Architect and Engineer that all copper piping installed below ground and inside grout filled block walls have been coated and wrapped with approved pipe wrap. Written report shall be included in the O & M Manuals.

B. Test domestic water distribution piping as follows:
   1. Test for leaks and defects in new water distribution piping system and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water distribution piping until it has been tested and approved. Expose work that was covered or concealed before it has been tested and approved for testing.

3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.12 ADJUSTING

A. Adjust balancing valves in hot-water system to provide adequate flow.
   1. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   2. Adjust calibrated balancing valves to flows indicated on the Plumbing Drawings or Domestic Water Piping Diagram.

3.13 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete and clean.

B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Disinfect potable domestic water distribution piping as follows:
   1. Purge new domestic water distribution piping systems before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed by that authority, the procedures described in either AWWA C651 or AWWA C652 or as described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 of outlets.
      e. If final disinfectant residual test less than 25 mg/L, repeat treatment.
      f. Flush disinfectant from system until residual equal to that of incoming water or 1.0mg/L.
      g. Take samples no sooner than twenty-four (24) hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651. Provide laboratory results to Owner’s Representative. Obtain approval from local health department.

D. Prepare and submit reports of purging and disinfecting activities.

E. Completely flush all domestic hot and cold water risers to eliminate all debris in the lines before using any flush valves.

F. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.14 STARTUP SERVICES

A. Verify incoming water pressure and temperature.

B. Replace all strainer screens with new at all mechanical and plumbing equipment.

C. Fill water systems. Check potable water expansion tanks to determine that they are not air bound and that system is completely full of water.

D. Before operating systems, perform these steps.
1. Close drain valves, hydrants, and hose bibbs.
2. Open all valves to full open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping systems and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens and aerators. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used, clean, and ready for use.

E. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

F. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 PROTECTION

A. Protect piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION

SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Backflow preventers.
2. Hose bibbs.
3. Water hammer arrester.
4. Flashing materials.

B. Related Sections
1. Section 07 60 00 - Flashing and Sheet Metal.
2. Section 08 31 13 - Access Door and Frames.
3. Section 22 05 00 - Common Work Results for Plumbing.
4. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
5. Section 22 11 16 - Domestic Water Piping.
6. Section 22 13 16 - Sanitary Waste and Vent Piping.
7. Section 22 40 00 - Plumbing Fixtures.
8. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
1. Domestic Water Piping, Below Ground: 160 psig.
2. Domestic Water Piping, Above Ground: 125 psig.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1.

B. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
1. Backflow Preventers.
2. Hose Bibbs.
3. Water Hammer Arresters.
4. Flashing Materials.

C. Field test reports.

D. Maintenance Data for inclusion in operating and maintenance manuals as specified in Division for the following:
1. Backflow Preventers.

1.4 QUALITY ASSURANCE

A. Design Concept: Drawings indicate capacities, size, profiles, and dimensional requirements of plumbing specialties and system components. Components having equal performance characteristics that deviate from the indicated size and dimensions may be considered, provided such deviations do not change the design concept or intended performance. Refer to Division 1.

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:
   1. Comply with NSF 61, "Drinking Water System Components-Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.5 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with labels clearly describing contents.

B. Operating Keys (Handles): Furnish 1 extra key for each key-operated hose bibb and hydrant installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Backflow Preventers:
      a. Conbraco Industries, Inc.
      b. Watts Industries, Inc.; Water Products Div.
      c. Zurn Industries, Inc.; Wilkins Div.
   2. Hose Bibbs:
      a. Jay R. Smith Mfg. Co., Div., Smith Industries, Inc.
      b. Woodford Manufacturing Co., Div. WCM Industries, Inc.
      c. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   3. Water Hammer Arresters:
      a. Jay R.Smith Mfg. Co., Div., Smith Industries, Inc.
      b. Precision Plumbing Products, Inc.
      c. Sioux Chief Manufacturing Co., Inc.
      d. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   4. Firestop Sleeve Penetration Systems:

a. Hilti Fire Stop Systems.
b. 3-M Fire Stop Systems.
c. Approved Equal.

2.2 BACKFLOW PREVENTERS

A. Hose Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

2.3 HOSE BIBBS

A. Hose Bibbs: Bronze body, with renewable composition disc, 3/4-inch threaded or solder joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker.
1. Finish: Rough brass.
2. Operation: Operating key, (handle). Provide 1 operating key.

2.4 WATER HAMMER ARRESTERS

A. Water Hammer Arresters: ASSE 1010, or PDl WH-201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, PDl WH-201 sizes “A” through “F.”

B. Roof Flashing Assemblies: Manufactured assembly consisting of 4-psf lead flashing collar with boot and skirt extending at least 8 inches from pipe, with galvanized steel boot reinforcement and counter flashing fitting.
1. Option 1: Open top.

2.5 FLASHING MATERIALS

A. Lead: ASTM B 749, Type L51121, copper-bearing sheet, at least 4 psf (0.0625-inch thick) for general use, and at least 6 psf (0.0937-inch thick) for burning (welding), except as otherwise indicated.

2.6 MISCELLANEOUS PIPING SPECIALTIES

A. Piping specialties such as escutcheons, dielectric fittings, sleeves, and sleeve seals are specified in Section 22 05 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with Section 22 05 00 for piping joining materials, joint construction, and basic installation requirements.

3.2 PIPING SPECIALTY INSTALLATION

A. Install strainers on supply side of each control valve, pressure-regulating valve, and solenoid valve, and where indicated.

B. Install hose bibbs with integral or field-installed vacuum breaker.

C. Install water hammer arrestors on all fixture groups of 3 or more fixtures, Water hammer arrestors to be sized according to P.D.I. Standard, see Table below:

P.D.I. Symbol	A	B	C	D	E	F
Fixture Unit Rating	1-11	12-32	33-60	61-113	114-154	755-330

D. Placement of arrestors on fixture branch line up to 20 feet in length should be between the last two fixtures. On fixture branch line over 20 feet in length two arrestors should be used with the second arrestor placed at the approximate midpoint of the line. The total sum of the fixture unit ratings of the water hammer arrestor should be equal to or greater than the total fixture unit of the branch line.

3.3 CONNECTIONS

A. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts to fixtures of sizes indicated but not smaller than required by plumbing code.

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.
   1. Grounding: Connect unit components to ground according to the National Electrical Code and Division 26 Section 26 05 26.

3.4 FLASHING INSTALLATION

A. Provide flashing Manufactured in a single piece except where large pans, sumps; or other drainage shapes are required.

B. Install 4-psf lead flashing or 16-oz. per sq. ft. copper, except when another weight or material is specified.

C. Install 8-psf lead flashing or heavier where burning (welding) of lead sheets is required.

D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with membrane waterproofing.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 3 inches around specialty.

E. Set flashing on floors and roofs in solid coating of bituminous cement.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 7 Section 07 60 00.

H. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having calking recess.

I. Fabricate and install lead sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

J. Fabricate and install copper sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

K. Fabricate and install galvanized-steel sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

L. Fabricate and install elastic-membrane sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

3.5 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer.
   1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
   2. Requirements for nameplates and signs are specified in Section 22 05 00.

3.6 PROTECTION

A. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 STARTUP SERVICES

A. Preparation: Perform the following checks before start-up:
   1. Systems tests are complete.
   2. Damaged and defective specialties and accessories have been replaced or repaired.
   3. There is clear space for servicing of specialties.

B. Before operating systems, perform these steps:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open valves to full open position.
   3. Remove and clean strainers.

3.8 ADJUSTING

A. Adjust operation and correct deficiencies discovered during startup services.

3.9 DOMESTIC WATER PIPING SPECIALTIES SCHEDULES

A. Provide specialties as scheduled on the following “Data Sheets.” Each Data Sheet begins with a new page.

DOMESTIC WATER PIPING SPECIALTIES DATA SHEET

Hose Bibb Type:	HB-1
Description:	Anti-siphon vacuum breaker protected wall faucet for installation in mechanical chases.
Appropriate Standard:	ASSE Standard 1019- Type C. CSA Certified UPC/IAPMO Listed
Body Material:	3/4-inch male hose thread; 1/2-inch turn full open; no lead solder joints; no wall flange.
Manufacturer:	Woodford 101C Zurn Watts

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END OF SECTION

SECTION 221316

SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Hub and Spigot pipe and Fittings (below ground).
   2. No-Hub Pipe, fittings (above ground).
   3. No-Hub Heavy Duty Couplings (above ground).
   4. Settlement Joints.
   5. Pipe Wrap for all sanitary waste and vent and grease waste and vent piping installed below ground and inside grout-filled block walls.
   6. Settlement Joints.
   7. Pipe Escutcheons.
   8. Fire Barrier Penetration Seals.

B. This Contractor shall furnish all labor, materials, sleeves, hangers, supports, tools, equipment and perform all work and services necessary for furnishing and installation of a complete sanitary waste and vent piping system. Although all work is not specifically shown or specified, all appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation shall be furnished and installed as part of this work.

C. This Contractor shall furnish to Owner's Representative a digital record of all underground sanitary waste and vent and grease waste and vent piping prior to issuing Certificate of Occupancy. Contractor shall review with the Owner's Representative entire underground waste and vent system for each building. All blockages and debris found shall be removed and piping systems replaced at no cost to the OWNER.

D. Related Sections
   1. Section 01 31 00 - Project Coordination.
   2. Section 22 05 00 - Common Work Results for Plumbing.
   3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   4. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   5. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
   6. Section 22 13 19 - Sanitary Waste Piping Specialties.
   7. Section 31 20 00 - Earthmoving

1.2 DEFINITIONS

A. Sanitary Waste and Vent Piping: Piping inside the building that conveys waste water and vapors from fixtures and equipment throughout the building.

B. Service Entrance Piping: Sanitary sewerage piping to a point approximately 5 feet outside each building between outside building sewer piping and inside sewer piping.

C. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewerage from building.

D. Grease Waste and Vent Piping: Grease waste piping to a point as indicated on the Underground Plumbing Plans.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Indirect Waste and Vent Piping: 10-foot head of water.
   3. Grease Waste and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

A. Submit in accordance with Sections 01 33 00 and 01 33 23.

B. Product Data for settlement joints, hub and spigot pipe and fittings, No-hub pipe, fittings, and heavy duty couplings, hangers, supports, pipe wrap for pipe installed below ground and installed in grout filled block walls, thrust and/or restraints or blocking at base of each sanitary stack, and seismic bracing. Provide manufacturers catalog information.

C. Shop Drawings
   1. For underground and above ground systems, and all mechanical and plumbing chases. Include plans, elevations, sections, and details.
   2. Details for the installation of the sanitary waste and vent piping for to be supported from the structural slab.
   3. In accordance with Sections 22 05 29 and 22 05 48.

D. Calculations: In accordance with Sections 22 05 29 and 22 05 48.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of CISPI, IAMPO and the specified testing agency.

B. Comply with the provisions of ASME B31.9 “Building Services Piping,” for materials, products, and installation.

C. All cast iron pipe and fittings shall be manufactured in the United States. Pipe shall bear the label or stamp that the cast iron was manufactured in the United States, with collective trademark of the Cast Iron Soil Pipe Institute.

D. Submittal for No-Hub heavy duty couplings to include copy of compliance to the requirements of FM 1680 Class I.

1.6 TESTING

A. Sanitary and Grease Waste and Vent Piping:
   1. Test all building sanitary and grease sewer and venting to ensure system is water tight.
   2. All sanitary and grease drainage piping shall be tested to the point of connection to mains outside each building.
   3. Refer to Part 3, Article “Testing” of this section.

B. Records:
   1. Provide record of all pipe tests and include in O&M Manual.
   2. Include certificate of all Tests in O & M Manual.
   3. Include digital record of all underground sanitary waste; grease waste and vent piping systems in O&M Manual.

1.7 DRAWING SCHEDULE

A. Refer to schedules on drawings for model numbers, symbols, and additional information concerning products specified in this section.

PART 2 PRODUCTS

2.1 PIPING MATERIALS MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed from that category:
   1. Hub and Spigot Cast Iron Pipe and Fittings:
      a. AB&I, Oakland, California.
      b. Charlotte Pipe & Foundry Company, Charlotte, North Carolina.
      c. Tyler Pipe Industries, Tyler, Texas.
   2. No-Hub Cast Iron Pipe and Fittings:
      a. AB&I, Oakland, California.
      b. Charlotte Pipe & Foundry Company, Charlotte, North Carolina.
      c. Tyler Pipe Industries, Tyler, Texas.
   3. No-Hub Heavyweight Couplings:
      a. Anaco, Inc., Oakland, California; Husky SD4000-Orange Shield.
      b. Clamp-All Corporation, Haverhill, MA; Clamp All Hi Torque 125.
      c. No other couplings are acceptable.

2.2 HUB AND SPIGOT SOIL, WASTE AND VENT PIPING

A. Hub and Spigot Pipe and Fittings:
   1. Service Cast Iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi.
   2. Pipe and fittings shall comply with ASTM A74. Compression gaskets shall be hydrostatically (water) tested by the manufacturer to verify compliance.
   3. Joints shall be made with an elastomeric compression gasket meeting requirements of ASTM C564.

2.3 CAST-IRON NO-HUB SOIL, WASTE AND VENT PIPING AND FITTINGS

A. No-Hub Pipe: Hubless cast iron pipe and fittings shall be manufactured from gray cast iron with a tensile strength of not less than 21,000 psi. Pipe and fittings shall comply with ASTM A888 and CISPI 301. Each length of pipe shall be hydrostatically (water) tested by the manufacturer to verify compliance. All systems shall utilize a separate waste and vent system.

B. Joints for Hubless Cast Iron Pipe and Fittings Above Grade: Couplings for joining hubless cast iron soil pipe and fittings conforming to ASTM A888, shall be 3 inches wide for nominal pipe sizes 1-1/2 to 4 inches in diameter, 4 inches wide for nominal pipe sizes 5 to 10 inches in diameter. Shields shall have a minimum thickness of 0.015 inches (28 gauge) type 304 stainless steel. Worm drive clamps shall be type 304 stainless steel with a minimum clamp torque of 80 in/lbs. Sealing Gasket shall be neoprene conforming to ASTM C564. Couplings shall conform to FM 1680, Class 1 or ASTM C1540.
   1. Alternate to above, cast iron split clamps secured by stainless steel bolts and nuts with neoprene gasket conforming to ASTM C564, as manufactured by MG Coupling Company.
   2. FM approved couplings may be hung with one hanger per length of pipe for 10-foot lengths and at every third fitting where they are contiguous in conformance with manufacturers installation instructions.

2.4 PIPE WRAP FOR BELOW GROUND PIPING

A. General: Provide pipe wrap for all cast iron pipe installed below ground and cast iron pipe installed inside grout-filled block walls.

B. All underground grease waste, waste and vent cast iron piping installed below finished grade shall be encased in two (2) layers of an ANSI/AWWA C105, 8-mil polyethylene jacket installed per ANSI/AWWA C105/A21.5.

2.5 SETTLEMENT JOINTS

A. General: Provide settlement joints on all service entrance sanitary waste and grease waste pipe from each building as indicated on the Plumbing Drawings.

B. Flexible settlement joints shall be manufactured of 65-45-12 ductile iron conforming to the material requirements of ASTM A536.84 and ANSI/AWWA C153/A21.53. Provide foundry certification of material with submittal.

C. Each settlement joint shall be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, shall apply. Factory Mutual Approval for the 12 inch and smaller sizes is required.

D. Each settlement joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20 degrees for 3 inches to 12 inches, and 4 inches minimum expansion.

E. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be holiday tested with a 1500 volt spark test conforming to said specification. Sealing gaskets shall be constructed of EPDM. The coating and gaskets shall meet NSF/ANI 61.

F. All external surfaces shall be coated with a catalyzed coal tar epoxy conforming to the material requirements of AWWA C210. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

G. Manufacturer's certification of compliance to the above standards and requirements shall be provided with submittal.

2.6 PIPE ESCUTCHEONS

A. General: Provide solid (not split-hinged) pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. All areas with escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid cast brass or sheet brass escutcheons, solid pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid sheet metal escutcheons.

D. Manufacturer: Chicago Specialty, Producers Specialty, Sanitary-Dash.

2.7 FIRE BARRIER PENETRATION SEALS

A. Provide seals for opening through fire-rated walls, floors, or ceiling used as passage for mechanical components such as piping or ductwork. Refer to details on Drawings.
   1. Piping: Provide fire stopping material as specified in Section 07 84 00.

PART 3 EXECUTION

3.1 EXCAVATION

A. Comply with Division 2 Sections for sitework, excavating, trenching, and backfilling.

3.2 SERVICE ENTRANCE PIPING

A. Extend building sanitary and grease waste piping and connect to building sanitary and grease drainage piping of size and in location indicated on the underground plumbing drawings for service entrance to each building in. Coordinate invert elevations, pipe sizes and points of connection with the Civil Drawings. Install cleanout and extension to grade at connection of building sanitary and grease drainage.

B. Provide settlement joint at each service entrance to each building as indicated on the Plumbing Drawings.

3.3 PREPARATION OF FOUNDATION FOR BURIED PIPING WHERE BUILDING IS SLAB-ON-GRADE

A. Grade trench bottom to provide smooth, firm, stable, and rock-free foundation throughout length of piping.

B. Remove unstable, soft and unsuitable materials at surface on which piping is to be laid and backfill with clean sand or pea gravel to indicated level.

C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped-sand backfill. Dig holes at each end of pipe joint to relieve loads and to ensure continuous bearing of pipe barrel on foundation.

3.4 PIPE SUPPORT FOR BUILDING WITH SUPPORTED SLABS

A. Attach all sanitary and grease waste drainage piping to structural slab as indicated on the underground plumbing plans for each building.

B. Comply with the requirements of Article 1.5 D of this Section.

3.5 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Underground, Sanitary and Grease Waste Drainage Piping: Use the following:
   1. 2 to 8 inches: Use service weight hub and spigot cast-iron pipe and fittings.
   2. Encase all underground piping in two (2) layers of ANSI/AWWA C105, 8-mil polyethylene jacket installed per ANSI/AWWA C105/A21.5 Standards.

C. Aboveground, Sanitary and Grease Waste Drainage Piping: Use the following:
   1. 2 to 8 inches: Use hubless cast-iron pipe; hubless cast-iron pipe fittings; and hubless cast-iron heavy duty stainless steel couplings.

3.6 SANITARY AND GREASE WASTE AND VENT PIPING INSTALLATION

A. General: Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

B. Make changes in direction for sanitary and grease waste drainage piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in piping and pull past each joint as completed.

D. Install sanitary and grease drainage piping at the following minimum slopes, except where another slope is indicated on the plumbing drawings:
   1. Building Sanitary and Grease Waste Drain: 1/4 inch per foot (2 percent) downward in direction of flow for piping 6 inches and smaller; unless otherwise indicated on the Drawings.
   2. Horizontal Storm Drainage Piping: 1/4 inch per foot (2 percent) downward in direction of flow, unless otherwise indicated on the Drawings.

E. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

F. Do not enclose, cover, or put piping into operation until it is inspected and approved by local plumbing inspector or authorities having jurisdiction.

G. Underground Horizontal Piping: Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

H. Trench shall be wide enough to assemble joints.

I. Trench Bottom shall be stable enough to support the complete barrel of the pipe. If possible, barrel to rest on even undisturbed soil. If it becomes necessary to excavate deeper than needed, place and tamp back fill material to provide an appropriate bed. Holes shall be provided at each joint for the couplings to allow for continuous support of the barrel along the trench bottom.

J. Maximum deflection (change in the direction of the line) shall not exceed ½-inch per foot of pipe.

K. Maintain proper alignment during backfilling, stabile the pipe in proper position by partial backfilling and cradling.

L. Piping laid on grade shall be adequately secured to prevent misalignment when slab is poured.

M. Closet bends installed under slabs shall be adequately secured.

N. Aboveground Horizontal Piping, Suspended: Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Support horizontal pipe and fittings at sufficiently close intervals to maintain alignment and prevent sagging or grade reversal. Support each length of pipe at every coupling, located not more than 18-inch for the joint.

P. Support terminal ends of all horizontal runs or branches at each change of direction or alignment with approved hanger.

Q. Closet bends installed above ground shall be firmly secured.

R. Horizontal pipe and fittings 6 inches and larger shall be braced to prevent horizontal movement. Provide at every branch opening or change of direction by the use of braces, blocks, rodding or other suitable method to prevent movement or joint separation.

S. Vertical Piping: Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

T. Support vertical piping at sufficiently close intervals to maintain alignment and to support the weight of the pipe and its contents. Support stacks at their bases and at each floor level. Provide riser clamps not to exceed 15'-0".

U. If vertical piping is to stand free of any support or if no structure element is available for stability during construction, secure the piping in its proper position by means of adequate stakes or braces fastened to the pipe.

V. Closet bends installed above ground shall be firmly secured.

3.7 JOINT CONSTRUCTION

A. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Hubless Joints: Make with heavyweight rubber gasket.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with Section 22 05 29 for pipe hanger and support devices and Section 22 05 48 for seismic-restraint devices.

B. Conform to Table below for maximum spacing of supports:

	Horizontal	Vertical
Pipe Material	In Feet	In Feet
Cast Iron Soil Pipe	5	15

C. Pipe Attachments: Install the following:
   1. Riser Clamps: MSS Type 8 or Type 42 for vertical runs.
   2. Adjustable Steel Clevis Hangers: MSS Type 1 for individual straight runs to 100 feet and less.

D. Support cast-iron soil pipe and fittings not included in Table, at a maximum horizontal spacing of 5 feet, except 10-foot sections of pipe may be supported at 10-foot spacing and at a maximum vertical spacing of 15 feet.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect sanitary and grease waste drain piping to exterior sanitary drainage piping. Use transition fitting to join dissimilar piping materials. Coordinate with Civil Drawings.

C. Connect sanitary and grease waste drainage piping to the following:
   1. Plumbing Fixtures and Equipment: Connect drainage piping in sizes indicated on Plumbing Drawings.

3.10 FIELD QUALITY CONTROL

A. During installation, notify local plumbing official or authority having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by local plumbing official and/or authority having jurisdiction to observe tests and to ensure all systems are in compliance with requirements.

B. Reinspection: If local plumbing official and/or authority having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by local plumbing official and/or authority having jurisdiction. A copy of all inspection reports shall be included in the O&M Manuals.

3.11 TESTING

A. Test sanitary and grease drainage and vent piping according to procedures of local plumbing inspector and as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed drainage and vent piping until it has been tested and approved. Expose for testing work that has been covered or concealed before it has been tested and approved.
   3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in piping installation. Tightly close all openings in the piping system, torque all couplings to recommended 80 in/lbs and all bends, changes of direction and ends of runs should be properly restrained prior to testing. Contractor shall have the option of hydrostatic or air test the system(s) as followings:
      a. Hydrostatic or Water Test: Prior to the hydrostatic test expelled all air from the system. A hydrostatic test of 10 feet of hydrostatic pressure (4.3 pounds per square inch) shall be performed. Test system for a minimum of 15 minutes, water level must not drop. Inspect joints for leaks.
      b. Air Test: The system shall be pressurized to a maximum of 6 psi utilizing a gauge graduated to no more than 3 times the test pressure. The gauge shall be monitored during the 15 minute test. A reduction of more than 1 psi during the test period indicates failure of the test.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch water column. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.12 CLEANING

A. Clean interior and exterior of piping prior to installation. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.13 STARTUP SERVICES

A. Before operating systems, perform these steps:
1. Remove all plugs used during testing of piping systems and plugs used for temporary sealing of piping during installation.

B. Check plumbing equipment and verify proper settings, adjustments, and operation.

C. Check plumbing specialties and verify proper settings, adjustments, and operation.

D. Refer to Part I, article 1.2/F.

3.14 PROTECTION

A. Protect all piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION

SECTION 221319

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Cleanouts.
   2. Floor Drains.
   3. Floor Sinks.
   4. Flashing Materials.

B. Coordinate electrical requirements with electrical contractor prior to commencing Work.

C. Related Sections
   1. Section 07 60 00 - Flashing and Sheet Metal.
   2. Section 08 31 13 - Access Doors and Frames.
   3. Section 22 05 00 - Common Work Results for Plumbing.
   4. Section 22 05 23 - General Duty Valves for Plumbing Piping.
   5. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
   6. Section 22 11 16 - Domestic Water Piping.
   7. Section 22 13 16 - Sanitary Waste and Vent Piping for Piping and Connections.
   8. Section 22 40 00 - Plumbing Fixtures.
   9. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:
   1. Sanitary Waste and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 and 01 33 23.

B. Shop Drawings
   1. Shop drawings and elevations of interceptor.
   2. Waterproofing and tie-down details for fully immersed interceptor.
   3. In accordance with Section 22 05 29 and 22 05 48.

C. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:
   1. Flashing Materials.
   2. Cleanouts.
   3. Floor Drains.
   4. Floor Sinks.

D. Calculations

1. Calculations for fully immersed interceptor.
2. In accordance with Section 22 05 29 and 22 05 48.

E. Field test reports.

1.4 QUALITY ASSURANCE

A. Design Concept: Drawings indicate capacities, size, profiles, and dimensional requirements of plumbing specialties and system components. Components having equal performance characteristics that deviate from the indicated size and dimensions may be considered, provided such deviations do not change the design concept or intended performance. Refer to Division 1.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of interceptors of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

C. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Codes and Standards:
1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
2. PDI Compliance: Test and rate grease interceptors in accordance with PDI Standard G101, Testing and Rating Procedure for Grease Interceptors.
3. Comply with State Health Department.

1.5 EXTRA MATERIALS

A. Deliver extra materials to owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with labels clearly describing contents.

B. Operating Keys (Handles): Furnish 1 extra key for each key-operated hose bibb and hydrant installed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle interceptors carefully to prevent damage, and/or breaking. Do not install damaged or broken interceptors; replace with new.

B. Store interceptors in clean dry place. Protect from weather, dirt, water, construction debris, and physical damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Floor Drains / Floor Sinks:
   1. Jay R.Smith Mfg. Co., Smith Industries, Inc.
   2. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   3. Wade Div., Tyler Pipe.

B. Cleanouts:
   1. Jay R.Smith Mfg. Co., Smith Industries, Inc.
   2. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   3. Wade Div., Tyler Pipe.

C. Vandal Proof Vent Caps:
   1. Jay R.Smith Mfg. Co., Smith Industries, Inc.
   2. Zurn by Hydromechanics Div., Zurn Industries, Inc.
   3. Wade Div., Tyler Pipe.

D. Approved Equal. Manufacturers: Subject to compliance with requirements, provide products by one of the following: In-Ground Grease Interceptors:
   1. Jensen Precast (Basis of Design)
   2. M.C. Nottingham.
   3. Park Environmental.

E. Sampling Box:
   1. Jensen Precast (Basis of Design)
   2. M.C. Nottingham.
   3. Park Environmental.

2.2 CLEANOUTS

A. General: Size cleanouts as indicated on Drawings, or where not indicated, same size as connected drainage piping. Cleanouts larger than 4 inches are not required except where indicated.

B. Cleanouts: ASME A112.36.2M, cast-iron body with straight threads and gasket seal or taper threads for plug, flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring. The Product Data Sheets at end of Part 3 of this Section indicate deck plate shape, top-loading classification, access cover, finish, and other specific features.

C. Products: Subject to compliance with requirements, provide one of the products specified in each Sanitary Waste Piping Specialties Product Data Sheet at end of this Section.

2.3 MOP SINKS

A. General: Size outlets as indicated on Product Data Sheet or drawings.

2.4 FLASHING MATERIALS

A. Lead: ASTM B 749, Type L51121, copper-bearing sheet, at least 4 psf (0.0625-inch thick) for general use, and at least 6 psf (0.0937-inch thick) for burning (welding), except as otherwise indicated.

B. Roof Flashing Assemblies: Manufactured assembly consisting of 4-psf lead flashing collar with boot and skirt extending at least 8 inches from pipe, with galvanized steel boot reinforcement and counter flashing fitting.
   1. Option 1: Open top.

2.5 MISCELLANEOUS PIPING SPECIALTIES

A. Piping specialties such as escutcheons, dielectric fittings, sleeves, and sleeve seals are specified in Section 22 05 00, Common Work Results for Plumbing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with Section 22 05 00 for piping joining materials, joint construction, and basic installation requirements.

3.2 PIPING SPECIALTY INSTALLATION

A. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of 1/8 inch per foot (1 percent) and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow.

B. Install cleanouts in above-ground piping and building drain piping as indicated, and where not indicated, according to the following:
   1. Size same as drainage piping up to 4-inch size. Use 4-inch size for larger drainage piping except where larger size cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping 4-inches and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil or waste stack.

C. Install cleanout deck plates (covers), of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.

D. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

E. Install flashing flange and clamping device with each stack and cleanout passing through floors having waterproof membrane.

F. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to the manufacturer’s written instructions.

3.3 FLOOR DRAIN / FLOOR SINK INSTALLATION

A. Install drains according to manufacturer’s written instructions, in locations indicated.

B. Trap drains connected to sanitary building drain.

C. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

D. Position drains for easy accessibility and maintenance.

3.4 CONNECTIONS

A. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, but not smaller than required by plumbing code.

B. Locate drainage piping runouts as close as possible to bottom of floor slabs supporting fixtures or drains.

C. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.
   1. Grounding: Connect unit components to ground according to the National Electrical Code and Section 26 05 26.

3.5 FLASHING INSTALLATION

A. Provide flashing Manufactured in a single piece except where large pans, sumps; or other drainage shapes are required.

B. Install 4-psf lead flashing or 16-oz. per sq. ft. copper, except when another weight or material is specified.

C. Install 8-psf lead flashing or heavier where burning (welding) of lead sheets is required.

D. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with membrane waterproofing.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve length of 10-inches, and skirt or flange extending at least 8-inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8-inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 3-inches around specialty.

E. Set flashing on floors and roofs in solid coating of bituminous cement.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Section 07 60 00.

H. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having calking recess.

I. Fabricate and install lead sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

J. Fabricate and install copper sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

K. Fabricate and install galvanized-steel sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

L. Fabricate and install elastic-membrane sheet flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection when indicated.

3.6 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each, trap seal primer system.
   1. Text: Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
   2. Requirements for nameplates and signs are specified in Section 22 05 00.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and grease recovery units and their installation, including piping and electrical connections. Report results in writing.
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

C. Protect interceptors during remainder of connection period, to avoid clogging with construction materials and debris, and to prevent damage from construction and traffic.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain trap seal primer systems. Comply with the requirements of Division 1.

3.10 STARTUP SERVICES

A. Preparation: Perform the following checks before start-up:
   1. Systems tests are complete.
   2. Damaged and defective specialties and accessories have been replaced or repaired.
   3. There is clear space for servicing of specialties.

B. Before operating systems, perform these steps:
   1. Close drain valves.
   2. Open valves to full open position.
   3. Verify drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:
   1. Energize circuits for grease recovery units. Start and run units through complete sequence of operations.

3.11 ADJUSTING

A. Adjust operation and correct deficiencies discovered during startup services.

3.12 SANITARY WASTE PIPING SPECIALTIES SCHEDULES

A. Provide plumbing specialties as scheduled on the following "Data Sheets." Each Data Sheet begins with a new page.

SANITARY WASTE PIPING SPECIALTIES DATA SHEET

Cleanout Type:	FCO.
Description:	Floor cleanout with round adjustable scorated nickel bronze top, lead seal and “Lekeromate” seal.
Appropriate Standard:	ASME A112.36.2M.
Material:	Cast-iron body.
Shape:	Round.
Top-Loading Classification:	Medium Duty.
Cover Finish:	Provide round top.
Closure Plug:	Brass.
Products:	J.R.Smith 4020. Wade. Zurn.

Note: All floor cleanouts shall have vandal proof screws (Comply with Section 05 05 23, Article 3.38).

SANITARY WASTE PIPING SPECIALTIES DATA SHEET

Cleanout Type:	CO.	
Description:	Cleanout; cast iron caulk ferrule with lead seal plug.	
Appropriate Standard:	ASME A112.36.2M.	
Material:	Cast-iron body.	
Shape:	Round.	
Products:	J.R.Smith Wade. Zurn.	4400.

Note: For installation in Mechanical Chases only.

SANITARY WASTE PIPING SPECIALTIES DATA SHEET

Cleanout Type:	GCO.
Description:	Grade cleanout.
Appropriate Standard:	ASME A112.36.2M.
Material:	Galvanized Cast-iron body.
Shape:	Round.
Top-Loading Classification:	Heavy Duty.
Cover Finish:	Nickel brass.
Closure Plug:	Brass.
Products:	J.R.Smith 4020. Wade. Zurn.

Notes: All cleanouts shall have vandal proof screws (Comply with Section 05 05 23, Article 3.38).

END OF SECTION

SECTION 223313

INSTANTANEOUS ELECTRIC DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Point of use, digital microprocessor based, electric water heaters, trim fittings and accessories, appurtenances associated with public/staff and detention plumbing fixtures.

B. Related Sections
   1. Section 22 05 00 - Common Work Results for Plumbing.
   2. Section 22 40 00 - Plumbing Fixtures.

1.2 REFERENCES

A. ASHRAE 90.1- Energy Standard for Buildings Except Low-Rise Residential Buildings.

B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.

C. NSF/ANSI 61 - Drinking Water System Components - Health Effects.

D. UL 499 - Standard for Safety Electric Heating Appliances.

E. UL 486A-486B - Standard for Safety for Wire Connectors.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. Product data including rated capacities of selected models, weight, furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.

C. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

D. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.

E. Maintenance Data: For water heaters to include in maintenance manuals specified in Division

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with performance efficiencies prescribed for ASHRAE 90.1.

E. Design Concept: The Drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equity of water heaters is on the proposer.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of instantaneous electric water heaters that fail in materials or workmanship within specified warranty period. Repair and replacement includes cost of labor and freight. Initiation and/or continuation of warranty coverage will not be dependent upon annual inspections, regular replacement of anode rods, or water chemistry.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period: From date of Project completion for Controls and Other Components: Two years.

B. Provide warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Point-of-Use, Tankless, Electric Water Heaters:
      a. Stiebel Eltron
      b. Chronomite Laboratories, Inc.
      c. Or equal known.

2.2 POINT-OF-USE, TANKLESS, ELECTRIC WATER HEATERS

A. Description: The point-of-use water heater shall be digitally controlled microprocessor electric tankless water heater with factory preset temperatures as indicated in the Equipment Schedule. The element assembly shall be Celcon plastic with stainless steel heating coils. Comply with UL 499.

B. Construction: Without hot-water storage.

1. Working-Pressure Rating: 150 psig.
2. Tappings: ASME B1.20.1, pipe thread.
3. Interior Finish: Materials complying with NSF 61, barrier materials for potable-water tank linings.
4. Jacket: Aluminum or steel, with enameled finish, or plastic.

C. Heating System: Electric-resistance type.
1. Temperature Control: Factory-set, temperature-control thermostat for fixed, outlet-water temperature. Requirements are indicated on Schedule on the Plumbing Drawings.

D. Mounting: Bracket or device for wall mounting.

2.3 WATER HEATER ACCESSORIES

A. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig maximum outlet pressure.

B. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

C. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated, steel bracket for wall mounting and capable of supporting water heater and water.

PART 3 EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install water heaters, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect hot and cold water piping with shutoff valves and unions.

D. Make connections with dielectric fittings where piping is made of dissimilar metal.

E. Electrical Connections: Power wiring and disconnect switches are specified in Division 26. Arrange wiring to allow unit service.

F. Ground equipment.
1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for location where installed.

B. Check that fixtures are complete with trim and faucet.

C. Engage a factory-authorized service representative to perform startup service.

D. In addition to manufacturer's written installation and startup checks, perform the following:
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   2. Verify that piping system tests are complete.
   3. Check for piping connection leaks.
   4. Check for clear valve inlets and outlets.
   5. Test operation of controls.
   6. Energize electric circuits.

3.4 CLEANING

A. Clean water heater and other fittings with manufacturer's recommended cleaning methods and materials.

3.5 PROTECTION

A. Provide protective covering for installed water heater.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by the Owner's Representative.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train the maintenance personnel to adjust, operate, and maintain water heaters.
   1. Train the maintenance personnel on procedures for starting and stopping, troubleshooting, servicing, and maintaining equipment.
   2. Schedule training with the Owner's Representative, with at least seven days advance notice.

3.7 COMMISSIONING

A. Perform the following before start-up final checks:
   1. Piping systems test complete.
   2. Check for piping connection leaks.
   3. Check for power wiring connected.

B. Perform the following start-up procedures:
   1. Energize circuits.
   2. Check for hot water flow.

END OF SECTION

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POINT-OF-USE

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FOR ALL POINT-OF-USE WATER HEATING APPLICATIONS!

STIEBEL ELTRON Mini™ tankless electric water heaters are the ideal choice for all point-of-use applications in the following settings:

Commercial • Industrial • Institutional

- » Office buildings
- » Stores
- » Malls
- » Warehouses
- » Restaurants
- » Gas stations
- » Schools
- » Hotels/Motels
- » Commercial condominiums
- » Manufacturing facilities

Residential

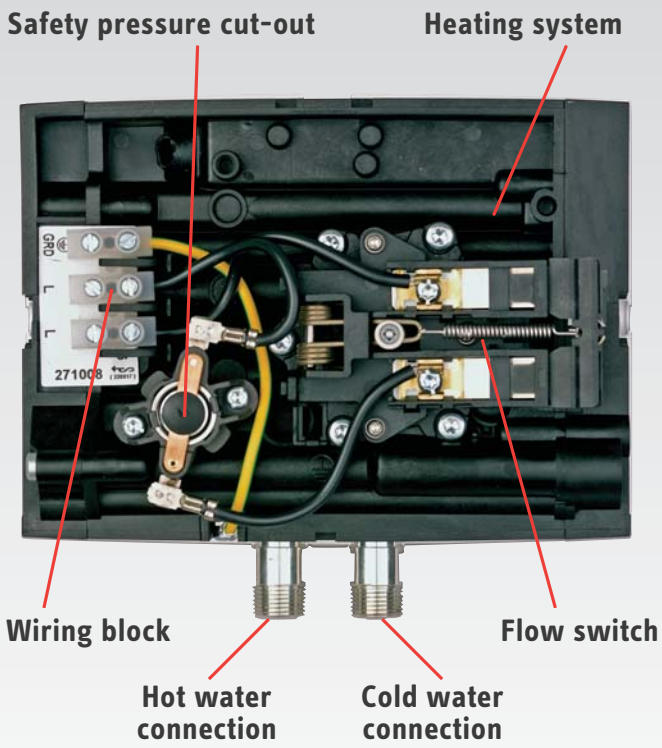
- » Bathroom sinks
- » Kitchen sinks
- » Laundry areas
- » Cabins/cottages

The Stiebel Eltron Mini™ tankless water heaters are designed for installation at the point-of-use. The Mini™ heats water instantaneously as it flows through the unit. Stand-by heat-losses are completely eliminated.

The efficient heating elements are controlled by a flow switch. Additionally, all Mini™ water heaters are equipped with a safety high-limit with manual reset. The combination of meticulous German engineering and the best available materials ensure that every Mini™ is of the highest quality and designed for many years of trouble-free service. Nobody can compare with our exceptional reliability record and customer support services!

All models except the Mini™ 6 ship with a pressure compensating flow reducer / aerator that fits most faucets. The Mini™ 2, 2.5, and 3 models ship with a 0.5 GPM aerator. The Mini™ 3.5 and 4 model ships with a 0.66 GPM aerator. Faucet aerators or other flow controls are highly recommended in conjunction with tankless water heaters. No pressure relief valve*, drains, or circulating pumps are needed.

*Except in Massachusetts

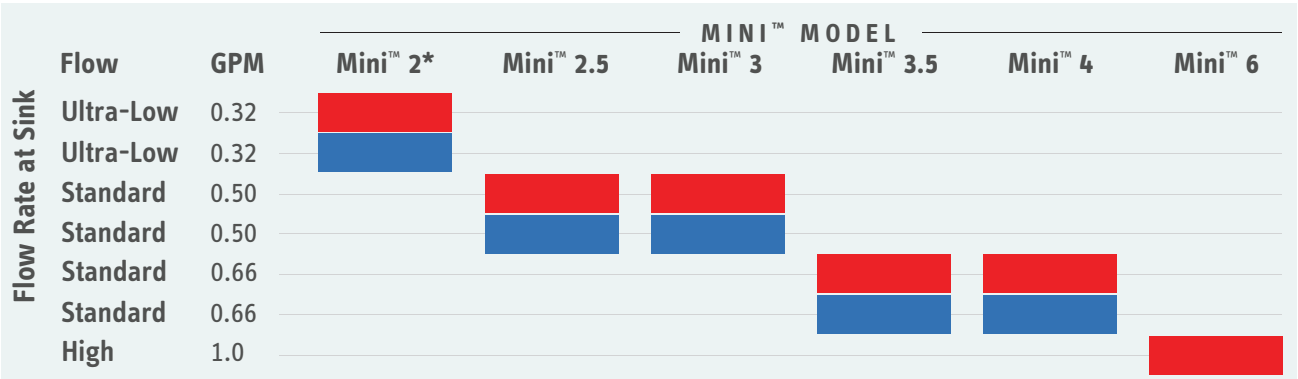


Engineer's Specifications: The tankless electric water heater shall be equipped with a bare wire nichrome type heating element housed in fiberglass reinforced high temperature plastic containment. The housing of the unit shall be made of high impact polycarbonate plastic. The flow switch that operates the heating element shall be of the mechanical pressure differential type. The unit shall be equipped with a safety high-limit switch with manual reset. The water connections shall be designed for standard 9/16"-24 flexible hose type connectors. The units shall ship with a AWG #12 wire harness with a length of 2 ft.

STIEBEL ELTRON



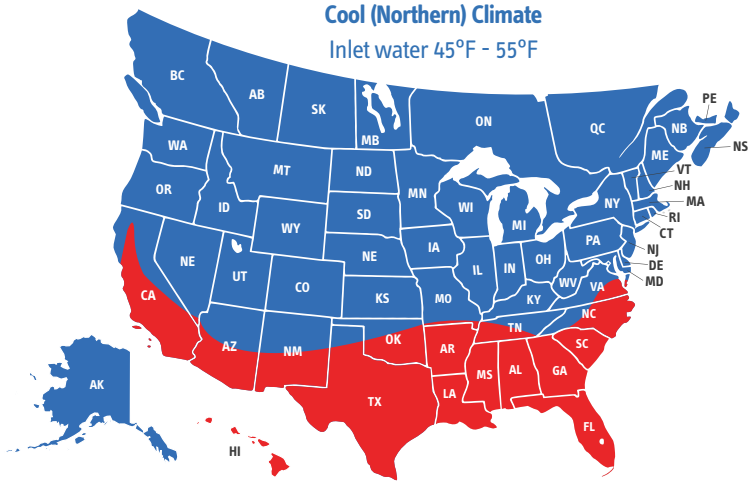

Mini™ Tankless Electric Water Heater Sizing Guide [1]



*Mini™ 2 is internally restricted to 0.32 GPM

[1] These recommendations are for 240 V units installed at that voltage. Increase one model size if unit will be installed with 208 V service.

Stiebel Eltron's main plant in Holzminden, Germany



Intertek

The Mini™ series is tested and certified by WQA against NSF/ANSI 372 for "lead free" compliance.

ISO 9001 CERTIFIED

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MINI™ SERIES TANKLESS ELECTRIC WATER HEATERS

Technical Data

Intertek

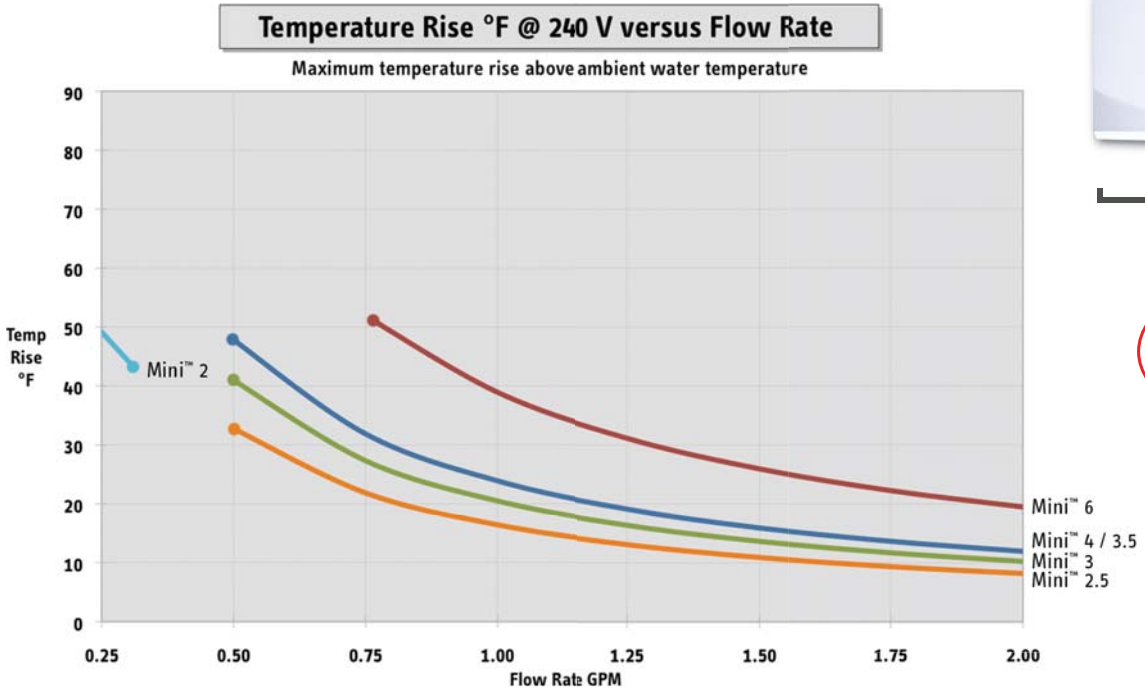
The Mini™ series is tested and certified by WQA against NSF/ANSI 372 for "lead free" compliance.

ISO 9001 CERTIFIED

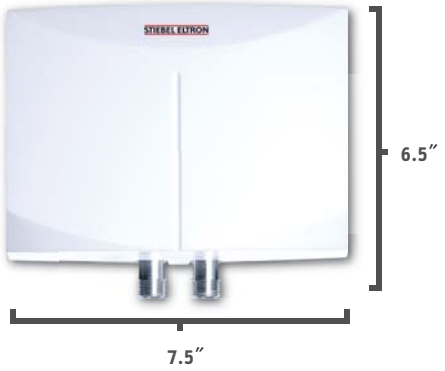
Mini™ Model	Mini™ 2	Mini™ 2.5	Mini™ 3	Mini™ 3.5	Mini™ 4		Mini™ 6	
Item Number	231045	232098	220816	232099	222039		220817	
Phase	1	1	1	1	1	1	1	1
Voltage	120 V	120 V	120 V	120 V	208 V	220 - 240 V	208 V	220 - 240 V
Wattage	1.8 kW	2.4 kW	3.0 kW	3.5 kW	2.9 kW	3.5 kW	4.7 kW	5.7 kW
Amperage Draw (see below for recommended breaker size)	16 A	21 A	25 A	31 A	13.8 A	15.2 A	22.4 A	24.7 A
Min. required circuit breaker size [1]	20 A	30 A	30 A	40 A	20 A	20 A	30 A	30 A
Recommended wire size [2]	12 AWG	10 AWG	10 AWG	10 AWG	12 AWG	12 AWG	10 AWG	10 AWG
Minimum water flow to activate unit	0.21 GPM / 0.8 l/min	0.40 GPM / 1.5 l/min	0.40 GPM / 1.5 l/min	0.40 GPM / 1.5 l/min	0.40 GPM / 1.5 l/min		0.77 GPM / 2.9 l/min	
Degree of protection according to IEC 529	IP 24							
Minimum water resistivity	2795 Ω x in / 1100 Ω x cm							
Weight	3.44 lbs / 1.56 kg							
Dimensions (Height/Width/Depth)	6.5″ (16.5 cm) / 7.5" (19.0 cm) / 3.25" (8.2 cm)							
Working Pressure	150 psi / 10 bar							
Tested to Pressure	300 psi / 20 bar							
Volume of water in unit	0.026 gal. / 0.1 l							
Water connections [3]	for 9/16″-24 flexible hose type connectors							

[1] This is our recommendation as the manufacturer. Check local codes for compliance if necessary. Tankless water heaters are considered a non-continuous load.
[2] Copper must be used. Conductors should be sized to maintain a voltage drop of less than 3% under load.
[3] For use with cold water supply only

Limited Warranty (Excerpt): Stiebel Eltron, Inc. warrants to the original owner that the Mini™ Series Tankless Electric Water Heater will be free from defects in workmanship and materials for a period of THREE (3) YEARS from the date of purchase. Should any part(s) prove to be defective during this period, Stiebel Eltron, Inc. will be responsible for replacement of the defective part(s) only. STIEBEL ELTRON, Inc. is not responsible for labor charges.



Super-compact dimensions!



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SECTION 224000

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Water Closets (Commercial and Security).
2. Lavatories (Commercial and Security).
3. Sinks.
4. Mop Sinks.
5. Drinking Fountain.

B. Related Sections

1. Section 06 41 16 - Plastic-Laminate-Clad Architectural Cabinets.
2. Section 07 90 00 - Joint Protection.
3. Section 22 05 00 - Common Work Results for Plumbing.
4. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
5. Section 22 11 16 - Domestic Water Piping.
6. Section 22 11 19 - Domestic Water Piping Specialties.
7. Section 22 13 16 - Sanitary Waste and Vent Piping.
8. Section 22 13 19 - Sanitary Waste Piping.
9. Section 26 27 00 - Equipment Wiring Systems.

1.2 REFERENCES

A. ADAAG - Americans with Disabilities Act Accessibility Guidelines.

B. ANSI/ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

C. ANSI/ASME A112.18.1 - Plumbing Fixture Fittings.

D. ANSI/ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.

E. ANSI/ASME A112.19.2M - Vitreous China Plumbing Fixtures.

F. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

G. ANSI/ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures.

H. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

I. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

J. ANSI/ARI 1010 - Self-Contained, Mechanically Refrigerated Drinkingwater Coolers.

K. ICC A117.1, - Accessible and Usable Buildings and Facilities.

L. CRR Title 24, Part 2, Section 511 and Part 5, Chapter 15.

M. Energy Policy Act of 1992 (EPACT)

N. IAPMD/UPC

1.3 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.

B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution system that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term “fixture” means the actual receptor, except when used in a general application where terms “Fixture” and “Plumbing Fixture” include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.

H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
   1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
   2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
   3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
   4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1.

B. Product Data: For each type of plumbing fixture specified, provide catalogue illustrations, sizes, rough-in dimensions, utility sizes including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

C. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring, as required.

D. Maintenance Data: Include fixture trim exploded view and replacement paints list. Plumbing fixtures to include in maintenance manuals specified in Division 1.

E. Warranty: Submit manufacturer's standard warranty and ensure forms have been completed in OWNER's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixture having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixture is on the proposer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.7 DELIVERY, STORAGE, HANDLING. AND PROTECTION

A. Deliver plumbing fixtures in manufacturer's protective packing, crafting, and covering. Inspect for damage. Report damage to OWNER field responsible.

B. Store and protect plumbing fixtures from damage on elevated platforms in a dry location by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Furnish quantity of identical units not less than 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Furnish quantity of identical units not less than 5 percent of amount of each type and size installed.
   3. Faucet, Laminar-Flow Fittings: Furnish quantity of identical units not less than 10 percent of amount of each type and size installed.
   4. Faucet, Flow-Control Fittings: Furnish quantity of identical units not less than 10 percent of amount of each type and size installed.
   5. Flushometer Repair kits: Furnish quantity of identical units not less than 10 percent of amount of each type and size installed.
   6. Toilet Seats: Furnish quantity of identical units not less than 10 percent of amount of each type toilet seat installed.

PART 2 PRODUCTS

2.1 WATER CLOSET (TANK TYPE) (ADA COMPLIANT) (WC-1)

A. Manufacturers:
   1. American Standard, Inc., Model Cadet 3 FloWise Right Height Elongated one-piece toilet
   2. Kohler, Kingston
   3. Crane Plumbing/Fiat Products.

B. Description:
   1. Material: Vitreous China.
   2. Color: White
   3. Bowl Configuration: Elongated, top spud.
   4. Spud Size: 1-1/2 inch.
   5. Passageway: 2-1/4 inch.
   6. Mounting and Outlet: Floor mounted, back outlet.
   7. Rim Height: 16-1/2-inches above finished floor. (ADA Compliant). Coordinate mounting heights with Architectural Drawings.
   8. Water Consumption: 1.28 gpf.

9. Wall Construction: As indicated on Architectural Drawings.
10. Fittings and Accessories: Provide the following compatible components:
    a. Tank Type: Close-couple tank with flat tank cover, Speed Connect tank to bowl coupling system, sanitary dam on bowl with four point tank stabilization.
    b. Toilet Seat: Type 1

2.2 LAVATORY (L-1)

A. Manufacturers:
1. American Standard, Inc., Model Lucerne
2. Kohler, Kingston Model K-2007.
3. Crane Plumbing/Fiat Products.

B. Description:
1. Material: Vitreous China
2. Color: White
3. Lavatory Size: 20-1/2 inches x 18-1/4 inches.
4. Mounting and Outlet: Floor mounted, wall outlet.
5. Rim Height: ADA Compliant. (Coordinate mounting height with Architectural Plans and Elevations.)
6. Wall Construction: Type of wall indicated on Architectural Floor Plans.
7. Faucet, Fittings and Accessories: Provide the following compatible components:
    a. Faucet: Kohler Coralais Model K-15199-P-CP, single control lavatory faucet.
    b. Supplies: Lavatory Type 1.
    c. Drain: Kohler K-7715 Grid Drain.
    d. Trap: Lavatory Type 1.
    e. Support Type: J.R. Smith, lavatory supports with concealed arms; floor mounted with “Pro-Set” uprights, Model 0700.
    f. Flow rate 0.35 gpm Vandal Resistant Head.

2.3 SINK (SK-1)

A. Manufacturers:
1. Elkay, Model LRAD1720.
2. Just.
3. Approved Equal.

B. Description:
1. Material: Stainless steel, type 304.
2. Gauge: 18 gauge.
3. Sink Type: Single compartment sink; self rimming.
4. Sink Dimensions: 17 inches by 20 inches by 6-1/2 inches deep.
5. Inside Bowl Dimensions: 14 inches by 14 inches.
6. Mounting: Self-rimming-counter mounting. (Coordinate mounting height with Architectural Plans and Elevations.)
7. Faucet, Fittings and Accessories:Provide the following compatible components:
    a. Faucet: Chicago Faucet Model 786-GN2FCCP deck mounted rigid fixed position gooseneck spout; Chicago Model 317-Chrome plated, 4-inch wrist-blade handles, hot and cold indents; quarter turn operating cartridge.
    b. Supplies: Sink Type 1
    c. Drain: Elkay Model LK-35 Strain Drain.
    d. Trap: Sink Trap, Type 2.

2.4 MOP SINK (MS-1)

A. Manufacturers:
   1. Willoughby, Model WMS-24246-MOD.
   2. Acorn.
   3. Elkay.

B. Description:
   1. Fixture: Stainless Steel Corner Mop Sink.
   2. Material:14-gauge, Type 304 stainless steel, all welded; exposed stainless steel surfaces #4 finish and bead blast interior and sound deaden underside.
   3. Sink Dimensions: 24 inch by 24 inch.
   4. Faucet, Fittings and Accessories:Provide the following compatible components:
      a. Faucet:Speakman Model SC-5812 polished chrome plated brass service sink fitting with ¼ turn ceramic cartridges; integral stops; cast brass nozzle with 3/4-inch hose thread and pail hook; brass vacuum breaker; brass top brace assembly with wall flange and mounting screws; 9-inch distance from finished wall to nozzle outlet; 8-inch centers with adjustable threaded brass wall flange;1/2-inch NPTF outlets; 5 feet vinyl hose with wall hook; ASSE-1001.

2.5 DRINKING FOUNTAINS (DF-1)

A. Manufacturers:
   1. Haws, Model 1119.
   2. Elkay.
   3. Acorn.

B. Description:
   1. The Haws 1119 barrier free "Hi-Lo" drinking fountain uses a patented stainless steel, push-button activated, valve assembly (Pat.# 6,981,692) allowing for front access stream adjustment as well as cartridge and strainer access. Wall mounted design allows the 1119 to be placed securely in multiple locations without taking up excess space. Equipped with vandal resistant components, this fountain is not easily disrupted, quickly discouraging vandals.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for potable cold water and hot water supplies and soil and for waste and vent piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer’s roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
   1. Carriers for following fixtures:
      a. Wall-hanging water closets.
      b. Wall-hanging fixtures supported from wall construction.
   2. Chair carriers for the following fixtures:
      a. Wall-hanging lavatories and sinks.
      b. Wall-hanging electric water coolers.
   3. Heavy-duty chair carriers for the following fixtures:
      a. Accessible lavatories.
      b. Fixtures where specified.
   4. Reinforcement for the following fixtures:
      a. Wall-mounted lavatories required to be secured to wall.
      b. Wall-mounted sinks required to be secured to wall.

3.3 INSTALLATION OF PLUMBING FIXTURES

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball valve if stops are not specified with fixture. Comply with Section 22 05 23, "General-Duty Valves for Plumbing Piping" for general-duty valves.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

Q. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

S. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with Section 22 05 00, for escutcheons.

U. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with Division 7 Section “Joint Sealants” for sealant and installation requirements.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. The drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
   1. Connect water supplies from water distribution piping to fixtures.
   2. Connect drain piping from fixtures to drainage piping.
   3. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
   4. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
   5. Ground equipment.

a. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Clean to new condition. Do the following:
1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.8 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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model 1119

Wall-Mounted Drinking Fountain

FEATURES & BENEFITS

BUBBLER HEAD

Polished chrome-plated brass bubbler head features an integral basin shank for added strength, and is equipped with a shielded, anti-squirt orifice that provides a steady sanitary source of water.

BACK PANEL

Stainless steel back panel helps to protect the wall from inadvertent splashing, and its decorative satin finish increases location visibility and completes the fountains attractive appearance.

BARRIER-FREE

Barrier-free capabilities combined with its ease of use allows for a number of installation location possibilities.

INTEGRATED TRAP

Spacious fountain design allows for the trap to be internally mounted which allows for easy access, and aids and reduces the installation process.

CONSTRUCTION

18 gauge Type 304 Stainless Steel construction with vandal-resistant bottom plates provides a long lasting unit with added peace of mind.

QUALITY CONTROL

Both fountains are pre-built and fully water and pressure tested to ensure no leaks and proper function for reduced installation time and added peace of mind.

PUSH BUTTON

With its patented (Pat. # 6,981,692) stainless steel, push-button activated valve assembly which allows for front access stream adjustment as well as cartridge and strainer access, this fountain offers 100% lead free waterways. The valve works at an operating pressure range of 30 to 90 psi (2.1 to 6.2 bar).

OPTIONS

- ☐ Filter: Model 6426, 12" x 2" (30.5 x 5.1 cm), in-line lead removal element that reduces lead from incoming water supply.
- ☐ Mounting: Model 6700.4 "Hi-Lo" universal mounting plate for most dual bubbler fountains.
- ☐ Support Carrier: Model 6800 universal in-wall mounting support for use with most fountains.
- ☐ Chiller: Model HCR8, 8 gph (30.3 L) remote water chiller provides instantaneous cooling to meet a continuous demand for chilled water.

To see all options for this model, visit www.hawsco.com

SPECIFICATIONS

Model 1119 "Hi-Lo" wall mounted barrier free drinking fountain shall include dual 18 gauge Type 304 Stainless Steel satin finish basins, push-button operated stainless steel valves with front-accessible cartridge and flow adjustment, 100% lead-free waterways, polished chrome-plated brass vandal-resistant bubbler heads, polished chrome-plated brass vandal-resistant waste strainers, vandal-resistant bottom plates, stainless steel satin finish back panel, high and low fountain mounting levels, and 1-1/4" IPS traps.

APPLICATIONS

Perfect for either public or private indoor/outdoor settings, Model 1119 is a great fit in areas where aesthetics are important to the overall appeal of the architecture. This series is precisely mounted, making it a nice addition to any surrounding. Beautiful satin finish helps to maintain the fountains overall appeal so it always remains looking as new as it did when it was installed. Specifically, this type of wall mounted drinking fountain may be placed in settings such as: schools and other locations in and around office buildings where the temperature remains above freezing.

Model meets all current Federal Regulations for the disabled including those in the Americans with Disabilities Act. Haws manufactures drinking fountains and electric water coolers to be lead-free by all known definitions including NSF/ANSI Standard 61, Section 9, California Proposition 65, and the Federal Safe Drinking Water Act. Product is compliant to California Health and Safety Code 116875 (AB 1953-2006).

1455 Kleppe Lane :: Sparks, NV 89431 :: p. 775.359.4712 :: f. 775.359.7424 :: e. info@hawsco.com :: www.hawsco.com :: 20 June, 2012

American Standard
Style That Works Better

BARRIER FREE

LUCERNE™ WALL-HUNG LAVATORY
VITREOUS CHINA

LUCERNE™ WALL-HUNG LAVATORY

- Wall-hung sink
- Vitreous china
- Front overflow
- D-shaped bowl
- Self-draining deck area with contoured back and side splash shields
- Faucet ledge

Faucet holes on 203mm (8") centers (Illus.):

❑ **0356.028** For exposed bracket support
Shown with 4801.862 Amarilis Heritage faucet with Triune Cross handles (not included)

❑ **0356.015** For wall hanger (included) or concealed arms support

❑ **0356.037** For wall hanger (included) or concealed arms support
- Extra right-hand hole

❑ **0356.073** For wall hanger (included) or concealed arms support
- Extra left-hand hole

Faucet holes on 102mm (4") centers:

❑ **0355.027** For exposed bracket support

❑ **0355.012** For wall hanger (included) or concealed arms support

❑ **0355.034** For wall hanger (included) or concealed arms support
- Extra right-hand hole

❑ **0355.041** For wall hung sink thru bolt support on backsplash for wall anchors

❑ **0355.056** For wall hanger (included) or concealed arms support
- Extra left-hand hole

Single center faucet hole (Illus.):

❑ **0356.041** For exposed bracket support
Shown with 1340.000 metering faucet (not included)

❑ **0356.421** For wall hanger (included) or concealed arms support

❑ **0356.137** For wall hanger (included) or concealed arms support
- Extra right-hand hole

❑ **0356.115** For wall hanger (included) or concealed arms support
- Extra left-hand hole

Nominal Dimensions:
521 x 464mm
(20-1/2" x 18-1/4")

Bowl sizes:
381mm (15") wide
254mm (10") front to back
165mm (6-1/2") deep

Compliance Certifications -
Meets or Exceeds the Following Specifications:
- ASME A112.19.2 for Vitreous China Fixtures

0356.028

0356.041

SEE REVERSE FOR ROUGHING-IN DIMENSIONS

To Be Specified:
- ❑ Color: ❑ White ❑ Bone ❑ Silver ❑ Black ❑ Linen
- ❑ Faucet*:
- ❑ Faucet Finish:
- ❑ Supplies:
- ❑ 1-1/4" Trap:
- ❑ Nipple:
- ❑ Bracket Support (by others):
- ❑ Concealed Arms Support (by others):

* See faucet section for additional models available

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.
Top of front rim mounted 864mm (34") from finished floor.

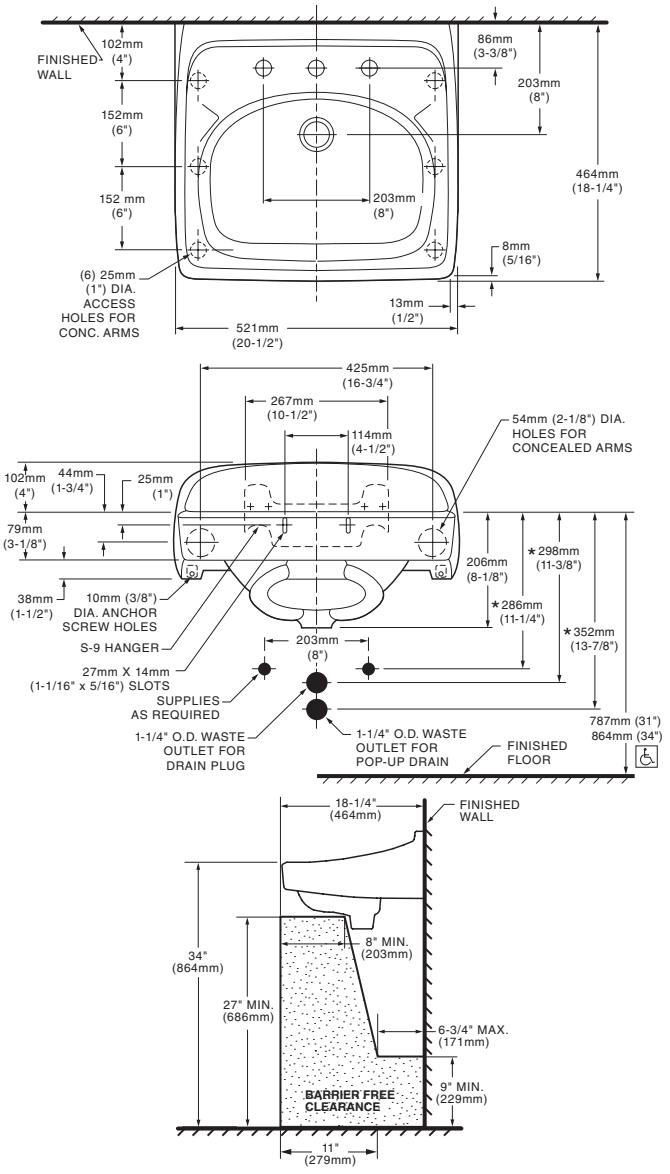
Revised 8/12

American Standard
Style That Works Better

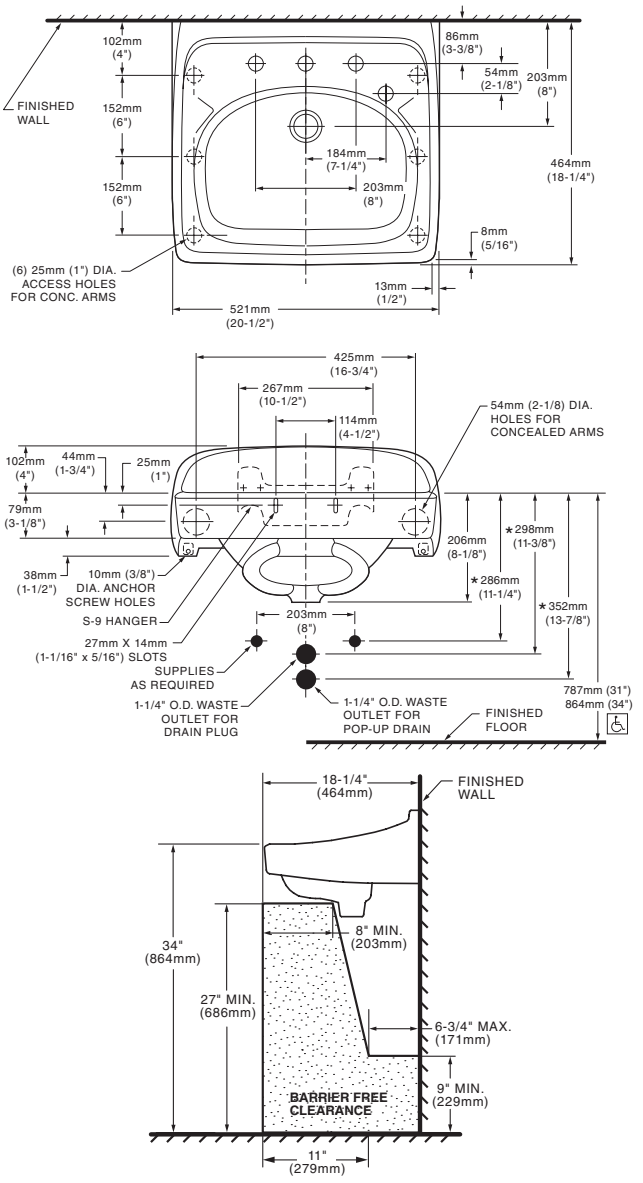
LUCERNE™
WALL-HUNG LAVATORY
VITREOUS CHINA

BARRIER FREE

0356.015 8" CTRS FOR WALL HANGER OR CONCEALED ARMS



0356.037 8" CTRS FOR WALL HANGER OR CONCEALED ARMS EXTRA RIGHT HAND HOLE

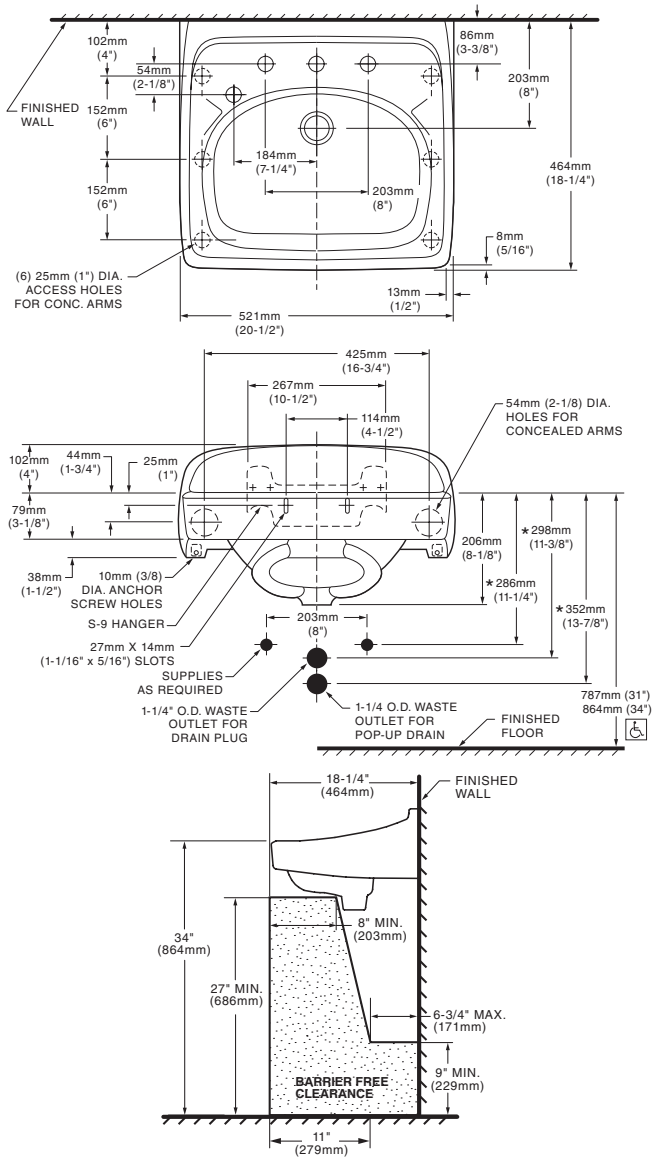


NOTES:
* DIMENSIONS SHOWN FOR LOCATION OF SUPPLIES AND "P" TRAP ARE SUGGESTED.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
FITTINGS NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
CONCEALED ARM SUPPORT AS REQUIRED TO BE FURNISHED BY OTHERS.

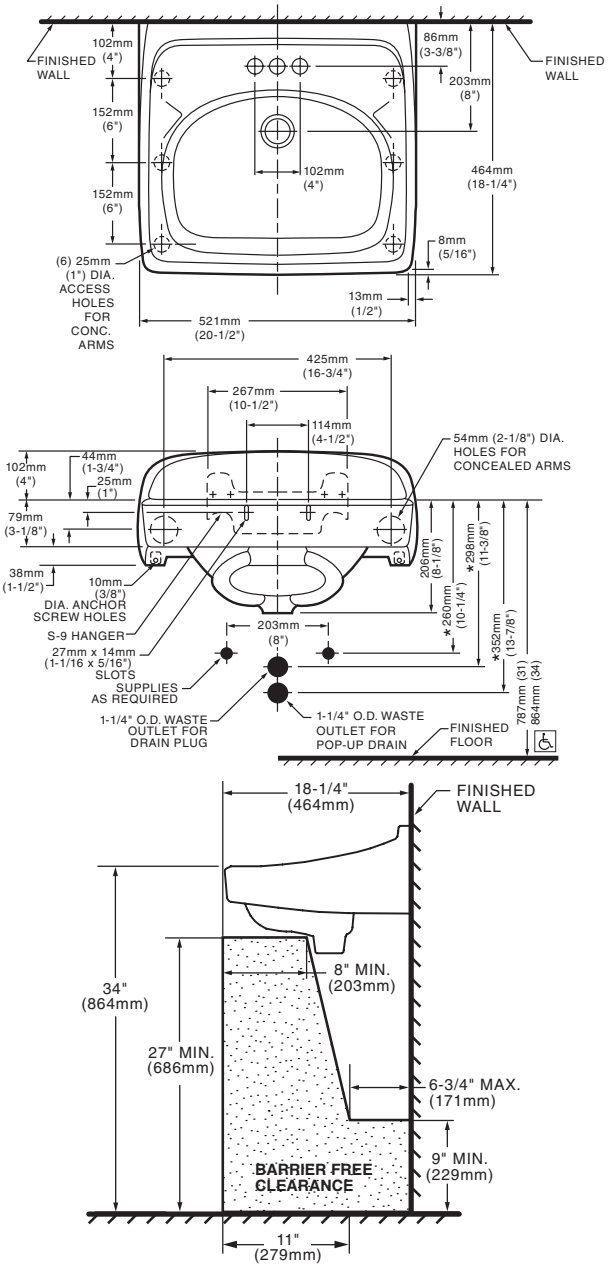
IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

LAVATORY DESIGNED TO MEET ADA HANDICAPPED GUIDELINES WITH MOUNTING HEIGHT SET AT 864MM (34") ABOVE FINISHED FLOOR.

0356.073 8" CTRS FOR WALL HANGER OR CONCEALED ARMS EXTRA LEFT HAND HOLE



0355.012 4" CTRS FOR WALL HANGER OR CONCEALED ARMS



NOTES:
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PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
FITTINGS NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
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LAVATORY DESIGNED TO MEET ADA HANDICAPPED GUIDELINES WITH MOUNTING HEIGHT SET AT 864MM (34") ABOVE FINISHED FLOOR.

American Standard

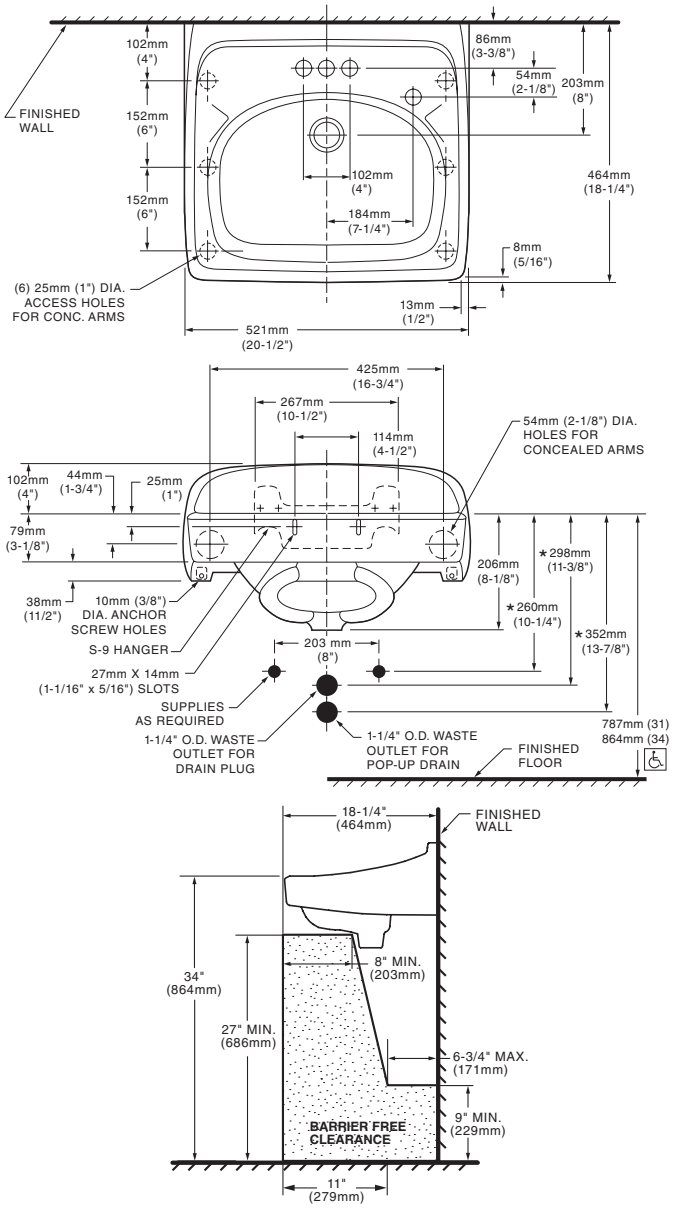
Style That Works Better

LUCERNE™ WALL-HUNG LAVATORY

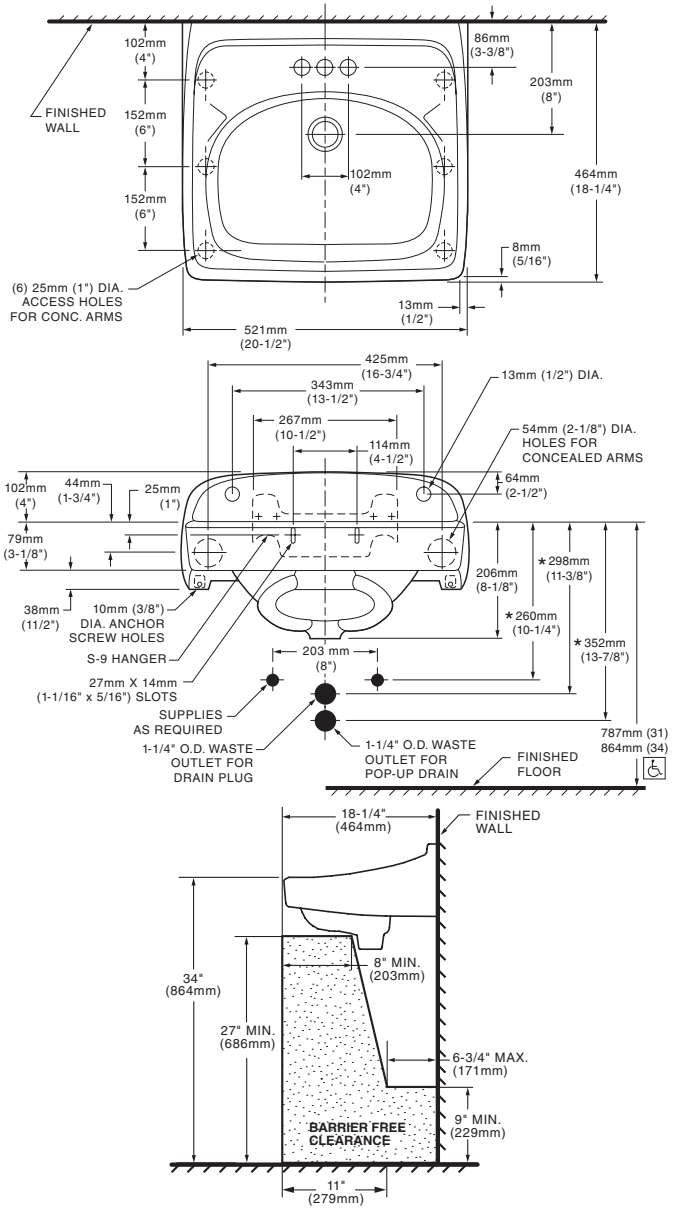
VITREOUS CHINA

BARRIER FREE

0355.034 4" CTRS FOR WALL HANGER OR CONCEALED ARMS EXTRA RIGHT HAND HOLE



0355.041 WALL HUNG SINK THRU BOLT SUPPORT ON BACKSPLASH FOR WALL ANCHORS



NOTES:
***** DIMENSIONS SHOWN FOR LOCATION OF SUPPLIES AND "P" TRAP ARE SUGGESTED.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
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LAVATORY DESIGNED TO MEET ADA HANDICAPPED GUIDELINES WITH MOUNTING HEIGHT SET AT 864MM (34") ABOVE FINISHED FLOOR.

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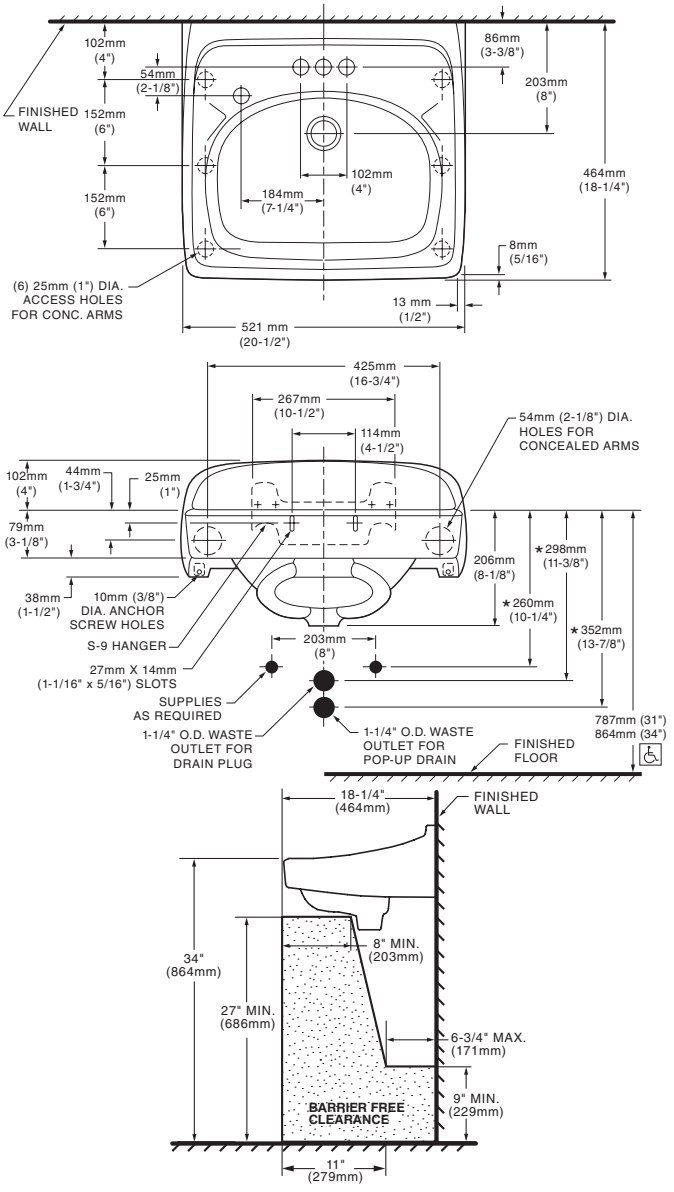
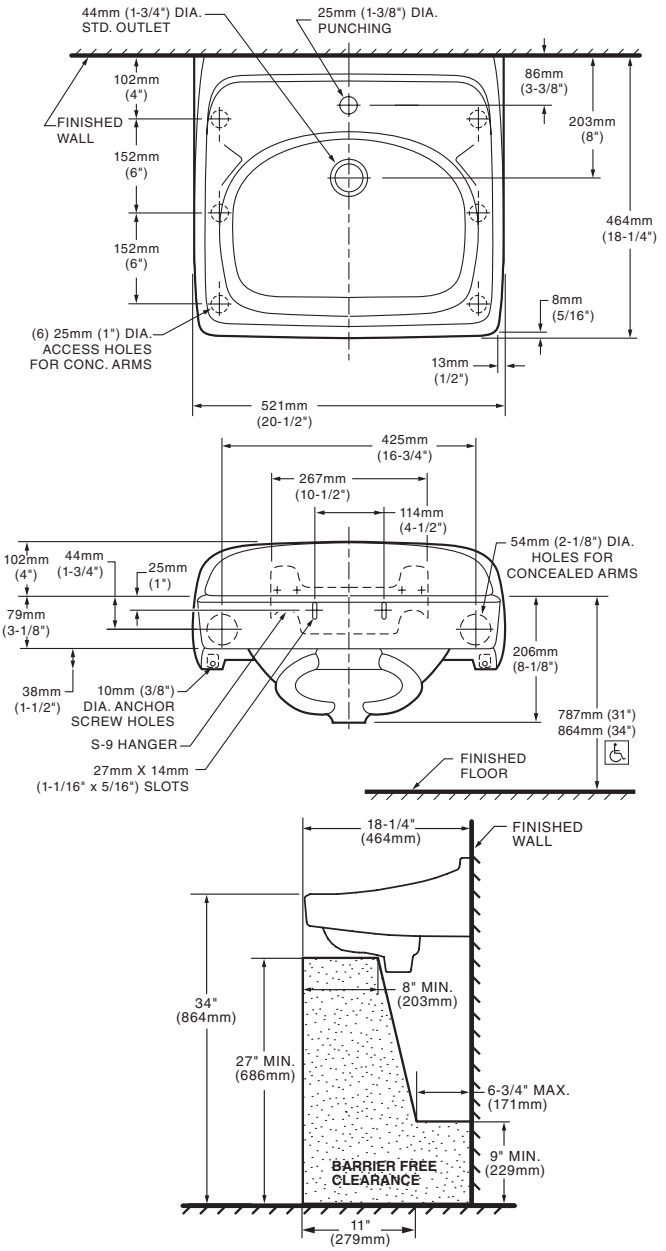
WALL-HUNG LAVATORY
VITREOUS CHINA

BARRIER FREE

0355.056 4" CTRS FOR WALL HANGER OR CONCEALED ARMS EXTRA LEFT HAND HOLE



0356.421 SINGLE CENTER HOLE FOR WALL HANGER OR CONCEALED ARMS



NOTES:
***** DIMENSIONS SHOWN FOR LOCATION OF SUPPLIES AND "P" TRAP ARE SUGGESTED.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
FITTINGS NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
CONCEALED ARM SUPPORT AS REQUIRED TO BE FURNISHED BY OTHERS.

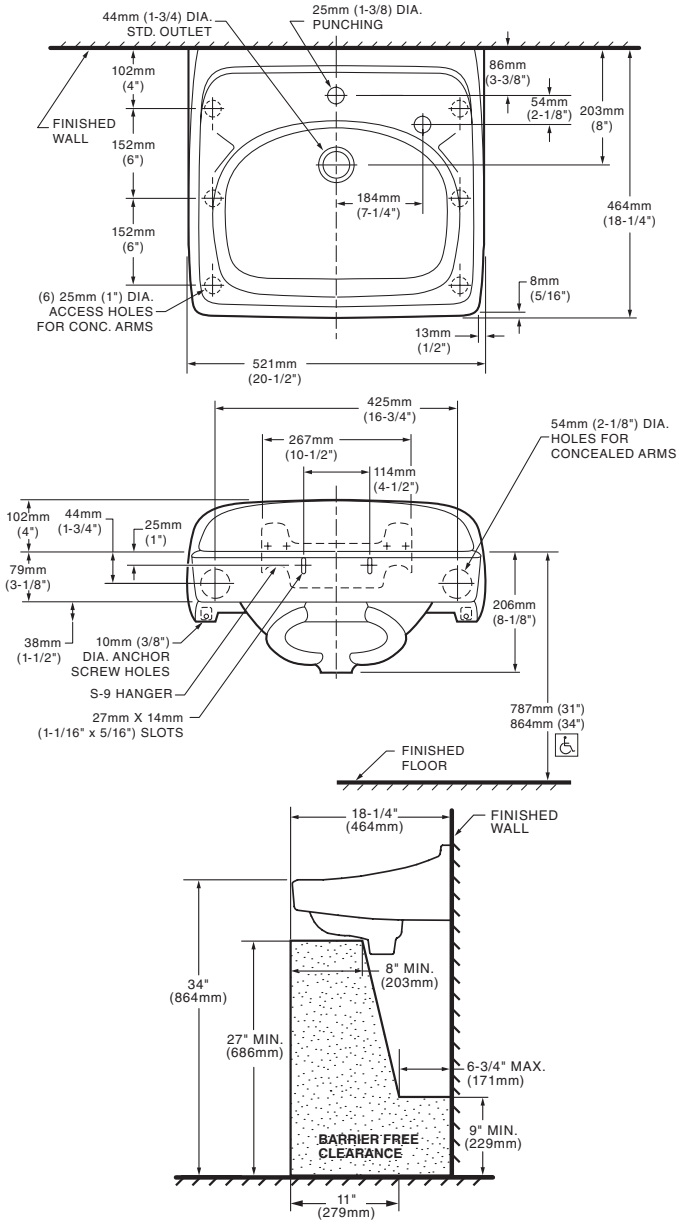
IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

LAVATORY DESIGNED TO MEET ADA HANDICAPPED GUIDELINES WITH MOUNTING HEIGHT SET AT 864MM (34") ABOVE FINISHED FLOOR.

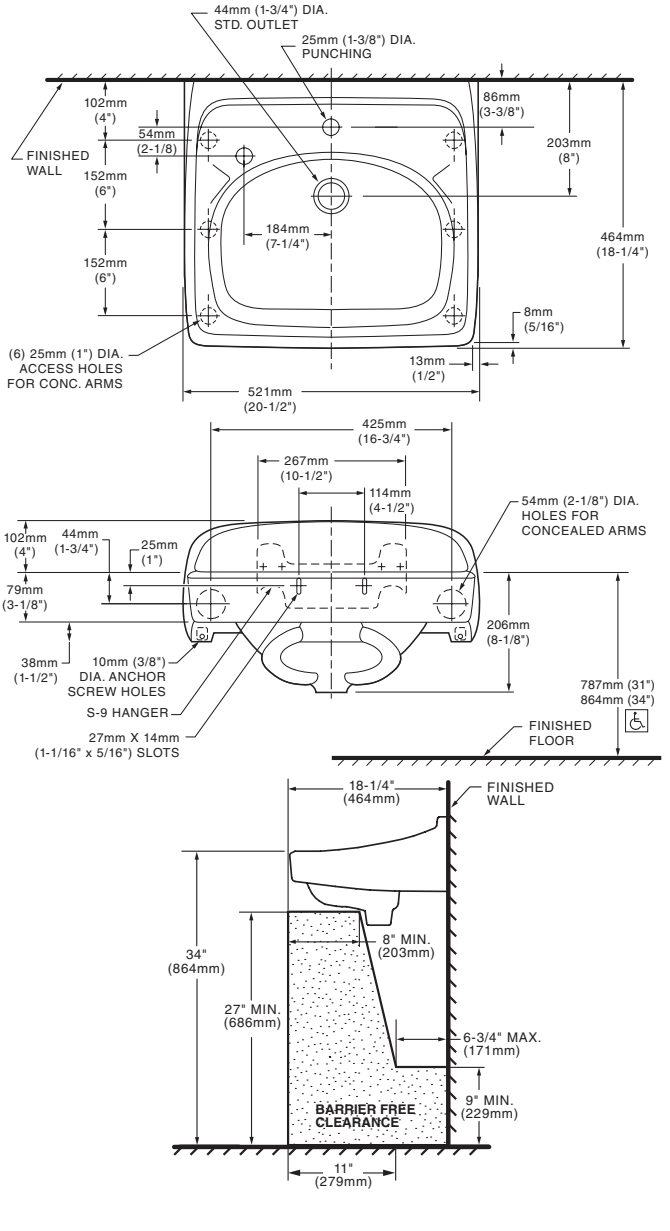
LUCERNE™ WALL-HUNG LAVATORY
VITREOUS CHINA

BARRIER FREE

0356.137 SINGLE CENTER HOLE FOR WALL HANGER OR CONCEALED ARMS WITH EXTRA RIGHT HAND HOLE



0356.115 SINGLE CENTER HOLE FOR WALL HANGER OR CONCEALED ARMS WITH EXTRA LEFT HAND HOLE



NOTES:
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IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

LAVATORY DESIGNED TO MEET ADA HANDICAPPED GUIDELINES WITH MOUNTING HEIGHT SET AT 864MM (34") ABOVE FINISHED FLOOR.

American Standard
Style That Works Better

BARRIER FREE

CADET® 3 RIGHT HEIGHT™ ELONGATED TOILET
VITREOUS CHINA

CADET® 3 RIGHT HEIGHT™ ELONGATED TOILET

❑ **2386.012**
- Vitreous china
- Low-consumption (6.0 Lpf/1.6 gpf)
- EverClean® surface inhibits the growth of stain- and odor-causing bacteria, mold, and mildew on the surface
- Features the **Cadet® 3 Flushing System**
- 16-1/2" rim height for accessible application
- Elongated siphon action jetted bowl
- Fully-glazed 2-1/8" trapway with 2" ball pass
- Generous 9" x 8" water surface area
- Close-coupled tank with flat tank cover for superior storage
- Oversized 3" flush valve with chemical resistant flapper
- Chrome trip lever
- Speed Connect® tank-to-bowl coupling system
- Sanitary dam on bowl with four point tank stabilization
- 2 color-matched bolt caps
- 100% factory flush tested
- 5 year warranty

❑ **3016.016** Right Height™ Elongated Bowl
❑ **3016.001** Right Height™ Elongated Universal Bowl
❑ **4021.016** Tank

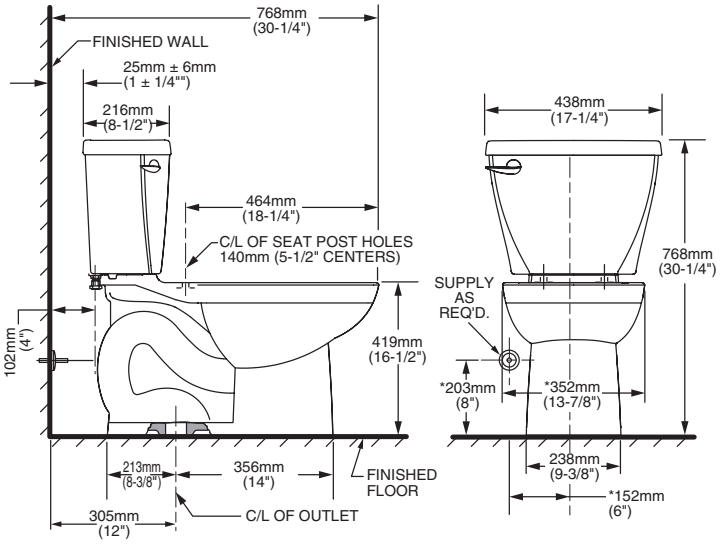
Nominal Dimensions:
768 x 438 x 768mm (30-1/4" x 17-1/4" x 30-1/4")

Fixture only, seat and supply by others

Alternative Tank Configurations Available:
❑ **4021.500** Tank complete with Aquaguard Liner
❑ **4021.600** Tank complete with tank cover locking device
❑ **4021.700** Tank complete with Aquaguard Liner and tank cover locking device
❑ **4021.800** Tank complete with trip lever located on right side
❑ **4021.900** Tank complete with tank cover locking device and trip lever located on right side
❑ **4021.950** Tank complete with Aquaguard liner, tank cover locking device, and trip lever on right side

Compliance Certifications -
Meets or Exceeds the Following Specifications:
- ASME A112.19.2-2008/CSA B45.1-08 for Vitreous China Fixtures

To Be Specified:
❑ Color: ❑ White ❑ Bone ❑ Linen ❑ Black
❑ Seat: #5325.010 Elongated Champion® Slow Close solid plastic seat and cover with easy lift off feature
❑ Seat: #5284.016 Elongated EverClean® solid plastic seat and cover
❑ Seat: #5321.110 EverClean® Elongated Seat with Slow Close Snap-Off Hinges
❑ Supply with stop:



NOTES:
THIS TOILET IS DESIGNED TO ROUGH-IN AT A MINIMUM DIMENSION OF 305MM (12") FROM FINISHED WALL TO C/L OF OUTLET.
SUPPLY NOT INCLUDED WITH FIXTURE AND MUST BE ORDERED SEPARATELY.
* DIMENSION SHOWN FOR LOCATION OF SUPPLY IS SUGGESTED.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2.
These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 REQUIREMENTS FOR ACCESSIBLE AND USABLE BUILDING FACILITIES-CHECK LOCAL CODES.

CADET® 3 Flushing System

TSECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Pipe, Tube, and Fittings.
2. Miscellaneous Piping Materials/Products.
3. Piping Specialties.
4. Pipe Escutcheons.
5. Mechanical Sleeve Seals.
6. Fire Barrier Penetration Seals.
7. Fabricated Piping Specialties.
8. Motors and Drives.
9. Combination Magnetic Starters.
10. Equipment Guards.

B. Related Sections
1. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
3. Section 23 05 53 - Identification for HVAC Piping and Equipment.
4. Section 23 05 93 -Testing, Adjusting, and Balancing for HVAC
5. Section 23 07 00 - HVAC Insulation.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME).
1. ASME B31.1 - Power Piping.
2. ASME B31.9 - Building Services Piping.
3. ASME B16.20 - Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.
4. ASME B16.10- Face to Face and End to End Dimensions of Valves.
5. ASME B16.34 - Valves Flanged, Threaded and Welding End.

B. National Certified Pipe Welding Bureau (NCPWB).

C. Standard Procedure Specifications

D. ASME SEC IX - ASME Boiler and Pressure Vessel Code - Section IX: Welding and Brazing Qualifications.

E. ANSI Standards.
1. ANSI B16.20 - Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed.

F. AWWA Standards
   1. AWWA C111/A21.11-07: Rubber-Gasket Joints for Ductile–Iron Pressure Pipe and Fittings

G. MSS Compliance:
   1. MSS SP-25 - Marking System for Valves, Fittings, Flanges and Unions.
   2. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
   3. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
   4. MSS SP-67 - Butterfly Valves.
   5. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
   6. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   7. MSS SP-78 - Gray Iron Plug Valves Flanged and Threaded Ends.
   8. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.

H. FCI Compliance:
   1. FCI 73-1 - Pressure Rating Standard for "Y" Type Strainers.
   2. FCI 78-1 - Pressure Rating Standard for Pipeline Strainers other than "Y Type.

1.3 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, flanges, valves, hangers and other accessories related to such piping.

B. "Wiring" includes in addition to conductors, all raceway, conduit, fittings, boxes, switches, hangers and other accessories related to such wiring.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings or embedded in construction.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Provide" means to furnish and install.

1.4 SUBMITTALS

A. General
   1. Comply with the requirements of Division 1 and the specific requirements of the Sections of Division 23.
   2. Submit all similar equipment together as part of the same submittal. For example:
      a. All roof exhaust fans shall be contained in the same submittal.
      b. All air outlets shall be contained in the same submittal.
   3. Contractor shall review all submittals prepared by each supplier and mark all copies as acceptable to the Contractor. This acceptance shall signify that all required service connections are shown and in the proper location to meet the installation requirements and that the equipment can fit in the space allowed.
   4. Do not order equipment until submittals have been reviewed and approved by the City Representative.
   5. Each item submitted shall be labeled or identified the same as on the Drawings.

6. Mark submittal “Exactly as Specified” or accompanied by a letter from the supplier explaining in detail what difference, if any, exists between the submitted item and the specified item. Failure to point out the differences will be considered cause for disapproval. The City Representative will not assume any responsibility for differences concealed or otherwise not brought to their attention, and the Contractor will be required to correct any deficiencies or differences discovered at a later date, and assume responsibility for any delays, damage, and/or expenses incurred by others due to such action.
7. Brands or trade names are mentioned to set standards of quality only; use no substitute materials, however, unless approved in writing by the City Representative. Approval of substitute materials does not relieve the Contractor of responsibility for providing a workable and functioning system as specified.
8. Submittals will be checked for general conformance with the design concept but acceptance by the City Representative in no manner is meant to verify that dimensions, quantities, or location of services are as necessary to meet the job requirements. This remains the responsibility of the Contractor.

B. Shop Drawings
1. General: Prepare and submit plans, sections, details and diagrams to required scales for specified areas. Drawings shall be coordinated, dimensioned and indicate equipment, piping, and ductwork in relation to architectural and structural features as well as other building systems. Include Minor piping, drains, air vents, etc. Indicate exact locations and elevations of valves, piping specialties, dampers etc.
2. Required Drawings: Prepare and submit drawings for all areas and all mechanical work. Scale shall be minimum 3/8” = 1’-0” in mechanical rooms, fan rooms, and mechanical areas, and minimum 1/4” = 1’-0” elsewhere.

C. Coordination Drawings
1. General: Coordination drawings are defined as “shop drawings” which also indicate, on the same drawings, the major utilities of all other trades. “Coordination Drawings” shall indicate location and elevations of existing structural slabs and beams, architectural elements, domestic water piping, plumbing vents, sanitary drains, storm drains, fire protection piping, lighting fixtures, electrical conduits (2-inch and larger), ductwork, penetrations of walls and roof, air outlets, ceiling mounted equipment and controls, gas piping, flues, fans, etc.
2. Submit coordination drawings for the following:
   a. Other areas for which space is limited.
3. It is the intent of the coordination drawings to ensure coordination of all major utilities, prior to the start of installation. This is a substantial effort which will require careful and detailed coordination and planning to ensure appropriate information is available, from all trades, in a timely manner. The coordination drawing effort shall be integrated into the project schedule and monitored to ensure conformance.
4. Conflicts between trades, which cannot be resolved through generally accepted practice of coordination between trades, shall be clouded on the coordination drawings and an appropriate description of the problem noted for review by the City Representative.
5. Nonconforming M/E work installed within designated coordination areas is subject to removal and replacement by installing contractor at no additional cost to City.

6. Coordination drawings shall be signed and dated by individual trade constrictors. By act of signature and submittal of singular combined coordination drawings, each trade contractor acknowledges coordination of their portion of the Work with all other plumbing, mechanical, electrical, architectural, and structural work contractors.

D. Product Data
   1. General: Manufacturer's specifications, data sheets, certified drawings, and installation instructions. Include physical and performance data such as weights, sizes, capacities, required clearances, performance curves, acoustical characteristics, finishes, color selection, location and size of field connections, and accessories. Include certified drawings on major equipment such as boilers, water chillers, cooling towers, controls, pumps, and tanks.
   2. Motors: Submit manufacturer's name, type, RPM, HP (KW), full load amps, efficiency, and power factor.
   3. Part Load Performance: Submit equipment data to indicate performance characteristics throughout ranges of possible load conditions.
   4. Include operating weight and location of center of gravity of each item of equipment in manufacturer's cut sheet for purposes of seismic calculation.
   5. Pipes and Pipe Fittings: Submit schedule showing pipe material data, sizes, fitting valve type k factor, working pressure for each service.
   6. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
   7. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
      a. Strainers: include pressure drop or chart for each type and size.
   8. Meters and gauges: include scale range for each service.

E. Test Reports
   1. Manufacturer's Tests
      a. Factory Tests: As specified for specific equipment.
      b. Field Tests: As specified.
   2. System Pressure Tests: As specified under "Testing" article. Test log of pressure tests on each system. Indicate date of test, scope of test, test pressure, duration, and observers.
   3. Balancing Reports: As specified under Section 23 05 93.

F. Certification
   1. Seismic Restraints: As specified under Sections 23 05 29 and 23 05 48.
   2. Controls: As specified under Section 23 09 23.
   3. Welding Certificates.
   4. Brazing Certificates.

G. Operating and Maintenance Manuals: Include, but not limited to, the following:
   1. List of all equipment with Manufacturer's name, model number, and local representative, service facilities and normal channel of supply for each item. Include phone number and address of service facilities
   2. System Description: Description of start-up, operating, and shutdown procedures.
   3. Controls: Diagrams and description of operation sequence of each system.
   4. Equipment: Manufacturer's brochures, ratings, certified shop drawings, lubrication charts and data, parts lists with part numbers, and belt and sheave data. Mark each sheet with equipment identification number and actual installed condition.

5. Materials and Accessories: Manufacturer's brochures parts list with part numbers and lubrication data where applicable. Mark each sheet with equipment identification number or system and location of installation; and to specifically identify which options are provided (in case where data sheet shows multiple options).
6. Certificate of factory tests, field tests and code compliance as specified.
7. Wiring and controls schematics.
8. Trouble shooting directions.
9. Maintenance procedures and frequencies.
10. Description of special tools.
11. Copies of warranties.
12. Safety precautions.
13. Emergency contingencies.

H. Record Documents
1. Comply with the Conditions of the Contract and the requirements of Section 23 05 53.
2. Indicate ductwork mains and branches, size and location, for both exterior and interior; locations of dampers, control devices, filters, and terminal units requiring maintenance or repair.
3. Indicate mains and branches of piping systems, with valves and control devices located and numbered per valve schedule, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, vents, etc.).
4. Indicate equipment locations (exposed and concealed), dimensioned from prominent building lines.
5. Identify approved substitutions, Contract Modifications, and actual equipment and materials installed.

I. Samples: When specified under applicable Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.6 SUBSTITUTIONS

A. General:
1. Base manufacturer is indicated in equipment schedules.
2. In Specification, additional acceptable manufacturer(s) may be indicated.
3. Other manufacturers, materials, or methods shall not be used unless approved in writing by the City Representative.
4. The burden of proof as to the equality of any proposed substitute manufacturer, material**,** or method shall be upon the Contractor.
5. The City Representative's decision shall be final.

B. Requests for substitution review and acceptance shall be accomplished by table of comparison listing pertinent features of both specified and proposed materials, such as materials of construction, performance, dimensions, weights, replacement or maintenance access, motor type, horsepower, voltage, phase, service factor. Review of proposed substitutions will not be made until receipt of satisfactory comparison tabulation.

C. Submittal of substitutions shall be limited to one proposal for each type or kind of item, unless otherwise permitted by the City Representative. If first proposed product submittal is rejected, Contractor shall then submit the first-named or scheduled product.

D. Contractor shall be responsible for all costs and coordination due to the substitution, such as impacts on electrical requirements, weight, openings in slabs and roofs, structural framing, housekeeping pad size, etc.

1.7 JOB CONDITIONS

A. Cause as little interference or interruption of existing utilities and services as possible. Schedule Work which will cause interference or interruption in advance with Construction Manager.

B. Examine Contract Documents to determine how other Work will affect execution of mechanical Work.

C. Determine and verify locations of all existing utilities.

D. Arrange for, coordinate, and pay costs incidental to providing utility company services indicated.

E. Establish lines and levels for each system and coordinate with other systems to prevent conflicts and maintain proper clearances and accessibility.

PART 2 PRODUCTS

2.1 PIPE, TUBE AND FITTINGS

A. Refer to individual Division 23 piping sections for pipe, tube, fitting materials joining methods. Comply with governing regulations.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Provide welding materials to comply with installation requirements.
   1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Gaskets for Flanged Joints: ASME B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

2.3 PIPING SPECIALITIES

A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or, if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Dielectric Unions and Flanges
   1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion. Pressure rating equal to or greater than that of nearby valves.
   2. Manufacturer:
      a. B & K Industries, Inc.
      b. Capitol Mfg. Co.; Div. of Harsco Corp.
      c. Eclipse, Inc.
      d. Epco Sales, Inc.
      e. Perfection Corp.
      f. Rockford-Eclipse Div.
      g. Victaulic Clearflow.
      h. Calpico, Inc.

2.4 PIPE ESCUTCHEONS

A. General: Provide solid (not split-hinged) pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas. All escutcheons shall be vandal proof.

B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide solid brass or solid sheet brass pipe escutcheons.

C. Pipe Escutcheons for Dry Areas: Provide solid sheet metal escutcheons.

D. Manufacturer: Chicago Specialty, Producers Specialty, Sanitary-Dash.

2.5 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Sleeve: To be furnished by same manufacturer of seals; schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.

C. Manufacturer: Thunderline Link Seal or Metraflex Metraseal.

2.6 FIRE BARRIER PENETRATION SEALS

2.7 FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges:
      a. 3-inch and smaller: 0.040-inch/20 gauge thick.
      b. 4 to 6-inch: 0.064-inch/16 gauge thick.
      c. Over 6-inch: 0.079-inch/14 gauge thick.
   2. Steel Pipe: See “Mechanical Sleeve Seals” article.

2.8 MOTORS AND DRIVES

A. Motor controls and power wiring.
   1. Provided as part of Division 26 work, unless indicated otherwise, including motor control switches, starters, disconnects, conduit and wiring, except for low voltage control wiring required for temperature controls.
   2. Where equipment is specified with factory pre-wired controls and is furnished instead with components shipped loose, mechanical contractor shall be responsible for coordinating the complete installation and assume any additional costs.
   3. See Section 23 09 23 for control wiring.

B. Motors
   1. Ball or roller bearing type, high efficiency type, with starting and running characteristics consistent with torque and speed requirements of driven machine.
   2. Use motors rated in accordance with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 72 degrees F above ambient with service factor of 1.15.
   3. Motors driven by variable frequency drives shall be rated for inverter duty and shall meet the requirements of NEMA MG-1 part 31.4.4.2.
   4. Where substitute manufacturers are provided with different control panels, starters, or electrical characteristics from scheduled equipment, contractor shall coordinate complete installation and assume any additional costs.
   5. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
   6. Do not include service factor when selecting motor horsepower.
   7. Motors exposed to moisture or rain shall be totally enclosed, fan cooled (TEFC). Others may be open drip proof (ODP), unless otherwise indicated.

C. Motor electrical power characteristics: 208 volt, 3 phase, 60 Hz for 1/2 HP and larger; 115 volt, 1 phase, 60 Hz for smaller than 1/2 HP, unless noted otherwise.

D. Efficiency
   1. Requirements apply to all motors, 1/2 HP and larger, except for refrigeration compressors**,** and for fans which run only in emergency mode, such as chemical exhaust fans.
   2. Ratings in accordance with IEEE 112b Rating Method.

3. Motors shall be labeled as NEMA "Premium" Efficient, with efficiencies as follows, based on 1750 RPM.;
    a. Motors with other than 1750 RPM shall be same type motor as would meet requirements for 1750 RPM motors.

E. Belt Drives
1. Manufacturers: Browning, Gates, Woods, or Dayton.
2. Belts: V-belt drives rated at 1-1/2 times the motor horsepower. High quality commercial-grade rubber with polyester reinforcing.
    a. Provide two belts minimum for motor sizes 2 HP and larger.
3. Sheaves: Per ARI Standard 435-78.

Motor HP	Fan RPM	Sheave
0-100	1800	Adjustable or Fixed
15 and Above	0-1800	Fixed
0-3	1801 & above	Adjustable or Fixed
5 & above	1801 & above	Fixed

4. Adjustments: Fan static pressures shown and related RPMs are only approximate. Adjust sheaves or change drives to obtain required performance.
5. Provide metal belt guard having sides of galvanized steel and expanded metal face with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes.
6. Spare Parts: Provide one complete set of spare belts for all equipment items. When two or more pieces of equipment require identical belts, provide quantity of spare belts sufficient to serve two pieces of equipment. (For example, if there are three identical fans, each requiring two fan belts, then provide four spare fan belts.)
    a. Obtain receipt from City.
    b. Identify each belt by equipment ID.
    c. For fans with two or more belts, fasten set of belts together to prevent separation during storage.

2.9 COMBINATION MAGNETIC STARTERS

A. These requirements apply to starters which are provided as part of mechanical equipment such as air handling units, chillers, etc.

B. Circuit breaker type with motor circuit protector. Provide external operator handles for circuit breakers. Color code handles to display red in ON position and black in OFF position; design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with three padlocks. Provide NEMA 4X weatherproof type enclosure. 24 VAC control circuit type; provide with integral 24 VAC transformer.

2.10 EQUIPMENT GUARDS

A. Use suitable structural frames with minimum 12-gauge, 3/4-inch galvanized mesh, or expanded metal mesh.

B. Attach to equipment by removable clips and bolts with swing nuts, or other approved connectors.

C. At belts, provide opening for measuring RPM's.

D. Provide at all belts, couplings, moving machinery and equipment in accord with OSHA.

E. Design for easy access to belts and other items requiring replacement.

F. Provide holes in guards for tachometer readings and checking of belt tension.

G. Install in least obstructive manner as possible, with respect to equipment operation. For example, keep fan drive guards as far out of inlet air stream as practical, so as to minimize effect losses.

PART 3 EXECUTION

3.1 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

C. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

D. Electrical and Elevator Equipment Spaces: Do not run piping or ductwork through transformer vaults, electrical rooms and other electrical or electronic equipment spaces and enclosures, unless piping or ductwork is for equipment serving that electrical space.

E. Comply with ASME B31.1.

F. Pressures: Do not install piping, valves or piping specialties where exposed to system pressures greater than their rated working pressures.

G. Sloping, Air Venting and Draining
   1. Slope piping as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in direction of flow as follows:

H. Install piping free of sags and bends. Support requirements are specified in Section 23 05 29.

I. Refrigerant: Clean, dehydrate, and cap refrigerant piping. Take care to ensure that entire system is clean and dry during installation. Clean tubing by means of swab saturated in methyl alcohol or refrigerant 12 drawn through tubing as many times as necessary to thoroughly clean and dry interior of tubing and to eliminate formation of copper oxide. Before refrigerant lines are silver brazed, flush all air from tubing and pass slow-running stream of dry nitrogen through system during brazing process. Purge lines completely and maintain nitrogen flow at steady rate of not less than three cubic feet per hour. After brazing, interior of refrigerant lines must be clean and bright.

J. Fittings
   1. Provide standard, manufactured fittings in all cases. Field fabricated fittings are prohibited. Bushings are prohibited on pressure piping.
   2. Weld-O-Lets and Thread-O-Lets may be used for non-galvanized steel piping if main pipe size is at least three standard pipe sizes larger than branch pipe, e.g. 2-inch main and 1-inch branch.
   3. Provide insulating couplings at connections of ferrous piping to non-ferrous piping.

3.2 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
   2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

D. Fluid Control: Except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ASME B31.9. Where throttling is indicated or recognized as principal reason for valve, install globe valves.

E. Installation of Check Valves
   1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
   2. Wafer Check Valves: Install between two flanges in horizontal or vertical position, position for proper direction of flow. Provide silent type wafer check valves at pump discharge locations.

3. Lift Check Valve: Install in piping line with stem vertically upward, position for proper direction of flow.

F. Install globe valves to close against pressure.

G. Install plug valve with seat toward equipment to be isolated.

H. Valve Discharge Piping: Provide discharge pipe to atmosphere from all relief and safety valves, sized with area equal to sum of outlet areas of all valves connected thereto, unless indicated larger.

3.3 INSTALLATION OF PIPING SPECIALTIES

A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surfaces.

B. Dielectric Unions and Flanges: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

C. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.

D. Fire Barrier Penetration Seals: Fill entire opening with sealing compound. Adhere to manufacturer's installation instructions.

3.4 INSTALLATION OF FABRICATED PIPING SPECIALTIES

A. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs.
   1. Do not install sleeves through structural members, except as detailed on Drawings, or as reviewed by the City Representative.
   2. Install sleeves accurately centered on pipe runs.
   3. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two pipe sizes larger than piping run.
   4. Where insulation includes vapor-barrier jacket, provide sleeve with sufficient clearance for installation.
   5. Pack 100 percent of annular space between sleeve and pipe or pipe insulation. Provide acoustical sealant at each end of pipe sleeve to seal packing in place.
      a. At fire-rated walls, partitions, floors, roofs, and ceilings: Packing shall be through-penetration firestop.
      b. At non-fire-rated walls, partitions, floors, roofs, and ceilings: Packing shall be fiberglass insulation, with density of 1.5 pcf.
   6. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves.
   7. Extend floor sleeves 1 inch above level floor finish.
   8. Provide temporary support of sleeves during placement of concrete and other work around sleeves.
   9. Provide temporary closure to prevent concrete and other materials from entering sleeves.

B. Type of Sleeves
   1. Install sheet-metal sleeves at walls and partitions.
   2. Install schedule 40 pipe sleeves in concrete slabs.
   3. Install mechanical sleeve seals at exterior penetrations; below grade, and at slabs-on-grade.

C. Mechanical Sleeve Seals: Install in accordance with the manufacture's instructions.

3.5 PIPING EXPANSION PROVISIONS

A. General: Install domestic hot water piping with at least 4 elbows or tees at following locations.
   1. Between piping mains and risers.
   2. Between equipment and pump or tank.
   3. Between piping main and equipment.

3.6 TESTING

A. General: Provide labor and test equipment including test pumps, gauges, instruments and other equipment required. Use test quality pressure gauges, instruments and other equipment required. Use test quality pressure gauges with range of approximately twice test pressure. Use calibrated gauges and instruments.

B. Piping
   1. General: Remove from systems, during testing, equipment which would be damaged by test pressure. Replace removed equipment after testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system.
   2. Correct leaks by remaking joints with new material; makeshift remedies will not be permitted. Test time accrues only while full test pressure is on system. Test before backfilling, concealing, insulating or making connections to potable water system.
   3. Test Schedule: Test each section of systems at one and one-half times the maximum working pressure of that section, but at not less than scheduled test pressure. Obtain maximum working pressures from the City Representative if not indicated on Drawings. Unless indicated otherwise, scheduled tolerance is "no pressure loss", except that due to temperature change, in 24 hour period.

C. Valves
   1. General Service Valves: Test bonnets for tightness. Test operate from closed-to-open-to-closed position while under test pressure.
   2. Automatic Valves: Test, including solenoid valves, water regulating valves, pressure reducing valves, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.
   3. Safety Valves: Test relief valves, safety relief valves, safety valves and temperature and pressure relief valves 3 times.

D. Piping Specialties: Test thermometers, pressure gauges, and flow measuring devices for accurate indication; air vents, and other specialties for proper performance.

E. Hangers and Supports: With systems in normal operation, test hangers, supports and rods to ensure they are plumb and supporting proper share of load. Additionally support systems and equipment that sway, crawl, or vibrate.

F. Ductwork: Comply with the requirements of Section 23 31 00.

G. Other Materials and Equipment
   1. Rotation: Verify.
   2. Motor Amperage: Verify operating motor amperage does not exceed motor nameplate rating.
   3. Test as specified; as recommended by equipment manufacturer; and as otherwise necessary or directed to assure they are complete, operable, and ready for use.

3.7 ADJUSTING AND CLEANING

A. Inspect all equipment and put in good working order.

B. Clean all exposed and concealed items
   1. Clean air surfaces of all coils, fans (including fan wheels and motors), air handler plenums and air filter frames.
   2. Clean floor drains/sinks, and plumbing fixtures related to HVAC operation.
   3. Clean specialties such as traps and strainers. Replace strainer screens with new prior to system start-up.

C. Ductwork: Clean ducts before installing air outlets.

D. Equipment and Materials: Remove foreign materials including dirt, grease, splashed paint, and plaster, etc. Restore damaged finishes to original condition.

E. Piping: Flush clean interior of piping. Upon completion of flushing, completely drain systems at low points; remove, clean, and replace strainer baskets and refill systems.

F. Gas: After testing of natural gas system, and before any gas is put into line, blow out entire system of piping to remove scale and dirt; purge air by filling system with gas.

G. Adjusting: Adjust equipment and system components as indicated or as otherwise required to result in intended system operation. Thereafter, as a result of system operation, or as directed, make readjustments as necessary to refine performance and to effect complete system tune-up.

3.8 SPECIAL TOOLS

A. Furnish to City not later than when City takes possession of equipment.

B. Definition of Special Tools: Identified in or otherwise implied by, the manufacturer's operation and maintenance manuals for the furnished equipment or which are otherwise required for the operation, with the manufacturer's recommended procedures for operation, adjustment and maintenance. Special tools do not include those required for major repairs normally done by factory trained or otherwise specialized service personnel, nor do they include those normally found in the possession of City's onsite maintenance personnel.

3.9 MANUFACTURER'S START-UP ASSISTANCE

A. Where the services of a factory authorized service representative are specified for the start-up of certain pieces of equipment, arrange to have the manufacturer of such equipment perform start-up and check-out service. Manufacturer shall provide a letter which shall be on the manufacturer's letterhead, shall list the equipment, shall certify that the equipment has been

examined, that it has been installed in accordance with the manufacturer's installation instructions, started up, adjusted, and checked out in accordance with the manufacturer's instructions, and is operating properly. The letter shall be addressed to the City and shall be signed by an authorized representative of the manufacturer.

3.10 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush clean interior of piping. Inspect each run of each system for completion of joints, supports and accessory items. Upon completion of flushing, completely drain systems at low points; remove, clean and replace strainer baskets and refill systems.
   1. Inspect pressure piping in accordance with procedures of ASME B31.

3.11 ADJUSTING AND CLEANING OF VALVES

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Valve Identification: Tag each valve in accordance with Section 23 05 53.

3.12 ADJUSTING AND CLEANING OF PIPING SPECIALTIES

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

3.13 EQUIPMENT VIBRATION

A. Mechanical Balance: Fans, pumps, motors, and drives, when equipment is installed and in normal operation, shall be within the following maximum limits, unless specified more restrictively for individual equipment items:
   1. 600 RPM and Less: 0.003-inch displacement, peak-to-peak.
   2. Over 600 RPM: 0.10-inch per second velocity, peak.

B. Pulley Run-Out: When equipment is installed and in normal operation, pulley run-out in radial and axial directions not to exceed 0.001-inch.

C. Field Tests: If requested, test equipment to determine compliance with specified requirements. Measure vibration displacement and velocity in vertical direction relative to floor. Make measurements on bearing housings (not end caps), or other heavy structural element directly connected to bearing housing, at each end of equipment.

D. Field Balancing: Balance and retest equipment as required for compliance with specified requirements.

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Manufacturers.
   2. General Construction and Requirements.
   3. Single Phase Electric Motors.
   4. Three Phase Electric Motors.
   5. Variable Frequency Drives.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 48 - Vibration and Seismic Control for HVAC Piping and Equipment.
   3. Section 23 09 23 - Direct Digital Control System for HVAC.
   4. Section 23 40 00 - HVAC Air Cleaning Devices.

1.2 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

D. NEMA MG 1 - Motors and Generators.

E. 2010 California Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data including complete motor data, motor enclosures.

C. Test results verifying nominal efficiency and power factor for motors larger than 1/2 horsepower.

D. Manufacturer’s installation instructions.

E. Operation and maintenance data.

F. Assembly Drawings: Include bearing data with replacement sizes and lubrication instructions.

G. Warranty: Sample of special warranty.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for HVAC System use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.5 REGULATORY REQUIREMENTS

A. 2010 California Electrical Code.

B. Conform to state Energy Code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace defective variable frequency drives within specified warranty period.
   1. Include parts and labor.
   2. Warranty Period: Five years from date of Project completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers
   1. Westinghouse.
   2. General Electric.
   3. Allis-Chalmers.
   4. Lincoln.
   5. Baldor.

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors: Design for continuous operation in 105 degrees F environment, and for temperature rise in accordance with NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, Service Factor, Power Factor, efficiency, ambient temperature.

C. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame. Provide grounding lug in conduit boxes.

D. Capacity: Minimum horsepower indicated and able to operate driven devices under all conditions without overload.

2.3 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Up to five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (125-degrees F temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.

G. Enclosed Motors: Class A (125-degrees F temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between one and one and one-half times full load torque.

B. Starting Current: Up to six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.

G. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13 - Enclosed Controllers.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.

K. Part Winding Start (Where Indicated): Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings double shielded with waterproof non-washing grease.

M. Nominal Efficiency: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

N. Nominal Power Factor: Meet or exceed values in Schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

PART 3 EXECUTION

3.1 APPLICATION

A. Motors drawing less than 250 watts and intended for intermittent service may be integral with manufactured equipment and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors 2 HP and larger or when indicated in the individual Section shall be the energy efficient type.
   1. The minimum efficiency of energy efficient motors shall be:

Motor HP	Efficiency, Percent
0.5	79
0.75	81
1.0	83
1.5	84
2.0	85
3.0	87.5
5.0	87.5
7.5	89.5

D. Single phase motors for fans and pumps: capacitor start type.

E. Motors located in exterior locations, air cooled condensers, and wet air stream: totally enclosed type.

F. Motors located in exterior locations: totally enclosed weatherproof epoxy-sealed type.

G. Belt connected motors: With slide bases and shaft as required for aligning pulleys.

H. In finished areas mount motor protection switches flush and install suitable cover plates.

3.2 NEMA OPEN MOTOR SERVICE FACTORS

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: SINGLE PHASE - OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/6	1800	48	49	58
1/4	1800	48,56	53	52
1/3	1800	48,56	56	55
1/2	1800	48,56	64	65
3/4	1800	56	63	64
1	1800	56,143T,182T	68	72
1-1/2	1800	56,145T,184T	70	64
2	1800	56,145T,182T	73	72
3	1800	184T	78	78
5	1800	184T,213T	74	76
7-1/2	1800	215T	77	85

3.4 PERFORMANCE SCHEDULE: SINGLE PHASE - TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/6	1800	42,48	49	58
1/4	1800	48,56	53	52
1/3	1800	48,56	56	55
1/2	1800	48,56	63	67
3/4	1800	56	66	68
1	1800	56,143T	68	72
1-1/2	1800	56,145T	73	77
2	1800	182T	75	81
3	1800	184T	78	87
5	1800	213T	82	87
7-1/2	1800	215T	84	

3.5 PERFORMANCE SCHEDULE: THREE PHASE - OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/4	1800	48		
1/3	1800	48,56	74	
1/2	1800	48,56	74	63
3/4	1800	48,56	74	60
1	1800	56,142T,143T	75	64
1-1/2	1800	56,145T	79	69
2	1800	56,145T	80	70
3	1800	56,145T,182T	81	77
5	1800	184T	84	82
7-1/2	1800	213T	86	76

3.6 PERFORMANCE SCHEDULE: THREE PHASE - TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1/6	1800	42		
1/4	1800	48		
1/3	1800	48,56	72	
1/2	1800	48,56	74	63
3/4	1800	48,56	74	60
1	1800	56,143T	77	62
1-1/2	1800	56,145T	79	66
2	1800	56,145T	81	74
3	1800	182T	82	78
5	1800	184T	84	82
7-1/2	1800	213T	86	79

3.7 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, OPEN, DRIP-PROOF

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1	1800	143T	82.5	84
1-1/2	1800	145T	85	85
2	1800	145T	86	85
3	1800	182T	87.5	86
5	1800	184T	88	87
7-1/2	1800	213T	89.5	86

3.8 PERFORMANCE SCHEDULE: THREE PHASE - ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM (Syn)	NEMA Frame	Percent Efficiency	Percent Power Factor
1	1800	143T	83	84
1-1/2	1800	145T	85	85
2	1800	145T	85	85
3	1800	182T	88	83
5	1800	184T	89	83
7-1/2	1800	213T	90	85

END OF SECTION

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SECTION 230523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Gate Valves.
2. Globe Valves.
3. Ball Valves.
4. Butterfly Valves.
5. Angle Valves
6. Check Valves.
7. Strainers.
8. Drain Valves.
9. Water Pressure Reducing Valves.
10. Temperature and Pressure Relief Valves.
11. Plug Valves.

B. Related Sections
1. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
2. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.2 SUBMITTALS

A. General: Submit the following in accordance with the Conditions of the Contract and Division 1.

B. Product Data for each valve type; include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application. Include pressure drop curve or chart for each type and size of valve.

C. Maintenance Data for valves to include in the operating and maintenance manuals as specified in Division 1 for the following:
1. Trap primers.
2. Strainers.
3. Water pressure reducing valves.
4. Temperature and Pressure Relief valves.

D. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing. Submit spare parts list for each type of valve. Include this data in Maintenance Manual.

E. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1.

B. ASME Compliance: Comply with ASME B31.9 for Building Services Piping for materials and installation.

C. ASSE Compliance: Comply with ASSE Standards for mixing valve applications.

D. MSS Compliance: Comply with the various MSS Standard Practice documents as follows:
   1. MSS SP-67 - Butterfly Valves
   2. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
   3. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
   4. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends.
   5. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
   6. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   7. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

E. ANSI Compliance: Comply with ANSI Z21.22 - Relief Valves for Hot Water Supply Systems and ANSI Z21.41 - Quick Disconnect Devices for Use with Gas Fuel Appliances.

F. Valves: Manufacturer’s name and pressure rating marked on valve body.

G. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state regulations.

H. Welders Certification: In accordance with ASME SEC IX.

I. NSF Compliance:
   1. Comply with NSF/ANSI 61, Drinking Water System Components - Health Effects, for potable domestic water plumbing specialties.

J. Valve Identification: Comply with MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

K. Valve Types; Provide valve of ‘same type’ by ‘same manufacturer.’

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set ball and plug valves open to minimize exposure of functional surfaces.
   4. Set butterfly valves closed or slightly open.
   5. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Strainers:
      a. Furnish stainless steel screens of quantity of identical units not less than 10 percent of amount of each type and size installed.
   2. Furnish gasket material of quantity of identical units not less than 10 percent of amount of each type and size installed.

1.6 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace defective hot water return balancing valve assembly within specified warranty period.
   1. Include components, parts, and labor.
   2. Provide components and parts the same as those used in the manufacture and installation of original valve assembly.
   3. Warranty Period: Five years from date of Project completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Gate Valves:
      a. Crane Valve Group.
      b. Lunkenheimer.
   2. Globe Valves:
      a. Crane Valve Group.
      b. Lunkenheimer.
   3. Ball Valves:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   4. Butterfly Valves:
      a. Kitz Corporation of America.
      b. Conbraco Industries, Inc-: Apollo Division.
      c. NIBCO Inc.
   5. Angle Valves:
      a. Crane Valve Group.
      b. Lunkenheimer.
   6. Check Valves:
      a. Kitz Corporation of America.
      b. NIBCO Inc.
      c. Walworth.
   7. Strainers:

a. Kitz Corporation of America.
b. Conbraco Industries, Inc-: Apollo Division.
c. NIBCO Inc.

8. Trap Seal Primer Valves:
   a. Sloan Valve Co.
   b. Precision Plumbing Products, Inc.
   c. Approved Equal.
9. Drain valves:
   a. Kitz Corporation of America.
   b. Conbraco Industries, Inc-: Apollo Division.
   c. NIBCO Inc.
10. Water pressure reducing valves:
    a. Conbraco Industries, Inc-: Apollo Division.
    b. Watts Industries, Inc., Water Products Div.
    c. Flomatic, Danfoss Flomatic Corporation.
11. Temperature and Pressure Relief Valves:
    a. Watts Industries, Inc.
    b. Wilkins, division of Zurn.
    c. Bell and Gossett.
12. Plug Valves (Non-Lubricated):
    a. Kitz Corporation of America.
    b. Canbraco Industries Inc: Apollo Division.
    c. NIBCO Inc.

2.2 VALVES - BASIC, COMMON FEATURES

A. General: Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators (If Applicable): Use specified operators and handwheels, except provide the following special operator features:
   1. Handwheels: For valves other than quarter turn.
   2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.

3. Chain-wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation. Furnish and install chain-wheel operators on valves located more than 3 feet above accessible ceiling or access doors with the chain extended to within 6 inches of the ceiling.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. Threads: ASME B16.4 for cast iron and ASME B16.15 for bronze valves.

H. Flanges: ASME B16.24 for bronze valves.

I. Solder Joint: ANSI/ASME B16.18.
1. Caution: Where soldered end connections are used, use solder having a melting point below 840-degrees F for gate, globe, and check valves; below 421-degrees F for ball valves.

2.3 GATE VALVES

A. Up to and including 2-Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge threaded ends.

B. Over 2-Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.

2.4 GLOBE VALVES

A. Up to and including 2-inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, renewable composition disc, screwed ends, with back seating capacity repackable under pressure.

B. Over 2-inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.5 BALL VALVES

A. Ball Valves, 2-Inches and Smaller: MSS SP-110 compliant; ANSI B1.20.1 (threaded end) and ANSI B16.18 (soldered end); Class 150 SWP and 600 psi non-shock CWP, ASTM B584 bronze body and bonnet, 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; true adjustable packing; soldered end or threaded connection. (Note: Standard and reduced port and hollow ball design not acceptable). Ball shall be vented to allow relief of any trapped media between body and ball. 1/4-inch through 2-inches valve shall be CSA approved for gas service of 1/2- psi at the appliance, and 5-psi from appliance to the meter.
1. Operator: Vinyl-covered steel lever handle.
2. Operator: Lever operators with lock.
3. Stem Extension: For valves installed in insulated piping provide 2-inches extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation.
4. Memory/Balancing Stop: For operator handles.

B. Ball Valves, 2-1/2-inches thru 4-inches: MSS SP-110; ANSI B1.20.1; Class 150 SWP and 600-psi non-shock CWP, ASTM B283 bronze body and bonnet, 3-piece or 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; adjustable packing; soldered end or threaded connection. (Note: Standard and reduced port and hollow ball design not acceptable).
   1. Operator: Vinyl-covered steel lever handle.
   2. Operator: Lever operators with lock.
   3. Stem Extension: For valves installed in insulated piping provide 2-inch extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation
   4. Memory/Balancing Stop: For operator handles.

2.6 BUTTERFLY VALVES

A. Butterfly Valves: 4-inches thru 12-inches: MSS SP-67 and API 609, 200-psi CWP,150-psi maximum pressure differential (except 14-inches through 24-inches which shall be rated at 150-psi), ASTM A536-84 ductile-iron body and bonnet, extended neck, stainless-steel stem, molded-in or bonded-in EPDM or Buna N seat, EPDM or Buna N stem seals, wafer, lug, or grooved style; valve shall be bi-directional and suitable for dead-end service in either direction at the full working pressure of the valve with the downstream flange removed for up to 96-hours.
   1. Disc Type: Nickel-plated ductile iron.
   2. Disc Type: Aluminum bronze.
   3. Disc Type: Elastomer-coated ductile iron.
   4. Disc Type: Epoxy-coated ductile iron.
   5. Operator for Sizes 2-Inches to 6-Inches: Standard lever handle with memory stop.

2.7 ANGLE VALVES

A. Up to and including 2-Inches: Bronze body, bronze trim, rising stem, handwheel, inside screw, renewable composition disc, screwed ends, with back seating capacity repackable under pressure.

B. Over 2-Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.8 CHECK VALVES (SWING)

A. Swing Check Valves, 3-Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP and Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B62 cast-bronze body and cap, rotating bronze disc with integral seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3-Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

2.9 STRAINERS (Y-TYPE)

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.
   1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
   2. 2-inches and Smaller: Bronze body, with female threaded ends.
   3. 2-1/2-inches and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
   4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.
      a. Drain: Factory installed, hose-end drain valve.
   5. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.

2.10 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110 compliant; ANSI B1.20.1 (threaded end) and ANSI B16.18 (soldered end); Class 150 SWP and 600-psi non-shock CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; machined solid chrome-plated brass ball, full port valves; blowout proof stem design; bronze or brass stem; multi-fill PTFE seats and seals; adjustable packing; threaded or soldered end connection. (Note: Standard and reduced port and hollow ball design not acceptable).
   1. Operator: Vinyl-covered steel fever handle.
   2. Operator: Lever operators with lock.
   3. Stem Extension: For valves installed in insulated piping provide 2-inches extended handle of non-thermal conductive material. Provide protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation
   4. Memory/Balancing Stop: For operator handles.
   5. Inlet: Threaded or solder joint.
   6. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.
   7. Cap: Die cast brass.
   8. Chain: Brass.

2.11 WATER PRESSURE REDUCING VALVES

A. General: The valve shall be approved or listed under ASSE 1003, CSA B356; Proposition 65 Compliant and IAMPO standards. The manufacturing facility shall be ISO 9001 registered. Water regulators, rated for initial working pressure of 150-psig (1035-kPa) minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.
   1. 2-inches and Smaller: Bronze body with threaded ends.
      a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
      b. Booster Heater Water Supply: Single-seated, direct operated with integral bypass.
   2. 2-1/2-inches and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA-approved, interior epoxy coating for regulators with cast-iron body.
      a. Type: Single-seated, direct operated.
      b. Type: Pilot-operated, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.
   3. Interior Components: Corrosion-resistant materials.
   4. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.

B. Low Flow Rates: Direct acting, spring loaded pressure reducing valve.

C. Higher Flow Rates: Pilot-operated, diaphragm-actuated pressure reducing valve.

2.12 PLUG VALVES (NON-LUBRICATED)

A. 2-1/2-inches and larger:
   1. MSS SP-78, 150-psi, cast iron body and plug, non-lubricated, Teflon packing, flanged ends. Provide lever operator or wrench.

B. Use ball valves 2-inches and smaller. Comply with Article 2.3.

C. Use non-lubricated plugs only when shut off valves are also provided.

D. For below grade polyethylene piping, use thermoplastic plug valves molded from polyethylene resin which conforms to ASTM D1248, Type II, Class B with antioxidants, Category 5, grade P23. Valves shall be plain-end for heat-fusion joining in the pipeline. Valves shall have elastomer seats, plug seals, and ground water seal. Plug shall be retained in body by a plug retainer Valves shall have 2-inch square nut operators.

2.13 PLUG VALVES (LUBRICATED)

A. Up to and including 2-Inches: Semi-steel, tapered plug, screwed gald type, threaded body.

B. 2-1/2-Inches through 4-Inches: Semi-steel, 2-bolt cover, tapered plug, flanged body.

C. Operator:
   1. Lever operator with memory stop smaller than 6-inches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 APPLICATION

A. Provide unions on both sides of all valves except valves that have flanged connections. Provide unions at piping connections to all equipment or apparatus unless equipment or apparatus have flanged connections.

B. Provide brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Provide ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers. Note: Ball valves shall be limited to pipe sizes 4 inches and smaller.

D. Provide globe or plug valves for throttling, bypass, or manual flow control services.

E. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment, for pressure reducing valves as indicated on Drawings.

F. Provide spring loaded check valves on discharge of water pumps.

G. Provide shutoff valves in natural gas systems for shut-off service.

H. Provide isolation shutoff valves and unions at inlet and outlet sides of all water pressure reducing valves, water/gas solenoid valves and gas pressure regulators.

3.3 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/4- inch/foot, 2-percent, minimum unless indicated otherwise on Drawings. Maintain gradients.

B. Install piping so that entire system is drainable. Provide drain valves with hose connections at low points.

C. Connect branch piping to top of mains.

3.4 INSTALLATION

A. Install valves as indicated, according to manufacturer’s written instructions.

B. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe.

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:
   1. Swing Check Valves: Horizontal position with hinge pin level.

3.5 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open ball valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

H. Solder copper tube-and-fitting joints where indicated, in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
   1. Use soft solders having a maximum melting point of 570-degree F (299-degree C).
   2. E.G.:95-5 tin-antimony = 460-degree F (238 degree-C)
      a. 96-4 tin-silver = 430-degree F (221- degree C)

I. Do not use hard solder with a melting point of 840-degree F (449-degree C) or higher, because resultant crack on a valve surface may cause fluid leakage.

J. Prepare copper tubes conforming to ASTM B88, “Seamless Copper Water Tubes.”

K. The maximum service pressure and temperature of solder jointed valves are limited by the properties of solder and tube materials. Information on typical solder materials are provided below:

	Max.	Maximum Working Pressure		
	Temp.	Size 1/4~1-inch	Size 1¼~2-inch	Size 2½~3-inch
Solders	Degree F	psi	psi	psi
95-5 TA	100	500	400	300
(H95 Sb-5A)	150	400	350	275
96-4TA	200	300	250	200
(H96 Ag-3.5A)	250	200	175	150

3.6 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

E. Do not apply an excessive force when threading pipes into valve bores. It will cause seat deformation and operational difficulty. Adequate threading torques are given below:

Valve Size	1/4~1/2-inch	3/4-inch	1-inch	1-1/4-inch	1-1/2-inch	2-inch	2-1/2 inch	3~4-inch
Threading Torque (Nm)	20~29	39~49	49~59	59~69	69~78	78~88	108~118	127~137

3.7 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.8 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:
   1. Copper Tube Size, 2-1/2-Inches and Smaller: Solder ends.
   2. Copper Pipe Sizes, 3-Inches and Larger: Flanged end.

3.9 APPLICATION SCHEDULE

A. General Application: Use ball and butterfly valves for shutoff duty; and ball for throttling duty. Comply with the requirements of piping system Specification Sections for specific valve applications and arrangements.

B. Non-Potable Water Systems: Use the following valve types:
   1. Ball Valves: Class 150, 600-psi CWP, with stem extension,
   2. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
   3. Bronze Swing Check: Class 125, with rubber seat.

C. Natural Gas Systems: Use the following valve types:
   1. Ball Valves: UL listed / CSA approved for gas service, Class 150, 600-psi.
   2. Plug Valves: Approved for gas service, Class 150-psi.

3.10 PROTECTION AND CLEANING

A. Clean interior and exterior of valves prior to installation. Remove dirt and debris as work progresses.

B. Protect valves during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted valves at end of day and when work stops.

3.11 ADJUSTING

A. Adjust valves and correct deficiencies discovered during startup services.

3.12 STARTUP SERVICES

A. Before operating systems, perform these steps:
   1. Remove all plugs used during testing of piping systems and plugs used for temporary sealing of piping and valves during installation.
   2. Open all valves.
   3. Remove and clean all debris from inside and outside of valves.
   4. Replace all strainer screens with new.

B. Check valves and verify proper settings, adjustments, and operation. Verify drain grates are secure to drain body using detention type screws.

3.13 PLUMBING VALVE SCHEDULES

A. Provide valves as scheduled on the following “Data Sheets.” Each Data Sheet begins with a new page.

BALL VALVE DATA SHEET

Ball Valves: 2-inches and smaller (two-piece):

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	77-204 thru 208
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	77-204 thru 208
Nibco	S-585-70

Ball Valves: 2½-inch (three piece and two piece):

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	82-209-01
Nibco	S-595Y
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Ball Valves - 3-inch (three piece and two piece)

MANUFACTURER	SOLDER ENDS
Kitz	#69
Conbraco (Apollo)	82-240-01
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Ball Valves - 4-Inch (three piece and two piece):

MANUFACTURER	SOLDER ENDS
Kitz	#68 (use threaded with C x MIP adapters)
Conbraco (Apollo)	82-24A-01
Nibco	S-585-70
MANUFACTURER	THREADED ENDS
Kitz	#68
Conbraco (Apollo)	82-209-01
Nibco	S-595Y

Comply with Article 2.2 and 2.5 for valve description and accessories.

BUTTERFLY VALVE DATA SHEET

Butterfly Valves: 2-inches and larger.

The following are model numbers for wafer-type, with nickel-plated ductile-iron disc;

MANUFACTURER	LEVER	GEAR
Kitz	5112-E-L	5112-E-G
Conbraco (Apollo)	6X13X-01	6W13X-02
Nibco	WD-20103	WD-20105

The following are model numbers for lug-type, with nickel-plated ductile-iron disc:

MANUFACTURER	LEVER	GEAR
Kitz	6112-E-L	6112-E-G
Conbraco (Apollo)	6L13X-01	6L-13X-02
Nibco	LD-20103	LD-20105

The following are model numbers for wafer--type, with aluminum-bronze disc:

MANUFACTURER	LEVER	GEAR
Kitz	5122-E-L	5112-E-G
Conbraco (Apollo)	6W 14X-01	6VW14X-02
Nibco	WD-20003	WD-20005

The following are model numbers for lug-type, with aluminum-bronze disc:

MANUFACTURER	LEVER	GEAR
Kitz	6122-E-L	6122-E-L
Nibco	LD-2000-3	LD-2000-5
Conbraco	6L14X-01	6W14X-02

Comply with Article 2.6 for valve description and accessories.

SWING CHECK VALVE DATA SHEET

Swing Check Valves - 2-Inch and Smaller--

MANUFACTURER	CLASS125 THREADED ENDS	CLASS 125 SOLDER ENDS	CLASS 150 THREADED ENDS	CLASS 150 SOLDER ENDS
Kitz	22	23	29	30
Crane	37	1342	137	
Nibco	T-413	S-413	T-433	

Swing Check Valves - 2½-Inch and Larger:

MANUFACTURER	CLASS 125	CLASS 175
Kitz	78	x
Crane	373	x
Nibco	F-918	x
Stockham	G-931	G-940

x means not available.
Comply with Article 2.8 for valve description and accessories.

DRAIN VALVE DATA SHEET

Drain Valves:

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Kitz	68C	69C
Conbraco (Apollo)	77-101 thru 109	77-204 thru 209
Nibco	T-585-70-HC	S-585-70-HC

Comply with Article 2.13 for valve description and accessories.

STRAINER DATA SHEET

Strainers: 2-inches and smaller.

MANUFACTURER	THREADED ENDS	SOLDERED ENDS
Kitz	#15	#16
Spirax Sarco	BT/TBT	
Mueller	351/352	

Strainers: 2½-inches and 3-inches.

MANUFACTURER	THREADED ENDS	FLANGED ENDS
Kitz	#15 (2-1/2" & 3")	

Strainers: 2-inches through 12-inches.

MANUFACTURER	THREADED ENDS	FLANGED ENDS
Kitz	(see above)	#80

Comply with Article 2.10 for valve description and accessories.

WATER PRESSURE REDUCING VALVE DATA SHEET

Water Pressure Reducing Valve: PRV-1

Description: General: ASSE 1003, water regulators, rated for initial working pressure of 150-psig (1035-kPa) minimum. Include integral factory-installed or separate field-installed Y-pattern strainer.

1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
   a. General Duty Service: Single-seated, diced operated, unless otherwise indicated.
2. NPS 2½ (DN 65) and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA approved, interior epoxy coating for regulators with cast-iron body.
   a. Type: Single-seated, direct operated.
3. Interior Components: Corrosion-resistant materials.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. General.
2. Manufacturers.
3. Pipe Hangers and Supports.
4. Vertical Piping Clamps.
5. Hanger-Rod Attachments.
6. Building Attachments.
7. Pipe Shields.
8. Miscellaneous Materials.

B. Related Sections
1. Section 23 05 00 - Common Work Results for HVAC.
2. Section 23 05 48 - Vibration and Seismic controls for HVAC piping and equipment.
3. Section 23 31 00 - HVAC Ducts and Casings.

1.2 DEFINITIONS

A. Terminology: As defined in MSS SP 90, Guidelines on Terminology for pipe hangers and supports.

1.3 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards
1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports and anchors.
2. Qualify welding processes and welding operators according to AWS D1.1, Structural Welding Code-Steel.
   a. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
3. Qualify welding processes and welding operators according to ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
4. Listing and Labeling: Provide hangers and supports that are listed and labeled as defined in NFPA 70, Article 100.
   a. UL and FM Compliance: Hangers, supports, and components include listing and labeling by UL and FM where used for fire protection piping systems
   b. Listing and Labeling Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

5. Licensed Engineer: Prepare hanger and support design drawings and calculations for seismic restraint of piping and equipment. Include seal and signature of Registered Structural Engineer licensed in the State of California certifying compliance with Specifications.
6. MSS Standard Compliance:
    a. Provide pipe hangers and supports of which materials design and manufacture comply with MSS SP-58. Select and apply pipe hangers and supports, complying with MSS SP-69.
    b. Fabricate and install pipe Local and supports, complying with MSS SP-89.
    c. Terminology used in this Section is defined in MSS SP-90.

C. Corrosion Resistance: Provide hot-dip galvanized steel, cadmium plating, or other approved corrosion resistant materials for exterior work and for work which will be subject to outdoor exposure during construction.

D. Coordination
1. Coordinate resiliently supported work with other trades to avoid rigid contact with the building. Inform other trades such as drywall, plastering, or electrical, to avoid any contact which would reduce the vibration isolation.

E. Conflicts and Discrepancies
1. Bring to the Library Representative's attention prior to installation any conflicts with other trades which will result in unavoidable contact to equipment, piping, etc., described herein, due to inadequate spaces, etc. Corrective work necessitated by conflicts after installation shall be at Contractor's expense.
2. Bring to the Library Representative's attention prior to installation any discrepancies between the Specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at Contractor's expense.

F. Inspection and Instruction
1. Obtain inspection and approval from the Library Representative of any installation to be covered or enclosed prior to such enclosure.

1.4 VIBRATION ISOLATION

A. Comply with the requirements of Section 23 05 48.

1.5 SEISMIC RESTRAINTS

A. Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Include the following:
1. Manufacturer's data (catalog cuts and data sheets), for each manufactured component including hangers, attachments, inserts, thermal shields anchors and guides, auxiliary framing and wall seals. Provide a project specific hanger and support schedule indicating all devices, manufacture and model, where used. Cross reference to product data and specification paragraph. Data shall demonstrate that components comply with Specifications.

2. Support and Bracing Shop Drawings: Submit plans, sections, details, schedules and other information necessary to describe support hangers for all HVAC systems. Submittal shall indicate location and type of all hangers and supports. Each attachment to the building structure shall have vertical and horizontal point loads identified.
3. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual in accordance with requirements of Division 1.
4. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
5. Shop drawings for each type of hanger and support, indicating dimensions weights, required clearances, and methods of component assembly.
6. Licensed Engineers hanger and support drawings specified in the "Quality Assurance' Article
7. Licensed Engineer's hanger and support installation report specified in the "Field Quality Control" Article.

PART 2 PRODUCTS

2.1 GENERAL

A. Where not fully called for in the Contract Documents, design of HVAC hangers and supports shall be the Mechanical Contractor's responsibility. Design shall conform to accepted engineering practice using a safety factor of 2-1/2.

2.2 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
1. Superstrut, Gold Galv.
2. B -Line Systems, lnc.
3. Pipe Shields Incorporated (PSI)
4. Elcen Metal Products Co.
5. Fee & Mason Mfg.Co.; Div. Figgie International ITT Grinnel Corp.
6. Michigan.
7. Hubbard Enterprises / HOLDRITE.
8. Tolco.

2.3 PIPE HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide felt-lined hangers and supports for copper piping systems in direct contact with copper piping components including galvanized coatings where installed for piping and equipment that will not have a field applied finish. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper piping.

B. Thermal-Hanger Shield Inserts: 100 psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Shield Insert shall cover entire circumference of pipe and be of length indicated by manufacturer for pipe size and thickness of insulation by CSS Pre-Insulated Supports.

C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

D. Adjustable Steel Clevises Hangers: MSS Type 1.

E. Yoke Type Pipe Clamps: MSS Type 2.

F. Steel Double Bolt Pipe Clamps: MSS Type 3.

G. Steel Pipe Clamps: MSS Type 4.

H. Pipe Hangers: MSS Type 5.

I. Adjustable Swivel Pipe Rings: MSS Type 6.

J. Adjustable Steel Bond Hangers: MSS Type 7.

K. Adjustable Band Hangers: MSS Type 9.

L. Adjustable Swivel Rings, Band Type: MSS Type 10.

M. Split Pipe Pings: MSS Type 11.

N. Extension Split Pipe Clamps: MSS Type 12.

O. U-Bolts: MSS Type 24.

P. Clips: MSS Type 26.

Q. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
   1. Plate: Unguided type.
   2. Plate: Guide type.
   3. Plate: Hold-down Clamp type.

R. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast-iron floor flange.

S. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

T. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.

U. Single Pipe Rolls: MSS Type 41.

V. Adjustable Roller Hangers: MSS Type 43.

W. Pipe Roll Stands: MSS Type 44.

X. Pipe Rolls and Plates: MSS Type 45.

Y. Adjustable Pipe Roll Stands: MSS Type 46.

Z. Makeshift, field devised methods of HVAC pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42.

2.4 VERTICAL PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide felt-lined or copper-plated clams for copper-piping systems.

B. For vertical mid-span supports of piping 4-inch and under, use Hubbard Enterprises/HOLDRITE Stout Brackets with Hubbard Enterprises/HOLDRITE Stout Clamps or two-hole pipe clamps (MSS Type 26).

C. Two-Bolt Riser Clamps: MSS Type 8.

D. Four-Bolt Riser Clamps: MSS Type 42.

2.5 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.6 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Powder-actuated fasteners are not acceptable.

B. Concrete Inserts
   1. Cast-in-Place Concrete Inserts: MSS Type 18.

2. Post-Installed Anchors: Proprietary type, designed for intended uses, and ICC ESR evaluated.
    a. Manufacturers
        1) ITW Ramset/Red Head.
        2) Simpson.
        3) Hilti Co.

C. Top Beam C-Clamp: MSS Type 19.

D. Side Beam or Channel Clamps: MSS Type 20.

E. Center Beam Clamps: MSS Type 21.

F. Welded Beam Attachments: MSS Type 22.

G. C-Clamps: MS Type 23.

H. Top Beam Clamps: MSS Type 25.

I. Side Beam Clamps: MSS Type 27.

J. Steel Beam Clamps with Eye Nut: MSS Type 28.

K. Linked Steel Clamps with Eye Nut: MSS Type 29.

L. Malleable Beam Clamps: MSS Type 30.

M. Steel Brackets: One of the following for indicated loading:
1. Light Duty: MSS Type 31.
2. Medium Duty: MSS Type 32.
3. Heavy Duty: MSS Type 33.

N. Side Beam Brackets: MSS Type 34.

O. Plate Lugs: MSS Type 57.

P. Horizontal Travelers: MSS Type 58.

2.7 INSULATED PIPE SUPPORTS (PIPE SHIELDS)

A. All insulated lines shall be protected at the point of support by insulated pipe supports provided and installed by the pipe erector.

B. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes:
1. ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

C. Insulation
1. 360-degrees insulation, encased in 360-degrees sheet metal shield.
2. Provide assembly of same thickness as adjoining pipe insulation.
3. Insulating Material:
    a. Cold Piping (below 50 degrees F): Urethane foam, 100 psi compressive strength.

b. Hot piping (above 50-degrees F): Calcium silicate, 100 psi compressive strength, treated with water repellent.

2.8 MISCELLANEOUS MATERIALS

A. Auxiliary Steel:
1. Provide auxiliary structural steel as required for supports, anchors, guides, seismic restraints and vibration isolators.
2. All structural steel systems to be designed in accordance with AISC Steel Handbook.
3. All systems to be secured to building structure in a method acceptable to and approved by the Project Structural Engineer.
4. Steel Work: Fabricate neatly. Grind off excess burrs and welding spatter. Paint with rust inhibitive primer.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A36.

C. Cement Grout: Portland cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No.2). Mix at a ratio of 1.0 part cement to 2.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

E. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
1. Manufacturers
a. Hyspan.
b. Metraflex.
c. Approved Equal.

F. Plenum Rated Pipe Clamps: ASTM E84 25/50 plastic clamps from Hubbard Enterprises/Holdrite.

PART 3 EXECUTION

3.1 GENERAL

A. Install devices in accordance with manufacturer’s recommendations.

B. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

C. Support of pipe tubing and equipment shall be accomplished through means of engineered products specific to each application. Makeshift field devised methods will not be allowed.

D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 PREPARATION

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

B. Prior to installation of hangers, supports, anchors and associated Work, Installer shall meet at Project site with Contractor, Installer of each component of associated Work, Inspection and testing agency representatives (if any), Installers of other Work requiring coordination with Work of this Section and the City Representative for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.3 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms.

B. Loading on Steel Beams
   1. Do not place eccentric loads on steel beams for loads greater than 50-pounds.
   2. For loads greater than 50 pounds, use attachments which create concentric loading.

C. Cast-in Place Concrete Inserts
   1. Install before concrete is placed. Fasten inserts securely to forms.
   2. Install with reinforcing bar through opening at top of insert or with steel plate to distribute load, as detailed on Drawings.
   3. Maximum load per insert in slabs shall be 200 pounds, with a minimum spacing of 5 feet in any direction. For loads greater than 200 pounds, or where spacing cannot be maintained, make attachment to building structure or auxiliary steel, rather than to slab.

D. Concrete Wedge Anchor Inserts: Maximum tension load per insert shall not exceed manufacturer’s published rating.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports of smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping. Install in accordance with Seismic Restraint manual Guidelines for Mechanical Systems (SMACNA).
   1. Materials, design and type numbers per MSS-58.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, felt-lined.

D. Provisions for Movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.1 Power Piping Codes are not exceeded.

G. Insulated Piping: Comply with the following installation requirements:
   1. Provide insulated pipe support (pipe shield) at each support of insulated piping.
   2. Select model of insulated pipe support according to published recommendations of insulated pipe support manufacturer, based on pipe size, pipe material, fluid medium, fluid temperature, support spacing, and type of support.
   3. Submit tabulation showing proposed uses of insulated pipe supports for different applications.

H. Provide pipe supports on all DWV vertical piping penetrating floor slabs.

I. Hanger components:
   1. Vertical Piping: Clamps attached to the pipe above each floor to rest on the floor. Provide copperplate on copper tubing. Provide additional support at base of cast iron risers. Provide intermediate support for vertical piping greater than 12 feet in length.
   2. Individually Suspended Piping: J-Hanger or Clevis, complete with threaded rod. All hangers on supply and return piping handling heating hot water or steam shall have a swing connector at point of support. Copper pipe will be used in conjunction with felt lined hangers.

Pipe Size	Rod Size
2-inch and Smaller	3/8-inch
2-1/2-inch to 3-1/2-inch	1/2-inch
4-inch to 5-inch	5/8-inch

3. Provide 3/8 inch or support of PVC and CPVC and provide continuous support.
4. Trapeze Suspension: 1-5/8-inch width channel in accordance with manufacturer's published load ratings. No deflection to exceed L/180 of a span.
5. Trapeze Supporting Rods: Shall have a safety factor of 5; securely anchor to building structure.
6. Pipe Straps: isolate copper pipe with two thicknesses of 2-inch wide 10-mil polyvinyl tape (Cush-A-Strip or Cush-A-Clamps). Where used for seismic support systems, provide Superstrut 702 or C708 series pipe straps.

J. Concrete Inserts: Superstrut C302 continuous insert or 452-TB spot insert. Do not use powder-actuated fasteners for support of overhead piping unless approved by the City Representative.
   1. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
   2. Install concrete inserts in new construction prior to placing concrete. Superstrut 452-TB, C745, or C302.
   3. Install post-installed concrete anchors after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.

K. Steel Connectors: Beam clamps with retainers.
   1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts washers, and other accessories

L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

M. Support to Structure
   1. Steel Structure: Provide and install additional steel bracing as required to suit structure. Provide through bolts with length to suit requirements of the structural components. Burning or welding on any structural member may only be done if approved by the CITY Representative.

N. Rubber Neoprene Pipe Isolators
   1. Pipe isolators shall comprise an internal rubber or neoprene material that isolates pipe from hanger and structure. Install at all piping located in acoustical walls. Architectural Drawings shall show location of acoustical walls.
   2. Isolation material shall be either a rubber or neoprene material that prevents contact between the pipe and the structure. Superstrut S716 or A716.

O. Pipe Hangers and Support Spacing: Locate hangers and supports at each change of direction, within one foot of elbow, and space at or within following maximum limits. Note that spacing listed are recommended maximums; increased spacing requirements due to California

Building Code requirements, CCR Title 24, or other regulations in force and applicable for this contract shall be adhered to.

Pipe	Steel	Steel	Copper	
	Diameter	Fluid	Vapor	Fluid
	1/2 to 1-inch	6	8	6
	1-1/4 to1-1/2-inch	8	10	6
	Over 2-inch	10	10	10

P. Provide support for piping through roof, arranged to anchor piping solidly in place at the roof penetration.

Q. Provide rigid insulation and a 12-inch long, 18 gauge galvanized sheet metal shield between the covering and the hanger whenever hangers are installed on the outside of the pipe covering or CSS Pre-Insulated Calcium Silicate Support.

R. Insulate copper tubing from ferrous materials and hangers with felt lined hangers.

S. Provide a support or hanger close to each change of direction of pipe either horizontal or vertical and as near as possible to concentrated loads.

T. Suspend rods from concrete inserts with removable nuts where suspended from concrete decks. Power-actuated fasteners will not be allowed.

3.5 ADJUSTING AND CLEANING

A. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.

B. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer’s touch-up paint.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint and exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA1 requirements for touching up field-painted surfaces.
   1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.7 FIELD QUALITY CONTROL

A. Licensed Engineer's Report: Prepare hanger and support installation report. Include seal and signature of Registered Structural Engineer, licensed in the State of California, certifying compliance with Specifications.

END OF SECTION

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Vibration Isolators.
   2. Seismic Restraints.
   3. Flexible Connectors.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves.

B. SMACNA “Guidelines for Seismic Restraints of Mechanical Systems”, OSHPD Approval No. R-0001.

1.3 QUALITY ASSURANCE

A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.

B. All items of a given type shall be the product of the same manufacturer.

C. Provide necessary design for avoidance of excessive noise and vibration in building due to operation of machinery or equipment, or due to interconnected piping or conduit.

D. Installation of all vibration isolation units, and associated hangers and bases, shall be under direct supervision of vibration isolation manufacturer’s representative.

1.4 REGULATORY REQUIREMENTS

A. Provide seismic restraints for pipes and equipment, including pipes above roofs, supported from below in accordance with the requirements of the California Code of Regulations, Title 24, Parts 3, 4, and 5.

1.5 SUBMITTALS

A. Shop drawings and product data; submittal shall include:
   1. Concrete and steel details for equipment.
   2. Vibration isolation devices: Catalog cuts, isolation efficiencies and rated static deflections.
   3. Welds or anchor bolt locations.
   4. Reinforcing and template steels.

5. Number and locations of seismic restraints for each piece of equipment; specific details of restraints including anchor bolts for mountings and maximum load at each location.
6. Spring O.D., free operation, and solid height of springs and ratio of horizontal to vertical stiffness.
7. Number and location of vibration isolators for each piece of equipment including actual operating load for each vibration isolator.

B. Seismic calculations for each seismic restraint sized and signed by registered Structural Engineer licensed in the State of California.

C. Manufacturer's installation instructions.

D. Manufacturer's Installation Report as specified in the "Field Quality Control" Article.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers
1. Mason Industries, Inc.
2. Vibration Mountings and Controls, Inc.
3. Vibration Eliminator Company.
4. Peabody Noise Control, Inc.

B. Manufactured Units.
1. Isolator Type "PN"; three layers of 1/4-inch neoprene waffle pad bounded between 16 gauge sheet metal shims or 3/4-inch thick neoprene waffle pad consisting of 2-inch square modules separated by thin web. Load distribution top plate utilized as required with additional 1/5 inch thick washer and bushing when pads are anchored to structure.
2. Isolator Type "NM": Double deflection neoprene mountings having a minimum static deflection of .35 inch. Metal surfaces neoprene covered to avoid corrosion. Friction pads top and bottom.
3. Isolator Type "NML": Neoprene mountings with integral seismic restraints and consisting of captive steel insert embedded in neoprene. Mountings may be used in tension and shear as well as compression. Neoprene pad may be bonded to base plate for additional deflection as required.
4. Isolator Type "MS": Spring type, free standing and laterally stable without any housing, complete with 1/4-inch neoprene acoustical friction pad or neoprene cup between base plate and support. Provide leveling height and solid spring height in submittals.
5. Isolator Type "MSL": Spring type mountings designed to resiliently resist seismic forces in all directions. Snubbing in all modes with adjustment to limit upward, downward and horizontal travel to a maximum of 1/4 inch before contacting snubbers. Provide spring with same characteristics as described in Type MS mountings. Provide mountings with leveling bolts that must be rigidly bolted to equipment, and with ports or openings to verify possible overload conditions. In submittals include spring diameter, deflections, compressed spring height and solid spring height.
6. Isolator Type "HN": Vibration hangers which contain minimum .35-inch static deflection neoprene element. Neoprene rod isolation bushing shall pass through hanger box lower hole to prevent metal to metal contact.
7. Isolator Type "HS": Vibration hangers which contain steel spring seated in 1/4-inch thick neoprene cup with integral rod isolation bushing. Bushing shall pass through lower

hanger box hole to prevent metal-to-metal contact. Provide spring diameters and hanger box lower hole sizes large enough to permit hanger rod to swing through 30 degree arc. Provide minimum additional travel to solid equal to 50 percent of rated deflection.

2.2 SEISMIC RESTRAINTS

A. Manufacturers
   1. Midland-Ross Superstrut.
   2. Pipe Shields, Inc.
   3. B-Line.

B. Restraint Types
   1. Type R-1: Provide directional seismic restraints with interlocking steel members restrained by replaceable, minimum 1/4-inch thick bridge bearing neoprene bushing, capable of rotation after installation to verify isolation system is out of contact with restraints. Incorporate minimum air gap of 1/8 inch in snubber design in all directions before contact is made between rigid and resilient surfaces.
   2. Type R-2: Restraints of all isolated suspended piping, ductwork and equipment using steel cables arranged to achieve required all-directional restraint and sized to resist seismic loads. Indicate proposed method of achieving sufficient slack to avoid short circuiting vibration isolators in submittal drawing.

C. General Requirements
   1. Provide seismic restraints for all vibration isolated equipment, ductwork and piping.
   2. Restrain supported and suspended equipment and piping by devices capable of restraint in all three mutually orthogonal directions.
   3. For suspended equipment, utilize stranded steel aircraft cable plus modifications to isolators to prevent excessive vertical motion.
   4. Seismic restraints must be installed and adjusted so equipment and piping vibration isolation is not degraded by utilization of restraints.

2.3 FLEXIBLE CONNECTORS

A. Manufacturers
   1. Mason Industries, Inc.
   2. Amber Booth.
   3. Approved Equal.

B. Neoprene Connectors
   1. Use flexible EPDM connectors on equipment as indicated on drawings or on equipment schedule, manufactured of multiple layers of frictioned nylon cord with EPDM cover and liner. Do not use steel wire or rings as internal pressure reinforcement. Provide straight connectors with two spheres with a centered molded external ductile iron ring to maintain two spherical shapes. Two inch and smaller sizes may have threaded ends. Provide floating flanges with recess to lock bead wire in raised face EPDM flanges. Use tapered twin sphere connectors as described above where line size changes are required in straight piping runs.
   2. Flanged equipment may be directly connected to neoprene elbows in size range 2-1/2 to 12 inches, if piping makes 90 degree turn and flanges are equal sized. Long radius reducing EPDM elbows may be used in place of steel or cast iron elbows at pump connections.

3. When pressure would cause connector to extend beyond its rated elongation, employ control rods using 1-1/2-inch thick bridge-bearing neoprene washer bushings designed for maximum loading of 1000 psi.
4. Provide twin sphere connectors with minimum rating of 250 psi at 170 degree F and 165 psi at 250 degree F. Provide elbows and reducing twin spheres with minimum pressure rating of 220 psi at 170 degree F and 145 psi at 250 degree F. Limit neoprene materials to 220 degree F. Certified safety factors shall be a nominal 4 to 1 with minimum acceptable test results of 3.6 to 1. Tests shall cover burst, flange leakage, extension without control rods and flange retention at 50 percent of burst pressure without control rods.
5. Include in submittals test reports by independent consultants showing minimum reduction of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies.

C. Flexible Stainless Steel Hose
1. Provide flexible stainless steel hose with stainless steel braid and carbon steel fittings. Provide flanged fittings for sizes 3-inch and larger, and make nipples for smaller sizes. Use bronze braided flexible hose with female sweat ends for copper lines. Install hoses on equipment side of shut-off valves horizontally and parallel to equipment shafts whenever possible. Flexible metal hose shall be Type BSS or BFF.

PART 3 EXECUTION

3.1 GENERAL

A. Isolate plumbing equipment from building structure by means of noise and vibration isolators.

B. Install isolators in accordance with manufacturer's written instructions.

C. Vibration isolators must not cause change of position of equipment or piping resulting in piping stresses or misalignment.

D. Make no rigid connections between equipment and building structure that degrade noise and vibration isolation system.
1. Loop electrical conduit connections to isolated equipment to allow free motion.

E. Do not use isolator leveling bolts as jacking screws.

F. Verify that installed isolators and mounting systems permit equipment motion in all directions.

G. Install vibration isolators for motor driven equipment.

3.2 SEISMIC CONTROL

A. Provide seismic restraints for pipes and equipment per CBC, CMC, and CPC, including pipes above roofs, supported from below.

B. Design and provide restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift.

C. Provide approved resilient restraining devices as required to prevent equipment and piping motion in excess of 1/4 inch.

D. Provide capability of safely accepting external forces without failures.

E. Do not short circuit vibration isolation systems or transmit objectionable vibration or noise.

F. Provide restraint for piping in mechanical rooms for pipe sizes covered by SMACNA.

G. Designs: Where designs, etc., are neither indicated nor referenced, submit such designs, together with supporting calculations prepared by Structural Engineer registered in the State of California. Calculations shall substantiate seismic restraint capability to safely accept external forces without failure and maintain equipment in position.

H. Rigidly Supported Piping
   1. Where required for all systems, restrain per SMACNA seismic standards.

I. Flexibly Supported Piping
   1. Provide and locate restraints to allow normal operation of systems without transmitting vibrations to building structure.
   2. Locations of Restraints: Per SMACNA and Factory Mutual where applicable.
   3. Construction of Restraint: Steel cables, installed slack, may be used.

3.3 EQUIPMENT ISOLATION AND SEISMIC CONTROL

A. Position equipment and structural base on blocks or wedges at proper operating height. Set steel bases for 1-inch clearance between pad and base. Set concrete bases for 2-inch clearance.

B. Provide operating load conditions prior to transferring base isolator loads to springs and remove wedges.

C. Adjust or provide additional resilient restraints to flexibly limit startup equipment lateral motion to 1/4 inch.

D. Prior to startup, clean out all foreign matter between bases and equipment.

E. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

F. Position all corner or side seismic restraints with equipment operating for proper operating clearance.

3.4 PIPING ISOLATION AND SEISMIC RESTRAINT

A. Isolate piping outside of shafts as follows:
   1. Water piping 1-1/4 inch and larger in mechanical equipment rooms: Within 50 feet or 100 pipe diameters whichever is smaller, of connected rotating equipment and pressure reducing stations.
      a. Piping where exposed on roof.

B. Provide spring isolators on piping connected to isolated equipment as follows:
   1. Up to 4 inches in diameter, first 3 points of support.
   2. 1.5 to 8 inches in diameter, first 4 points of support.
   3. Static deflection of first point shall be twice deflection of isolated equipment.

C. Locate Isolators:
   1. Close to building structure.
      a. Hanger boxes butted to ceiling structure.
   2. Between building structure and supplementary steel if required.

D. Supplementary steel to be sized for maximum deflection of 0.08 inches at center span.

E. Seismic restraint spacing shall be in accordance with specified hanger spacing.

F. Provide Seismic Restraint For All Piping:
   1. In equipment room.
   2. On roofs.

3.5 FIELD QUALITY CONTROL

A. Provide inspection by manufacturer's representative of all vibration isolating devices after installation of all devices.

B. Submit written report by manufacturer regarding installation error, improper selection of devices, and other faults that could affect performance of system. Include report on steps to properly complete isolation work.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe Markers.
2. Valve Tags.
3. Equipment Nameplates.
4. Duct Labels.
5. Stensils.
6. Chart and Diagram Frames.

B. Related Sections:
1. Section 23 05 00 - Common Work Results for HVAC.
2. Section 23 31 00 - HVAC Ducts and Casings.

1.2 REFERENCES

A. ASME A13.1-2007 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Indicate model, type, and application usage.

C. Submit list of wording, symbols, letter size**,** letter style, and color coding for each system and vault cover.

D. Submit valve numbering scheme**,** valve chart and schedule, including valve tag number, location, function type, and valve manufacturer's name and model number.

1.4 COORDINATION

A. Coordinate with City Representative for preferred color schemes and service abbreviations and valve and equipment numbering schemes prior to submittal review.

B. Coordinate installation of identifying devices with completion of covering of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment. If not installed before ceiling is installed, the Contractor shall remove ceiling at no additional cost to the City and install identifying devices.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Seton Name Plate Corp.

B. Brimar.

C. Brady.

2.2 PIPE MARKERS

A. Markers: ASME A13.1.
   1. Pressure sensitive vinyl (self sticking) material.
   2. Mechanically fastened type: Snap on or strap on.
      a. For dirty, greasy, or oily pipe where pressure sensitive markers may not perform satisfactorily.
   3. All weather film for outdoor exposed piping.
   4. Provide 360 degree and pipe flow arrows and fluid being conveyed.
   5. Size of letters legend:

OUTSIDE DIAMETER OF PIPE OR PIPE COVERING	LENGTH OF COLOR FIELD	SIZE OF LETTERS AND ARROWS
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
Ductwork		2-1/2 inch

2.3 VALVE TAGS

A. Tags: Brass or anodized aluminum type.
   1. Brass: Minimum 19 gauge, polished, 2-Inch diameter with following lettering:
      a. Service: ¼-inch stamped black filled letters.
      b. Valve numbers: 3/8-inch stamped black filled letters.
   2. Aluminum: 2-inch diameter, 0.032-inch thick, with following lettering:
      a. Service: ¼-inch engraved letters.
      b. Valve numbers: 3/8-inch engraved letters.

B. Fasteners: 4 ply 0.018 copper or monel wire meter seals, brass “S” hooks or No. 16 brass jack chain.

2.4 EQUIPMENT NAME PLATES

A. **1/8**-inch rigid plastic or bakelite with 4 edges beveled, with black background and white border and letters.
   1. Two 3/8-inch mounting holes.
   2. Minimum ½-inch high lettering.
   3. Commercial quality, rust resisting nuts and bolts with backwashers, self tapping screws or rivets.

2.5 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.6 STENSILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4-inches for ducts; and minimum letter height of ¾-inch for access panel and door labels, equipment lables, and similar operational instructions.3
   1. Stencil Material: Aluminum.
   2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.7 CHART AND DIAGRAM FRAMES

A. Chart and diagram frames: Extruded aluminum with plexiglass or glass windows.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment, valves, dampers and terminal units by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. Dampers.
      c. All items indicated on equipment schedules except registers, grilles and diffusers.
   2. Designation shall match that indicated.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location, directly on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.

E. For unsuitable surfaces, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts.
   1. Mount 1 chart in frame and secure on wall in location directed by City Representative.
   2. Include remaining 3 sets in “Operation and Maintenance Manuals”.
   3. Show valve tag numbers on project as-built drawings.

G. Provide safety sign for each piece of exposed mechanical equipment that may start automatically.

3.3 PIPE IDENTIFICATION

A. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take off.
   3. At each passage through walls, floors and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.4 SERVICE ABBREVIATIONS

A. Coordinate with CITY Representative for preferred color schemes and service abbreviations as indicated below:
   1. G (xxx psi) Natural Gas (indicate pressure).
   2. REF Refrigerant (exposed)

3.5 CONTROL DIAGRAMS AND INSTRUCTIONS

A. Provide HVAC control and systems instructions and diagrams in wall mounted frames. Mount framed diagrams in conspicuous, easily accessible places in equipment rooms housing appropriate HVAC system.

B. Diagrams and instructions may be reduced in size provided they are legible and lettering is not smaller than “elite” type of standard typewriter.

3.6 DUCTWORK IDENTIFICATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For cold-air supply ducts.
   2. Yellow: For hot-air supply ducts.
   3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer’s option, if lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.

END OF SECTION

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SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Testing, adjustment, and balancing of air systems.
   2. Testing, adjustment, and balancing of hydronic systems.
   3. Sound measurement of equipment operating conditions.
   4. Vibration measurement of equipment operating conditions.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
   3. Section 23 31 00 - HVAC Ducts and Casings.
   4. Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCES

A. AABC - National Standards for Field Measurement and Instrumentation, Total System Balance.

B. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.3 TOLERANCES

A. Adjust air handling systems to plus 10 percent or minus 5 percent for supply, return and exhaust systems from figures indicated.

B. Adjust hydronic systems to plus or minus 10 percent of design conditions indicated.

C. Indicate system air leakage loss. Loss shall not exceed 3 percent.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Name of adjusting and balancing agency for approval within 30 days after award of Contract.

C. Sample forms to be used in field, to be reviewed and approved by Engineer of Record.

D. Test Reports: Report Forms.
   1. Submit reports on AABC National Standards for Total System Balance or NEBB forms.

E. Closeout Submittals.

F. Project Record Documents:

1. Submit record documents under provisions of Division 1.
2. Accurately record actual locations of balancing valves and rough setting.

1.5 QUALITY ASSURANCE

A. Agency shall be company specializing in adjusting and balancing of systems specified in this Section with minimum three years documented experience certified by AABC or NEBB. Perform work under supervision of AABC or NEBB Certified Test and Balance Engineer or registered Professional Engineer.

B. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

C. Pre-Installation Meetings:
1. Convene a conference two weeks prior to commencing work of this Section, under provisions of Division 1.

1.6 SEQUENCING AND SCHEDULING

A. Sequence work under provision of Division 1.

B. Sequence work to commence after completion of systems, and schedule completion of work before Substantial Completion of Project.

PART 2 PRODUCTS

2.1 GENERAL

A. Products and materials shall be as described in pertinent sections of Division 23.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

D. Examine equipment performance data including fan and pump curves.
1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

F. Examine test reports specified in individual system and equipment Sections.

G. Before commencing work, verify that systems are complete and operable. Ensure the following:
   1. Equipment is operable and in safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Fan rotation is correct.
   7. Fire and volume dampers are in place and open.
   8. Coil fins have been cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage has been minimized.
   12. Hydronic systems are filled, clean, and free of air.
   13. Pump rotation is correct.
   14. Proper strainer baskets are clean and in place.
   15. Service and balance valves are open.
   16. Air vents are installed and operating properly.
   17. Test ports, gauge cocks, and thermometer wells are in place.
   18. Windows and doors can be closed so indicated conditions for system operations can be met.

H. Promptly report to County Representative any defects, deficiencies, or abnormal conditions in mechanical systems which prevent system balance, or are noted during performance of services.

I. Commencement of work indicates acceptance of existing conditions.

3.2 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to County Representative to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. The following procedures shall be used for starting and testing of each item of equipment.

B. Adjust work under provisions of Division 1.

C. Prior to equipment startup, submit in writing to County Representative approval to begin Checking Equipment/Test Procedure and Startup Procedure. Submit manufacturer's recommendations for startup/testing.

D. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."

E. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. Do not cut holes in flex connectors.
   2. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

F. Recorded data shall represent actually measured or observed condition. Take and report testing and balancing measurements in inch-pound (IP) units.

G. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

H. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

I. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

J. Where equipment and components are interlocked into a system, test and verify proper operation as a complete system.

K. Cooperate with control system installer and equipment installer in making adjustments to equipment as required to accomplish indicated performance.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Checking Equipment/Test Procedure:
   1. Fans:
      a. Record serial numbers, model, brand, etc.
      b. Lubricate where necessary.
      c. Check belts.
      d. Check rotation.
      e. Check voltage and phase.
      f. Check for free movement.
      g. Turn fan on and begin testing.

B. Startup Procedure:
   1. Fans:
      a. Check control sequence of fan. Check interlocks.
      b. Correct deficiencies.

c. Request the presence of a County Representative and control Subcontractor for startup test.
d. In the presence of a County Representative:
1) Check control sequence of fan. Check interlocks.

2. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
3. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
4. Measure air quantities at air inlets and outlets.
5. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
6. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers.
7. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
8. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
9. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
10. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Set minimum position for outside air dampers to achieve indicated minimum outside air CFM's.
11. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
12. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
13. Take sound level reading at two diffusers per zone at approximately 5 feet above floor. Readings shall be between 43 and 41 db.

3.5 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.6 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.

3.7 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.8 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers’ test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect’s name and address.
   6. Engineer’s name and address.
   7. Contractor’s name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution system. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

3.9 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

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SECTION 230700

HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Acceptable Manufacturers.
   2. Piping Insulation and Jacketing Materials.
   3. Equipment Insulation Materials.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment,
   3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   4. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.2 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this Project.

C. Flame/smoke ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.
   1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

D. Insulation on pipes, ducts, and plenums in building spaces shall not breed or promote microbial growth.

E. Insulation products shall be formaldehyde-free.

F. K Values: Thermal conductivity in BTU-in/hr. sq.ft. deg.F.

G. Density: In pound/cu.ft. (pcf).

H. Vapor Permeability, in perms: (0.02 perms = 0.02 grains/hr x sq. ft x inch Hg.)

1.3 SUBMITTALS

A. Product data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Project site.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:
1. Armacell.
2. CertainTeed Corp.
3. Knauf Fiber Glass GmbH.
4. Johns Manville Corp.
5. Owens-Corning Corp.
6. RBX Industries.

2.2 PIPING INSULATION AND JACKETING MATERIALS

A. Fiberglass piping insulation: Preformed, one piece, with all service jacket/self sealing lap; K value of 0.23 at 75°F mean temperature.
1. Vapor Barrier Jacket: With integral, factory-applied, paintable, white reinforced kraft outer surface bonded to aluminum foil with self-sealing lap. Maximum vapor permeance of 0.02 perms, and minimum beach puncture of 50 units.

B. Elastomeric Foam Piping Insulation: Closed cell. K-value of 0.27 or less at 75°F mean temperature. Maximum vapor permeance of 0.08 perms. Meet 25 flame / 50 smoke rating for thicknesses up to 1.5 inch. Insulation shall be CFC free.
1. Pipe sizes up to 6": Preformed, one-piece insulation. Armacell AP/Armaflex, Rubatex Insul-Tube 180, or approved equal.

C. Jackets:
1. Interior Applications:
a. Vapor Barrier Jackets: Kraft, reinforced foil vapor barrier with self-sealing adhesive joints.
b. PVC Jackets: One piece, premolded type.
c. Canvas Jackets: UL listed treated cotton fabric, 6oz/sq. yd.
2. Exterior Applications:
a. Aluminum Jackets: ASTM B209, 20 mils thick; with 2 joint longitudinal seams, and factory supplied butt straps.

D. Fittings and Valves: Manville Zeston, Speed-Line. Premolded PVC fitting covers over pre-cut insulation of same thickness as adjacent piping.

E. Bands, wires, and cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, sealers, and protective finishes: As recommended by insulation manufacturer for applications indicated.

2.3 EQUIPMENT INSULATION MATERIALS

A. Rigid fiberglass equipment insulation: 6 lb./cu.ft. insulation board; All Service Jacket; K value of 0.22 at 75 degrees F mean temperature mean temperature.

B. Flexible equipment insulation:
1. Johns Manville Micro-Flex APT Jacket. K value of 0.24 at 75 degrees F mean temperature.
2. Elastomeric Foam: Closed cell sheet and roll. K-value of 0.27 or less at 75 degrees F mean temperature. Maximum vapor permeance of 0.08 perms. Meet 25 flame/50 smoke rating for thicknesses up to 1 inch. Armacell AP/Armaflex, Rubatex Insul-Sheet 1800.

C. Jacketing material for equipment insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.

D. Equipment insulation compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

E. Equipment insulation accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work of this Section until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PIPING SYSTEM INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems after acceptance of pressure testing.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Insulate valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Factory molded, precut or job fabricated units may be used in accordance with manufacturer's published recommendations. Cover with premolded PVC fitting covers for fiberglass insulation.

F. Maintain integrity of vapor-barrier jackets on cold pipe insulation, including at valves and fittings. Protect vapor barrier to prevent puncture or other damage. Do not use staples. Follow recommendations of insulation manufacturer for applications indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Insulation shall be butted against insulated pipe supports, as specified in Section 23 05 29. For hot pipes, apply 3 inches wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inches wide vapor barrier tape or band.

I. If grooved piping system is employed where piping insulation is specified, insulate all mechanical joints as specified for pipe fittings. Maintain thermal expansion capability of grooved piping system intact.

J. Elastormeric Foam insulation:
   1. Install per manufacturer's published recommendations.
   2. Cut custom pieces from insulation sheets for use at elbows, valves, Victaulic fittings, strainers, and other irregular surfaces. Follow manufacturer's published recommendations. Obtain manufacturer's cutting templates.
   3. Seal all joints completely with proper adhesive such as Armacell 520 or Rubatex Contact Adhesive. Apply adhesive to both sides of all joints.

K. For insulated piping installed in locations exposed to weather, provide sealants, etc.for aluminum jacketing to result in watertight finished installation.

L. For insulated valves installed out-of-doors, provide removable weatherproof stainless steel box at each valve to completely enclose and protect the insulation and (if applicable) the piping freeze protection heater strips.

3.3 EQUIPMENT INSULATION

A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

D. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and

depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

E. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable.

F. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

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SECTION 230800

COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Responsibilities.
      a. Divisions 23 responsibilities in the commissioning process which consists of:
         1) Commissioning Mechanical Systems
         2) Commissioning Controls Systems
         3) Commissioning Testing, Adjusting and Balancing (TAB)

B. Related Sections
   1. Section 01 91 13 – General Commissioning Requirements.
   2. Section 22 08 01 – Commissioning of Domestic Hot Water System.
   3. Section 23 09 00 – Instrumentation and Control of HVAC.

1.2 DEFINITIONS

A. CxA: Commissioning Agent.

B. O&M: Operations and Maintenance.

C. TI: Technical Inspector

D. Refer to Section 01 91 13 for further definitions.

1.3 DESCRIPTION

A. This Section describes commissioning requirements applicable to commissioned items and systems specified in Divisions 23 to ensure that all systems are operating in a manner consistent with the Contract Documents.

B. Conform to commissioning requirements and the Commissioning Plan.

1.4 RESPONSIBILITIES

A. General Commissioning:

   1. Refer to Commissioning Plan and Section 019113.

B. Mechanical Systems:
   1. Commission the mechanical systems listed in Section 019113 and the Commissioning Plan.
   2. Provide submittals as required by A/E and those listed on the pre-functional test sheets.
   3. Provide start-up for all HVAC equipment, except for the building automation control system. Clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
   4. Provide all test equipment necessary to fulfill specified testing requirements.

5. Assist and cooperate with the TAB Contractor and CxA by:
    a. Putting all HVAC equipment and systems into operation and continue the operation during each working day of TAB and commissioning, as required.
    b. Including cost of sheaves and belts that may be required by TAB.
    c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
    d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
6. Install a P/T plug at each water sensor which is an input point to the control system.
7. List and clearly identify on the as-built drawings the locations of all air-flow stations.
8. Prepare a preliminary schedule for Divisions 23; duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
9. Notify the CxA when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Responsible for notifying the CxA ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.
10. Refer to Section 019113 for specific details on non-conformance issues relating to prefunctional checklists and tests and for issues relating to functional performance tests.
11. The training shall consist of a review of the O&M manuals and hands-on training. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment. The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packages controls, not controlled by the central control system. Training shall occur after functional testing is complete, unless otherwise approved by the Owner Representative.

C. Controls system:
1. Sequences of Operation Submittals. The Contractor's submittal of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
    a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
    b. All interactions and interlocks with other systems.
    c. Detailed delineation of control between any packaged controls and the building automation system (BAS), listing what points the BAS monitors only and what BAS points are control points and are adjustable.
    d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative.)
    e. Start-up sequences.
    f. Warm-up mode sequences.
    g. Normal operating mode sequences.

h. Unoccupied mode sequences.
i. Shutdown sequences.
j. Capacity control sequences and equipment staging.
k. Temperature and pressure control: setbacks, setups, resets, etc.
l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
m. Effects of power or equipment failure with all standby component functions.
n. Sequences for all alarms and emergency shut downs.
o. Seasonal operational differences and recommendations.
p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
q. Schedules, if known.
r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers shall not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal:
   a. The control drawings shall have a key to all abbreviations.
   b. The control drawings shall contain graphic schematic depictions of the systems and each component.
   c. The schematics shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
   d. Provide a full points list with at least the following included for each point:
      1) Controlled system
      2) Point abbreviation
      3) Point description
      4) Display unit
      5) Control point or setpoint (Yes / No)
      6) Monitoring point (Yes / No)
      7) Intermediate point (Yes / No)
      8) Calculated point (Yes / No)
      9) Point description: DB temp, airflow, etc.
      10) Control or setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
      11) Intermediate point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
      12) Monitoring point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
      13) Calculated point: "Virtual" point generated from calculations of other point values.
      14) The Contractor shall keep the CxA informed of all changes to this list during programming and setup.
3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the TAB Contractor in the following manner:
    a. Meet with the TAB Contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB Contractor any unique instruments needed and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
    b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed prior to TAB.
    c. Provide a qualified technician to operate the controls to assist the TAB Contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
5. Assist and cooperate with the CxA in the following manner:
    a. Using a skilled technician who is familiar with the installed systems in this building, execute the functional testing of the controls system. Assist in the functional testing of all equipment. Provide two-way radios during the testing.
    b. Execute all control system trend logs.
6. The Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
    a. System name.
    b. List of devices.
    c. Step-by-step procedures for testing each controller after installation, including:
        1) Process of verifying proper hardware and wiring installation.
        2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
        3) Process of performing operational checks of each controlled component.
        4) Plan and process for calibrating valve and damper actuators and all sensors.
        5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
    d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
    e. A description of the instrumentation required for testing.
    f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CxA and TAB Contractor for this determination.
7. Provide a signed and dated certification to the Contractor upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points.

9. List and clearly identify on the as-built duct and piping drawings the locations of all monitoring and control sensors.
10. Provide all test equipment necessary to fulfill specified testing requirements.

D. Test and Balancing (TAB):
1. Submit the outline of the TAB plan and approach for each system and component to the CxA and TI six weeks prior to starting the TAB.
2. The submitted plan shall include:
   a. Certification that the TAB Contractor has reviewed the construction documents and systems with the design engineers and Contractor to sufficiently understand the design intent for each system.
   b. An explanation of the intended use of the building control system. The Contractor shall comment on feasibility of the plan.
   c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
   e. Final test report forms to be used.
   f. Detailed step-by-step procedures for TAB work for each system and issue; terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors shall be discussed. Provide the analogous explanations for the waterside.
   g. List of all airflow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
   h. Details of how total flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
   i. The identification and types of measurement instruments to be used and their most recent calibration date.
   j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
   k. Confirmation that TAB Contractor understands the outside air ventilation criteria under all conditions.
   l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
   m. Details of how building static and exhaust fan / relief damper capacity will be checked.
   n. Proposed selection points for sound measurements and sound measurement methods.
   o. Details of methods for making any specified coil or other system plant capacity measurements.
   p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
   q. Details regarding specified deferred or seasonal TAB work.

r. Details of any specified false loading of systems to complete TAB work.
s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
t. Details of any required interstitial cavity differential pressure measurements and calculations.
u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
v. Plan for formal progress reports (scope and frequency).
w. Plan for formal deficiency reports (scope, frequency and distribution).

3. The Contractor shall keep a running log of events and issues. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and TI at least twice a week.
4. Communicate in writing to the controls operator all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
5. CxA or TI to witness the TAB to verify that the systems are being balanced per specifications.
6. Provide a draft copy of the TAB report to the CxA within two weeks of completion. The report shall contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
7. Provide the CxA with any updates as a result of A/E review.
8. Provide all test equipment necessary to fulfill specified testing requirements.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. The Contractor shall provide all test equipment necessary to fulfill the testing requirements of this Section.

PART 3 EXECUTION

3.1 SUBMITTALS

A. The Contractor shall provide submittal documentation relative to commissioning as required in this Section and Division 1.

3.2 STARTUP

A. The Contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 13. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CxA and TI.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the PM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.3 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.

B. The Contractor shall compile and prepare documentation for all commissioned systems covered in Division 23.

C. The Contractor shall deliver this documentation to the CxA four months prior to the training of personnel.

D. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the Contractor shall compile and organize at a minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Three copies of the controls training manuals in a separate manual from the O&M manuals.
2. Operation and Maintenance Manuals containing:
    a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
    b. Full as-built set of control drawings.
    c. Full as-built sequence of operations for each piece of equipment.
    d. Full points list. A listing of all rooms shall be provided with the following information for each room:
        1) Floor
        2) Room number
        3) Room name
        4) Air handler unit ID

5) Reference drawing number
6) Air terminal unit tag ID
7) Heating and/or cooling valve tag ID
8) Minimum cfm
9) Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.
f. Full as-built print out of software program.
g. Electronic copy on disk of the entire program for this facility.
h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.
i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
j. Control equipment component submittals, parts lists, etc.
k. Warranty requirements.
l. Copies of all checkout tests, other than commissioning tests, and calibrations performed by the Contractor.

3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation
   b. Control drawings
   c. Points lists
   d. Controller / module data
   e. Thermostats and timers
   f. Sensors and DP switches
   g. Valves and valve actuators
   h. Dampers and damper actuators
   i. Program setups (software program printouts)
4. Field checkout sheets and trend logs should be provided to the Contractor for inclusion in the on-site Commissioning filing system.

E. Special TAB Documentation Requirements. The Contractor shall compile and submit the following with other documentation that may be specified elsewhere in the Specifications.
   1. The Contractor shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

3.4 TRAINING OF PERSONNEL

A. The Contractor shall be responsible for training coordination and scheduling to ultimately ensure that training is completed.

B. The CxA shall be responsible for reviewing the content and adequacy of the training of Owner personnel for commissioned equipment or systems. TI will verify compliance.

C. Mechanical Systems:
   1. Provide the CxA with a training plan four weeks before the planned training.
   2. Provide designated personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of commissioned equipment.
   3. Training shall start with classroom sessions followed by hands-on training on each piece of equipment.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated.
5. The Contractor shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
    a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    c. Discussion of relevant health and safety issues and concerns.
    d. Discussion of warranties and guarantees.
    e. Common troubleshooting problems and solutions.
    f. Explanation of information included in the O&M manuals.
    g. Discussion of any peculiarities of equipment installation or operation.
    h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
10. Fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional testing is complete, unless otherwise approved by the PM.
12. Minimum Duration of Training. Provide training on each system according to training hours included in individual Division 1, and 23 sections.

D. Controls System:
1. Provide the CxA with a training plan four weeks before the planned training.
2. The Contractor shall provide designated personnel training on the control system in this facility. The intent is to clearly and completely instruct the building maintenance personnel on all the capabilities of the control system.
3. Training Manuals: The standard operating manual for the system and any special training manuals shall be provided for each trainee. In addition, copies of the system technical manual shall be demonstrated during training. Manuals shall include a detailed description of the subject matter for each session. The manuals shall cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Copies of audiovisuals shall be delivered to the building owner and CxA.
4. The training sessions shall be tailored to the needs and skill-level of the trainees.

5. The trainers shall be knowledgeable on the system and its use in buildings.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated.
7. The Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. Provide three training sessions structured as follows:
    a. Training I. Control System: The first training shall consist of eight hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    b. Training II. Building Systems: The second session shall be held on-site for a period of 24 hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
        1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, any interface with security and communication systems.
        2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
        3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, and viewing of both tabular and graphically printed trends. Trainees shall actually set-up trends in the presence of the trainer.
        4) Every screen shall be completely discussed, allowing time for questions.
        5) Use of keypad or plug-in laptop computer at the zone level.
        6) Use of remote access to the system via phone lines or networks.
        7) Setting up and changing an air terminal unit controller.
        8) Graphics generation
        9) Point database entry and modifications
        10) Understanding DDC field panel operating programming (when applicable)

c. Training III. The third training will be conducted on-site six months after occupancy and consist of 16 hours of training. The session shall be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

PART 4 PREFUNCTIONAL CHECKLIST AND FUNCTIONAL TEST FORMS

4.1 Test Forms

A. See attached sample.

B. For complete set of test sheets see commissioning plan.

END OF SECTION

SECTION 230910

INSTRUMENTATION FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Pressure Gauges.
   2. Pressure Gauge Taps.
   3. Stem Type Thermometers.
   4. Thermometer Supports.
   5. Test Plugs.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

A. ASME B40.100 - Pressure Gauges and Gauge Attachments.

B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.

C. ASTM International:
   1. ASTM E1 - Specification for ASTM Liquid-in-Glass Thermometers.
   2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

D. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.

E. ANSI/AWWA C701 - Cold Water Meters - Turbine Type for Customer Service.

F. AWWA C702 - Cold Water Meters - Compound Type.

G. ANSI/AWWA C706 - Direct-Reading Remote-Registration Systems for Cold-Water Meters.

H. AWWA M6 - Water Meters Selection, Installation, Testing and Maintenance.

I. FS-GG-G-76 - Gauges, Pressure and Vacuum, Dial Indicating (for Air, Steam, Oil, Water, Ammonia, Chloro-Fluorohydrocarbon Gases, and Compressed Gases).

J. ISA-SP3 - Flange–Mounted, Sharp-Edged Orifice Plates for Flow Measurement.

K. UL 393 (Ed. 8) - Indicating Pressure Gauges for Fire-Protection Service.

L. UL 404 - Safety for Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components. Operating instructions, and maintenance and repair data.

C. Manufacturer's Installation Instructions.

D. Closeout Documents:
   1. Project Record Documents: Accurately record actual locations of instrumentation.

1.4 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Trerice.

B. Weiss.

C. Approved Equal.

2.2 PRESSURE GAUGES

A. ASME B40.1, UL 393, UL 404, FS-GG-G-76, 4-1/2 inch diameter drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background, one percent mid-scale accuracy, scale calibrated in psi.

B. ASME B40.1, UL 393, UL 404, FS-GG-G-76, 4-1/2 inch diameter cast aluminum case, phosphor bronze bourdon tube, rotary brass movement, brass socket, front recalibration adjustment, black figures on white background, one percent mid-scale accuracy, scale calibrated in psi.

2.3 PRESSURE GAUGE TAPS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psig.

B. Needle Valve: Stainless Steel for maximum 200 psig.

C. Pulsation Damper: Pressure snubber, brass with 1/4-inch connections.

D. Syphon: Bronze, 1/4-inch angle or straight pattern.

2.4 STEM TYPE THERMOMETERS

A. ASTM E1, 7-inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, 3-1/2 inch brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees F.

B. ASTM E1, 7-inch scale, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass window, 3-1/2 inch brass stem, cast aluminum adjustable joint with positive locking device, 2 percent of scale accuracy to ASTM E77, scale calibrated in degrees F.

2.5 DIAL THERMOMETERS

A. ASTM E1, 2-inch diameter dial in stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed glass lens, stainless steel stem, one percent of full scale accuracy, calibrated in degrees F.

B. ASTM E1, 3-inch diameter dial in stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed glass lens, stainless steel stem, one percent of full scale accuracy, calibrated in degrees F.

C. ASTM E1, 2-1/2 inch diameter dial in stainless steel case, vapor or liquid actuated with brass or copper bulb, 5 feet minimum copper or bronze braided capillary, white with black markings and black pointer glass lens, 2 percent mid-scale accuracy, calibrated in degrees F.

2.6 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

B. Flange: 3-inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.7 TEST PLUGS

A. Test Plug: 1/4-inch or 1/2-inch brass or stainless steel fitting and cap for receiving 1/8-inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200-degrees F, Nordel core for temperatures up to 350 degrees F, Viton core for temperatures up to 400-degrees F.

B. Test Kit: Carrying case, internally padded and fitted containing one 3 1/2-inch diameter pressure gauges, one gauge adapters with 1/8-inch probes, two 1 1/2-inch dial thermometers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

C. Install pressure gauges with pulsation dampers. Provide gauge cock or needle valve to isolate each gauge.

D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets.

E. Install thermometers in air duct systems on flanges.

F. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted Thermometers are not required.

G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Coil and conceal excess capillary on remote element instruments.

I. Provide instruments with scale ranges selected according to service with largest appropriate scale.

J. Install gauges and thermometers in locations where they are easily read from normal operating level.

K. Locate test plugs adjacent to control device sockets and where indicated.

3.2 SCHEDULES

A. Pressure Gauge Schedule

LOCATION	SCALE RANGE
Pumps	0 to 200 PSI
Expansion tanks	0 to 200 PSI

B. Stem Type Thermometer Schedule

LOCATION	SCALE RANGE
Hydronic chilled/ hot water supply and return	30 to 200 degrees

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Refrigerant piping used for air-conditioning applications.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
   3. Section 23 05 19 - Meters and Gauges for HVAC Piping.
   4. Section 23 05 23 - General-Duty Valves for HVAC Piping.
   5. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
   6. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   7. Section 23 05 53 - Identification for HVAC Piping and Equipment.
   8. Section 23 07 00 - HVAC Insulation.

1.2 REFERENCES

A. ANSI/ASHRAE 15 - Safety Standard for Refrigeration Systems.

B. ANSI/ASHRAE 34 - Designation and Safety Classification of Refrigerants.

C. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

D. ANSI/ASME B31.5 - Refrigeration Piping and Heat Transfer Components.

E. ASTM B32 - Solder Metal.

F. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

G. ASTM B828 - Making Capillary Joints by Soldering of Copper and Copper-Alloy Tube and Fittings.

H. AWS A5.8/A5.8M - Filler Metals for Brazing and Braze Welding.

I. ASME Boilers and Pressure Vessels Code.

J. ANSI/ARI 49 - Refrigerant Liquid Receivers.

K. ARI 730 - Flowcapacity Rating and Application of Suctionline Filters and Filterdriers.

L. ARI 750 - Thermostatic Refrigerant Expansion Valves.

M. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.

N. UL 429 (Ed. 5) - Electrically Operated Valves.

1.3 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include Pressure drop based on manufacturer's test data.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Comply with ASHRAE 15, Safety Code for Refrigeration Systems.

B. Comply with ASME B31.5, Refrigeration Piping and Heat Transfer Components.

1.5 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch long assembly.
   4. Pressure Rating: Factory test at minimum 500 psig.

5. Maximum Operating Temperature: 250 degrees F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
   1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
   2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
   3. Operator: Rising stem and hand wheel.
   4. Seat: Nylon.
   5. End Connections: Socket, union, or flanged.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 275 degrees F.

B. Packed-Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
   5. Seal Cap: Forged-brass or valox hex cap.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Working Pressure Rating: 500 psig.
   8. Maximum Operating Temperature: 275 degrees F.

C. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   3. Piston: Removable polytetrafluoroethylene seat.
   4. Closing Spring: Stainless steel.
   5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Maximum Opening Pressure: 0.50 psig.
   8. Working Pressure Rating: 500 psig.
   9. Maximum Operating Temperature: 275 degrees F.

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
   6. Working Pressure Rating: 400 psig.
   7. Maximum Operating Temperature: 240 degrees F.
   8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by and NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat Disc: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig.
   6. Maximum Operating Temperature: 240 degrees F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 degrees F.
   6. Superheat: Nonadjustable.
   7. Reverse-flow option (for heat-pump applications).
   8. End Connections: Socket, flare, or threaded union.
   9. Working Pressure Rating: 450 psig.

H. Straight-Type Strainers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   4. Working Pressure Rating: 500 psig.
   5. Maximum Operating Temperature: 275 degrees F.

I. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.
   5. Working Pressure Rating: 500 psig.
   6. Maximum Operating Temperature: 275 degrees F.

J. Moisture/Liquid Indicators:
   1. Body: Forged brass.
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60-ppm.
   5. End Connections: Socket or flare.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 240 degrees F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   3. Desiccant Media: Activated alumina.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurements.
   7. Maximum Pressure Loss: 2 psig.
   8. Rated Flow: 5-tons.
   9. Working Pressure Rating: 500 psig.
   10. Maximum Operating Temperature: 240 degrees F.

L. Permanent Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted-steel shell.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   3. Desiccant Media: Activated alumina.
   4. Designed for reverse flow (for heat-pump applications).
   5. End Connections: Socket.
   6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
   7. Maximum Pressure Loss: 2 psig.
   8. Rated Flow: 5-tons.
   9. Working Pressure Rating: 500 psig.
   10. Maximum Operating Temperature: 240 degrees F.

M. Liquid Accumulators: Comply with ARI 495.
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or threaded.
   3. Working Pressure Rating: 500 psig.
   4. Maximum Operating Temperature: 275 degrees F.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, bur are not limited to the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arkema Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.

C. ASHRAE 34, R-22: Monochlorodifluoromethane.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Suction Lines NPS 1½ and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.

B. Suction Lines NPS 4 and Smaller MPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

C. Hot-Gas and Liquid Lines and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.

D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
   1. NPS 1½ and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
   2. NPS 1½ and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
   3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
   4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

G. Safety-Relief-Valve Discharge Piping:
   1. NPS 1½ and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
   2. NPS 1½ and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
   3. NPS 2 to 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
   4. NPS 4: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at strainers if they are not an integral part of strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalize liners are required, make connection where it will reflect suction line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install Refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to buildings walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 Section “Access Doors and Frames” if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed below ground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do no apply heat near expansion-valve bulb.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

Q. Seal penetrations through fire and smoke barriers according to Section 07 84 00, Firestopping.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

T. Seal pipe penetrations through exterior walls according to Section 07 90 00, Joint Protection for materials and methods.

U. Identify refrigerant piping and valves according to Section 23 05 53, Identification for HVAC Piping and Equipment.

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA’s “Copper Tube Handbook.”

B. Brazed Joints: Construct joints according to AWS’s “Brazing Handbook,” Chapter “Pipe and Tube.”
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20-feet long.
   2. Roller hangers and spring hangers for individual runs 20-feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20-feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60-inches; minimum rod size, 1/4-inch.
   2. NPS 5/8: Maximum span, 60-inches; minimum rod size, 1/4-inch.
   3. NPS 1: Maximum span, 72-inches; minimum rod size, 1/4-inch.
   4. NPS 1-1/4: Maximum span, 96-inches, minimum rod size, 3/8-inch.
   5. NPS 1-1/2: Maximum span, 96-inches, minimum rod size, 3/8-inch.
   6. NPS 2: Maximum span, 96-inches; minimum rod size, 3/8-inch.
   7. NPS 2-1/2: Maximum span, 108-inches; minimum rod size, 3/8-inch.
   8. NPS 3: Maximum span, 10-feet; minimum rod size, 3/8-inch.
   9. NPS 4: Maximum span, 12-feet; minimum rod size, 1/2-inch.

D. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Line Test Pressure for Refrigerant R-410A:
      a. Suction Lines for Air-Conditioning Applications: 185 psig.
      b. Suction Lines for Heat-Pump Applications: 325 psig.
      c. Hot-Gas and Liquid Lines: 325 psig.
   4. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in No. 3 above.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Acceptable Manufacturers.
   2. Duct Materials.
   3. Ductwork - General.
   4. Round Ductwork.
   5. Flexible Ductwork.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 22 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   3. Section 23 05 53 - Identification for HVAC Piping and Equipment.
   4. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
   5. Section 23 07 00 - HVAC Insulation.
   6. Section 23 33 00 - Air Ductwork Accessories.
   7. Section 23 37 13 - Air Outlets and Inlets.

1.2 REFERENCES

A. ASHRAE - Handbook Fundamentals; Duct Design.

B. ASHRAE - Handbook Equipment; Duct Construction.

C. ASTM A90/A90M - Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

D. ASTM A167-99 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

E. ASTM A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

F. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

G. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.

H. SMACNA - HVAC Duct Construction Standards.

I. UL 181 - Factory-Made Air Ducts and Air Connectors.

1.3 DEFINITIONS

A. Duct Sizes: Outside clear dimensions.

B. Pressure Classifications:
   1. SMACNA 1-inch Standard with Seal Class C:
      a. All ductwork unless indicated otherwise.

C. Seam: Locks or weld applied longitudinally to close section of duct, e.g., longitudinal seam, spiral seam.

D. Joint: Abutting connection between duct sections for continuity of air passage, e.g., cross joint, transverse joint, coupling.

E. Reinforcement: Hardware applied to strengthen duct, e.g., girth angles, tie rods, fasteners (not connectors), etc.

F. Stiffening: Folding, bending, beading, crossbreaking or corrugating of sheets to achieve strength through shape, e.g., pocket lock secures joint and is transverse stiffener, with girth angle and/or fasteners applied (not connectors), joint or stiffener.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the City Representative. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 REGULATORY REQUIREMENTS

A. Construct ductwork to California Mechanical Code.

1.6 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data:
   1. Provide make and model, gages for each duct size, material data sheets, and information for fittings.

C. Shop Drawings: CAD-generated and drawn to 1/4-inch equals 1-foot scale. Show fabrication and installation details for metal ducts.
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevations of top and bottom of ducts.
   4. Dimensions of main duct runs from building to grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Equipment installation based on equipment being used on Project.
   9. Duct accessories.
   10. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

D. Quality Control Submittals:
   1. Coordination Drawings: reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
      a. Ceiling suspension assembly members.
      b. Other systems installed in same space as ducts.
      c. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, and sprinklers, whether existing or new.
   2. Welding certificates.
   3. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code - Steel, for hangers and supports and AWS D9.1, Sheet Metal Welding Code, for duct joint and seam welding.

B. NFPA Compliance:
   1. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
   2. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Spiral Round Ducts:
   1. United McGill.
   2. Approved Equal.

B. Flexible Connections:
   1. Ventfabrics, Inc.
   2. Duro Dyne.
   3. Approved Equal.

C. Flexible Ducts:
   1. Thermaflex.
   2. United McGill.
   3. Automatic Industries, Inc.

D. Spring Fasteners:
   1. Dzus.
   2. Simmons “Quick-Lock.”
   3. Approved Equal.

E. Duct Protective Coatings:

1. Varni-lite Corporation of America.
2. Approved Equal.

F. Duct Sealants:
1. Minnesota Mining and Manufacturing Company (3M).
2. Benjamin Foster Company.
3. United McGill Corporation.
4. Hardcast Corporation Inc.
5. Miracle Adhesive Corporation.

G. Spin-in Fittings:
1. Modular Metals.
2. R & J Manufacturing.
3. Approved Equal.

2.2 DUCT MATERIALS

A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.

B. Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25-ounce per square foot for each side in conformance with ASTM A90.

C. Fasteners: Rivets, bolts, or sheet metal screws.
1. Screws and Rivets:
a. Same material as sheet, except as noted.
b. Zinc or cadmium plated, permitted on galvanized sheets.
c. Minimum Screw Size: No. 1C.
d. Minimum Rivet Size: 4-lb.

D. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used alone or with tape, or heavy mastic. Gaskets: Continuous, reinforced, inert self-conforming type. 1/8-inch thick. Width, to match angle connection.

E. Hard-Setting Joint Tape:
1. Two-part Tape:
a. Mineral impregnated woven fiber tape.
b. Impregnated with activator/adhesive of polyvinyl acetate type.
2. UL Listed:
a. Flame Spread: 10.
b. Smoke Contributed: 0.

F. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

G. Spring Fasteners:
1. Oval head stud and receptacle.
2. Screwdriver slot.
3. Self-ejecting.
4. Similar to Dzus.

H. Angles, tie rod and shapes for reinforcing ducts in accordance with SMACNA Duct Construction Standards, except as noted.

2.3 DUCTWORK - GENERAL

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.

C. Construct T's, bends, and elbows with radius of not less than 1½ times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Only where absolutely unavoidable, divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

E. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10-percent duct area, split into two ducts maintaining original duct area.

2.4 ROUND DUCTWORK

A. General:
1. Flow low pressure.
2. Prefabricated spiral lockseam duct.
3. Prefabricated fittings.
    a. Same manufacturer as duct and as detailed.
    b. Continuity welded seams.
    c. Die-stamped elbows for 8-inches or smaller.
    d. Mitered elbows larger than 8-inches.
        1) 2 Gores: less than 35 degrees.
        2) 3 Gores: 36 degrees through 71 degrees.
        3) 5 Gores: over 71 degrees.
4. Not Acceptable:
    a. Corrugated or flexible metal duct.
    b. Shop fabricated circular duct, except above maximum factory-fabricated size.
    c. Fiberglass ductwork.
5. Provide ducts with gauges meeting CMC and NFPA 90A, whichever is more strict.

B. Round Duct and Fittings:
1. Duct Construction:

Duct Diameter (in)	Spiral Duct Gage	Fitting Gage
3-14	26	20
15-26	24	20

2. Similar to United Sheet Metal "Uniseal" with "Uniform" fittings.

C. Accessories: Factory fabricated.
   1. Couplings.
   2. Volume dampers.
   3. Bellmouth fittings.
   4. End caps.
   5. Angle rings.
   6. Insulation Ends: Connections of double to single wall ducts.

2.5 FLEXIBLE DUCTWORK

A. General:
   1. Use only where specified or indicated.
   2. UL 181, Class I Air Duct.
   3. Labeled for compliance with CMC.

B. Low Pressure:
   1. Insulated Flexible Duct:
      a. Minimum working pressure 1.5-inches w.g.
      b. Nominal 1-inch insulation with vapor barrier.
      c. Maximum thermal conductivity 0.27-Btuh/sq. ft. degrees f/inch at 75 degrees F.
   2. Use At Following Locations:
      a. Connection to ceiling air outlets.
      b. As indicated.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. Construct with gauges, joints, bracing, reinforcing, and other details per CMC, ASHRAE, SMACNA, or NFPA standard unless specified otherwise.
      a. Comply with most stringent.
   2. Install ductwork of sizes, runs and connections as shown on the drawings.
   3. Verify all dimensions at the site, making all field measurements and shop drawings necessary for fabrication and erection of sheet metal work. Dimensions shown are net free areas. Make allowances for beams, pipes or other obstructions in building construction and for work of other trades. Check plans showing work of other trades and consult with County Representative in the event of any interference.
   4. Fabricate ductwork in workmanlike manner with airtight joints, presenting smooth surfaces on inside, neatly finished on outside, construct with curves, bends, turning vanes to aid in easy flow of air. Make internal ends of slip joints in direction of airflow.
   5. Construct, brace and support ducts to prevent sagging and to minimize vibration when fans are operating.
   6. Maintain rectangular cross section of ductwork unless otherwise shown.
   7. Blow out all dirt and foreign matter from ductwork, and clean diffusers, registers and grilles before fans are started.
   8. Unless otherwise noted, construct ductwork as specified for low pressure ductwork.
   9. All angle irons required for ductwork construction and support shall be galvanized.
   10. Construct of galvanized sheet metal, except where otherwise indicated.
   11. Diagonally crossbrace all panels on metal rectangular ducts over 18-inches in either direction. Beading for reinforcing is acceptable.

12. Duct dimensions indicated are net, outside, clear dimensions.
13. Alter duct sizes on basis of equal friction where required to facilitate installation.
14. Penetrations of ducts are forbidden without approval from the County Representative. Provide airtight rubber grommets at unavoidable penetrations of hanger rods.
15. At supply diffusers, grilles and/or registers extend branch duct 1-foot beyond air outlet.
16. Tapers: Pitch sides of duct in “diverging” or “converging” airflow maximum of 1 to 4 taper.
17. Duct Opening:
    a. Provide openings where required to accommodate thermometers, smoke detectors, controllers, etc. Insert through airtight rubber grommets.
    b. Provide Pitot tube openings where required for testing of systems:
        1) Complete with metal cap with spring device or screw to ensure against air leakage.
        2) For Pitot tube test install test holes.
    c. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
18. Tapers:
    a. Pitch sides of duct in a “diverging” airflow maximum of 20 degrees.
    b. Pitch sides of duct in a “converging” airflow maximum of 30 degrees.
    c. Design elbows for minimum friction with inside radius not less than width of duct. Use square elbows with hollow double radius type duct turns where radius is less than duct width. Attach duct turns to duct securely with spot weld, screws, or rivets. Friction type attachment not acceptable.
19. Branch Duct Connections: Make branch duct connections to other ducts in such a manner that it provides a smooth airflow with minimum turbulence and minimum air pressure drops at the connections. Use parallel flow connections or 45-degree clinch collars or bell mouth, and provide air volume control dampers. Straight tap connections are not acceptable unless specifically shown.
20. Test Holes: Drill instrument test holes into ductwork for Pitot tube tests. Install hole covers attached to ductwork by sheet metal screws. Locate test holes at intake and discharge from each air handling unit and as shown.
21. Remove all debris and oily residue from ductwork after manufacturing and prior to installation.
22. Cover and seal all openings in ductwork during transportation and storage; remove just prior to installation. Prevent dirt and moisture from entering ductwork after installation. Cover and seal openings at the end of each work day.

B. Elbows and Transitions:
    1. Construct radius elbows with inside radius not less than duct width.
    2. Use square turns in rectangular ductwork, unless indicated otherwise, at following locations:
        a. Immediately upstream from supply air outlets.
        b. Where required to facilitate installation.
    3. Provide turning vanes in miter elbows in round ducts.
    4. Where indicated, provide turning vanes of special size and shape.
    5. Two-way Splits:
        a. Supply, return and exhaust.
        b. Two Elbows:
            1) Proportionally sized per SMACNA Duct Standards.
            2) Radius or square.
        c. Single fitting acceptable with turning vanes. Duct opening sized as above.

C. Joint Sealing:
   1. Seal transverse and longitudinal joints of sheet metal ducts, including angle iron connections, by one of following methods:
      a. Six ounce canvas strip, six inches wide. Adhere with lagging adhesive.
      b. Applications as recommended by manufacturer.
   2. Seal punched holes and corner cracks.
   3. After installation and balancing reseal joints found to be leaking.

3.2 ROUND DUCTWORK

A. Fittings: Factory fabricated with radius of elbows and angles minimum of 1½-times diameter of duct. Where tee fittings of conical type change in shape from round to rectangular, utilize a transformation joint with a taper ratio of 1 to 7.

B. Joints Between Ducts:
   1. Made with beaded sleeve joints as scheduled.
   2. Duct sealer applied to male end.
   3. Mechanically fastened with sheet metal screws or pop rivets.
   4. Over joint and screw or rivet heads, apply coating of duct sealer.
   5. Cover entire joint with duct tape.

C. Joints, Duct and Fitting:
   1. Slip projecting collar of fittings into duct. Insertion length 2-inches minimum.
   2. Apply duct sealer. Seal and tape as specified above.
   3. Mechanically fasten per following Fastening Schedule:

No. of Rivets	Diameter	Slip Joint
4	8-inches	3/4-inch
6	9 to 16-inches	1-inch

D. Junctions Between Ducts: Branch takeoff conical 90 degrees.

E. Horizontal Supports:
   1. One or two-piece clamp band strap.
   2. Minimum: One per section.
   3. Support fittings to prevent sagging.

F. Vertical Support: One of the following:
   1. Clamp bands with knee bracing.

3.3 FLEXIBLE DUCTWORK

A. Provide insulated flexible ducts continuous, single pieces not over seven feet in length, adequately supported, and have a minimum inside bending radius of two-thirds the internal diameter, but not installed with a radius of bend less than two duct diameters.

B. Provide 4-inches wide sheet metal protection saddles under ductwork at each hanger.

C. Where flexible ducts join other ductwork and air terminals, apply duct sealer to outside surface of collar. Secure duct to collar with sheet metal screws and clamps, and seal joint with three wraps of pressure sensitive vapor seal adhesive tape.

D. Use only on supply air application.

E. Install flexible ducts in as straight a manner as possible. Cut ducts to lengths required, maximum 7-feet, rather than create bends to take up excess lengths. Terminate flexible duct perpendicular to the connection.

F. Connect flexible ducts to metal ducts with draw bands.

G. Use crimp joints with or without bead for joining round duct sizes 8-inch and smaller with crimp in direction of air flow.

H. Use double nuts and lock washers on threaded rod supports.

3.4 DUCT HANGERS AND SUPPORTS

A. General:
   1. Attachment to structure, as specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
   2. Seismic restraints shall be as specified in Section 23 05 48 - Vibration Isolation and Seismic Control.

B. Horizontal Duct Supports:
   1. Support horizontal ducts with hangers of size and spacing as indicated in pertinent SMACNA HVAC Duct Construction Standards.
   2. Install hangers at each change in direction of duct.
   3. Strap Hangers:
      a. Extend strap down both sides of ducts.
      b. Turn under bottom one inch minimum.
      c. Metal screw hangers to bottom of duct, upper and lower sides of ducts, and not more than 12-inches on center.
   4. Angle Hangers:
      a. Provide angle hangers formed by extended vertical bracing angles.
      b. Or by rods connecting to bottom angles if size or bracing angles conform to hanger schedule.

3.5 SLEEVES

A. Sleeves are specified in Section 23 05 00 - Common Work Results for HVAC.

3.6 LEAKAGE

A. General:
   1. Leakage of ductwork shall not exceed 3-percent of design cfm. The 3-percent leakage limit applies to each duct system as a whole.
   2. Leakage shall be determined by summation of all supply outlet cfm's on any one system subtracted from the total cfm developed by the unit serving that system.
   3. Balancer to inform County Representative of any system that exceeds the 3-percent leakage allowance.
   4. Contractor to inspect the systems that exceed the 3-percent leakage allowance and reseal leaking ductwork at no additional cost to the city until the leakage rate is within the 3-percent allowance.

3.7 DUCT CLEANING (EXISTING SYSTEM ONLY)

A. Force air at high velocity through duct to remove accumulated dust.

B. Clean half system at time.

C. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. When closures are removed, avoid spilling dust in room.

D. Insulation inside the duct shall not be used on any HVAC systems.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Acceptable Manufacturers.
   2. Volume Control Dampers.
   3. Air turning devices.
   4. Flexible duct connections.
   5. Duct test holes.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   3. Section 23 07 00 - HVAC Insulation.
   4. Section 23 31 00 - HVAC Ducts and Casings.

1.2 REFERENCES

A. ASHRAE - Handbook, Fundamentals, Duct Design.

B. ASHRAE - Handbook, Equipment, Duct Construction.

C. NFPA 90A- 2002 - Installation of Air Conditioning and Ventilating Systems.

D. SMACNA - HVAC Duct Construction Standards.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: For the Following:
   1. Volume dampers.
   2. Turning vanes.
   3. Flexible connectors.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Special fittings.
   2. Manual-volume damper installations.

D. Quality Control Submittals.
   1. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, Installation of Air Conditioning and Ventilating Systems, and NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

1.5 MAINTENANCE

A. Extra Materials
   1. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      a. Fusible Links: Furnish quantity equal to 10-percent of amount installed.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Multiblade Volume Dampers:
   1. Ruskin Manufacturing Company.
   2. Air Balance Inc.
   3. American Warming and Ventilating Inc.

B. Damper Hardware:
   1. Ventfabrics, Inc.
   2. Duro Dyne Corporation.
   3. Young Regulator Company.

C. Acceptable Manufacturers - Air Turning Devices
   1. Titus.
   2. Kruger.
   3. Price.

D. Acceptable Manufacturers - Flexible Duct Connections
   1. Vent Fabrics Inc., Ventglas or Ventlon.
   2. Duro Dyne Corporation; Super Metal Fab DDFDC-483.
   3. Approved Equal.

2.2 VOLUME CONTROL DAMPERS.

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 12 x 48-inch.

C. Except in round ductwork 12-inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

D. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30-inches provide regulator at both ends.

E. Single Blade Dampers:
   1. Galvanized Steel Ductwork: 16-gauge galvanized steel, except as noted.
   2. Low Pressure Systems: SMACNA HVAC Duct Construction Standards, except as noted.
      a. Bearing at one end of damper rod: Similar to Ventlok No. 60 or Ruskin.
      b. Accessible quadrant at other end of damper rod:
         1) With lever and lockscrew, similar to Ventlok No. 635. or Ruskin.
         2) Insulated Ducts: Quadrants mounted on bracket to clear insulation; similar to Ventlok Nos. 637, 638, or 639. Selection based on insulation thickness.

2.3 AIR TURNING DEVICES

A. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps; Model TV manufactured by Titus.

B. Vane length not to exceed 36-inches. Provide separate equal size sections for greater lengths.

2.4 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. With metal collar frames at each end.

C. 2-inch slack in fabric.

D. Install to allow minimum movement of 1-inch.

E. Length Of Fabric Connections
   1. Minimum: 4-inches.
   2. Maximum: 10-inches.

F. Coated Glass Fabric:
   1. Indoors - Neoprene.
   2. Flame Spread Rating: 25.
   3. Smoke Development Rating: 50.
   4. 30-oz. per sq. yd.
   5. Sewed and cemented seams.

2.5 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions. Manufacturers' installation instructions shall be made available to the County Representative and inspecting authorities.

B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems at the following locations:
   1. Where shown on drawings.
   2. Dampers at air outlets and inlets cannot be used in lieu of balancing dampers.

C. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Attach tightly, and allow at least 1-inch slack.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. The construction and installations for damper openings in wall and ceilings shall conform to Chapter C, CBC, and the manufacturer's approved installation instructions.

END OF SECTION

SECTION 233400

HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Ceiling Exhaust Fans.
   2. Accessories.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
   3. Section 22 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   4. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
   5. Section 23 07 00 - HVAC Insulation.
   6. Section 23 09 10 - Instrumentation for HVAC.
   7. Section 23 31 00 - HVAC Ducts and Casings.
   8. Section 23 33 00 - Air Duct Accessories.
   9. Section 26 27 29 - Equipment Wiring Systems.

1.2 REFERENCES

A. AMCA 99 - Standards Handbook.

B. ANSI/AMCA 210/ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

C. ANSI/AMCA 300 - Reverberant Room Method for Sound Testing of Fans.

D. ANSI/AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.

E. BSR/ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

F. SMACNA - Low Pressure Duct Construction Standard.

1.3 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Conform to AMCA 99.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data
   1. Submit information including air flow capacities, static pressures, rpm, sound levels at design operating point. Provide fan curve clearly showing plotted design point.
   2. For adjustable axial fan blades, provide performance data and fan curves for at least five blade settings.

C. Shop Drawings
   1. Submit full set of drawings showing a minimum of three views with all dimensions clearly shown, including duct connections.

D. Quality Control Submittals
   1. Provide factory test reports with each submittal.
   2. Manufacturer's Installation Instructions.

E. Closeout Submittals
   1. Operation and Maintenance data include instructions for lubrication, motor and driven replacement, spare parts list, and wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.6 SYSTEM START-UP

A. Refer to Sections 23 05 00 and 23 05 93.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Greenheck.

B. Loren Cook Company.

C. Penn Ventilator.

D. ILG.

E. ACME.

2.2 CEILING EXHAUST FANS

A. Ceiling mounted, direct drive centrifugal type, steel housing, Units over 100-cfm shall include 1/2-inch acoustical insulation.

B. Integral ceiling grille constructed of non-yellowing high-strength polymer or high impact polystyrene. Grilles for larger sizes shall be aluminum.

C. Duct collar shall be constructed of steel and shall accept a minimum 6-inch duct size. Collar shall include integral backdraft damper.

D. Motor shall be mounted on vibration isolators. Disconnect shall be internal plug-in type.

E. Fan wheel shall be forward-curved centrifugal type, statically and dynamically balanced.

2.3 ACCESSORIES

A. Consult notes in equipment schedules for exact options to include with fans.

B. Dampers: Welded steel construction, consisting of two semi-circular vanes pivoted on oil-retaining bearings in short casing section, finished with one coat enamel. Provide airstream operation closing blades by reverse air flow and gravity. Hand operation with handwheel control of screw and link mechanism.

C. Inlet Screens: Galvanized steel welded grid to fit inlet bell.

D. Access Doors: Shaped to conform to casing with quick opening latches and gaskets.

E. Blade Pitch Actuator: Factory mounted and calibrated, electric actuator requiring single phase power and accepting electric input.

F. Vibration Detector: Factory installed vibration switch to stop fan.

G. Guide Vanes: Welded steel construction with airfoil vanes and casing flanges, finished to match casing.

H. Adjustable Inlet Vanes: Steel construction with blades supported at both ends cantilevered with two permanently lubricated bearings, variable mechanism out of airstream terminating in single control lever with control shaft for double width fans and locking quadrant.

I. Inlet Bell: Bell mouth inlet fabricated of steel with flange.

J. Outlet Cones: Fabricated of steel with flanges, outlet area/inlet area ration of 1.5/1.0, with center pod as recommended by manufacturer.

K. Scroll Drain: 1/2-inch steel pipe coupling welded to low point of fan scroll.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

C. Install fans as specified, with resilient mountings and flexible electrical leads. Refer to Section 23 05 48.

D. Install flexible connections specified in Section 23 33 00 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

E. Install fan restraining snubbers as required. Refer to Section 23 05 48. Flexible connectors shall not be in tension while running.

F. Provide sheaves required for final air balance.

G. Provide safety screen where inlet or outlet is exposed.

H. Pipe scroll drains to nearest floor drain.

I. Provide backdraft dampers on discharge of exhaust fans and as indicated.

J. Secure roof exhausters with lag screws to roof curb. Provide shims or spacers between roof curb and fan.

K. Ceiling Fans: Provide adjustable mounting brackets to allow for ceiling thickness.

L. Provide access to adjustable blade axial fan wheels for varying blade angle setting. Adjust blades for varying range of volume and pressure.

M. Provide floor mounted axial fans with reinforced legs. Provide ceiling suspended units with support brackets bolted to casing flange.

3.2 DEMONSTRATION

A. Instruct OWNER personnel under provisions of Division 1.

B. Provide instruction for 10 people.

C. Duration: 5 working days, coincident with instruction period specified in other Division 23 sections.

D. Demonstrate system and instruct OWNER personnel in operation, repair, and maintenance of the work of this section.

END OF SECTION

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Ceiling Diffusers.
   2. Grilles.
   3. Roof Hoods.

B. Related Sections
   1. Section 09 90 00 - Painting and Coating.
   2. Section 23 05 00 - Common Work Results for HVAC.
   3. Section 23 31 00 - HVAC Ducts and Casings.

1.2 REFERENCES

A. ADC 1062: LCM-83 - Laboratory Certification Manual.

B. ADC 1062: GRD-84 - Test Code for Grilles, Registers, and Diffusers.

C. ANSI/AMCA 500 - Laboratory Methods for Testing Louvers and Dampers for Rating.

D. ANSI/ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Air Inlets.

E. SMACNA - HVAC Duct Construction Standard.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawing to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, and sprinklers, whether existing or new.

C. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

D. Manufacturer's Installation Instructions.

1.4 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate performance of louvers in accordance with:
1. AMCA 500.

C. Acoustical Criteria:
1. Air Distribution System Equipment: Maximum permissible sound-power levels in octave bands of airborne transmissions through combination of grilles, registers and diffusers when operated in installed condition per plans and specifications:

D. Maximum PWL re 10 to the minus 12 Watts

Octave Bands	NC-30	NC-35	NC-40	NC-45	NC-50
1	60	62	66	68	7
2	53	56	63	66	68
3	45	49	54	58	62
4	41	46	51	56	61
5	38	43	48	53	58
6	37	42	47	52	57
7	36	41	46	51	56
8	37	42	47	52	57

E. Except as noted, maximum permissible NC levels shall be as follows:
1. NC-35: Libraries.
2. NC-50: Kitchens, toilets, storage rooms.

1.5 REGULATORY REQUIREMENTS

A. Conform to California Mechanical Code.

PART 2 PRODUCTS

2.1 AIR OUTLETS AND INLETS

A. Manufacturers
1. Anemostat.
2. Carnes.
3. Titus.
4. Enviro-Tec.
5. Metal-Aire.
6. Price.

B. General:

1. Manufacturer shall examine application of each outlet and guarantee that each will provide comfort space conditions without drafts at noted capacity.
2. Noise level at noted capacities: Not to exceed criteria specified in Part 1.
3. Suitable for operation at 10-percent excess and 25-percent less than noted capacity.
4. Ceiling diffusers and registers shall be supplied with volume damper adjustable from face except as noted. May be omitted when a single outlet is installed on branch with volume damper.
5. Finish matching color sample as selected by the City Representative.
    a. Other special materials and finishes as indicated in schedule on drawings.
    b. Other outlets, standard finish for field painting.
6. Provide gaskets at supply outlet flanges.

2.2 CEILING DIFFUSERS

A. Supply Air Diffusers: With air-equalizing deflectors.

B. Diffusers In Same Room: Same size and type, except as otherwise indicated.

C. Diffusers suitable for ceiling construction in which installed.

D. Drop collar as indicated.

E. Outside may be steel or aluminum unless indicated otherwise.

2.3 GRILLES

A. Grilles:
1. Material: Steel
2. Finish: Baked enamel, white, Baked enamel, color selected by the City Representative where called out by drawings.
3. Face Blade Arrangement: Adjustable horizontal. Spaced 3/4-inches apart.
4. Rear Blade Arrangement: Adjustable horizontal. Spaced 3/4-inches apart.
5. Frame: 1-inch wide.
6. Mounting Frame: See air distribution schedule.
7. Mounting: Countersunk screw.

2.4 ROOF HOODS

A. Manufacturers:
1. Greenheck.
2. ACME.
3. Penn.

B. Roof Hoods:
1. Fabricate air inlet or exhaust hoods in accordance with SMACNA Low Pressure Duct Construction Standards.

2. Fabricate of galvanized steel, minimum 16-gauge base and 20-gauge hood, or aluminum, minimum 16-gauge base and 18-gauge hood; suitably reinforced; with removable hood; birdscreen with 1/2-inch square mesh for exhaust and 3/4-inch for intake, and factory prime coat finish.
3. Mount unit on minimum 12-inch high curb base with insulation between duct and curb.
4. Make hood outlet area minimum of twice throat area.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement. Refer to Section 09 90 00.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Ceiling Diffusers:
   1. Attach removable cores with security screws to diffuser body.
   2. Touch up paint screw heads with matching color supplied by diffuser manufacturer.

F. Refer to reflected ceiling plans for exact location of ceiling air outlets.

G. Install inclined blade return and exhaust grilles and registers so that blades obstruct vision by inclining blades as follows:
   1. Ceiling Outlets: Incline toward nearest wall.

H. On grilles utilizing a plenum box, provide box fabricated of 0.034-inch/22-gauge thick, galvanized steel with internal surface internally lined with minimum ½-inch thick duct liner as specified in this Section.

END OF SECTION

SECTION 234000

HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Low Efficiency Cartridge Filters.

B. Related Sections
   1. Section 23 05 00 - Common Work Results for HVAC.
   2. Section 23 31 00 - HVAC Ducts and Casings.

1.2 REFERENCES

A. ASHRAE 52.1- 1992 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.

B. ARI 680-93 - Residential Air Filter Equipment.

C. UL 900 - Test Performance of Air Filter Units.

1.3 QUALITY ASSURANCE

A. Filter media shall be UL 900 listed, Class 2, as approved by state authorities.

B. Provide all filters as product of one manufacturer.

C. Assemble filter components to form filter banks from products of one manufacturer.

D. Size, media area, face area, efficiency, initial and final air resistance of alternative manufacturers shall be same as type specified.

E. Provide standard size frames to provide interchangeability of filter media of other manufacturers.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings and product data on filter media, filter performance data, and filter assembly.

C. Operation and Maintenance Data. Include instructions for operation, changing, and periodic cleaning.

1.5 SPARE FILTERS

A. Furnish three sets of spare elements for each low efficiency filter bank on completion and acceptance of work. Supply boxed in cartons.

PART 2 PRODUCTS

2.1 GENERAL

A. Filters shall be UL listed Class 2.

B. Arrestance and efficiencies noted are minimum average.

C. Design airflow not to exceed catalogued capacity.

D. Initial and final resistances not to exceed schedules values.

E. Service access as indicated on drawings.

2.2 LOW EFFICIENCY CARTRIDGE FILTERS

A. Manufacturers:
   1. Camfill Farr 30/30 Series.
   2. EFC-Enviropleat.
   3. American Air Filter AM Air 300X.

B. Filter media of disposable type, 2-inch thick, preformed, pleated, nonwoven cotton batting material.

C. Supporting media welded wire grid.

D. Efficiency at 30-35 percent STD 52.1.

E. Enclosing frame shall be constructed of rigid, heavy-duty, high wet-strength beverage board, with diagonal support members bonded to the air entering and air exiting side of each pleats. The inside periphery of the enclosing frame shall be bonded to the filter pack.

F. Frame shall be constructed of galvanized steel and equipped with gaskets and spring type sealing fasteners.

PART 3 EXECUTION

3.1 INSTALLATION

A. Temporary Pre Filters for Construction: Protect all filters upstream of air handling units during construction with blankets of 2-inch fiberglass filter media. UL Class 2 listed.

B. Install filters in accordance with manufacturer’s instructions.

C. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction with new low efficiency filters at substantial completion.

E. Verify and furnish all required filters to suit submitted equipment.

3.2 DEMONSTRATION AND PERSONNEL INSTRUCTION

A. Instruct City personnel under provisions of Division 1.

B. Provide instruction for 8 people.

C. Duration: 5 working days, coincident with instruction period specified in other Division 23 sections.

D. Demonstrate system and instruct City personnel in operation, repair, and maintenance of the work of this section.

END OF SECTION

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SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 23 Specification Sections, and Common Work Requirements for HVAC apply to the work specified in this Section.

1.2 SUMMARY

A. This Section includes a 2-pipe split system heat pump unit consisting of evaporator-fan and single speed compressor-condenser components. Evaporator units are designed for concealed mounting, and can be connected to ducts. Condensing units are designed for exterior mounting. System shall be capable of heating or cooling at each individual evaporator at all times. 3-pipe systems are not acceptable.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, dimensions, connections for piping and electric, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance: Applicable requirements in the latest edition of ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1 Latest Edition Compliance: Applicable requirements in the latest edition of ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air- Conditioning."

E. Standards: Title 24, California Mechanical Code.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases.

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations.

1.6 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within one year warranty period (parts and labor). Compressor shall be warranted for a period of five years.
   1. Special Warranty: Provide and alternate price for an extended warranty for all parts and components for five years from date of Substantial Completion (parts and labor).

1.7 DELIVERY AND STORAGE

A. Deliver products to site and store and protect products until installation.

B. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and by providing temporary covers after installation.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.
   2. Fan Belts: One set of belts for each unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Trane.
   2. Carrier.
   3. Or equal.

2.2 EVAPORATOR-FAN COMPONENTS

A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel. Low profile or horizontal type as noted.
   1. Insulation: Faced, glass-fiber duct liner.
   2. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with the latest edition of ASHRAE 62.1.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest edition of ASHRAE 62.1.

B. Refrigerant Coil: Staggered copper tubing, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

D. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multi tapped, multispeed with internal thermal protection and permanent lubrication.

E. Disposable Filters: 1 inch (25 mm) thick, in fiberboard frames with ASHRAE 52.2MERV rating of 6 or higher.

F. Wiring Terminations: Connect motor to chassis wiring with plug connection.

G. Electronic valve control with computerized PID control to maintain space temperatures.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Galvanized steel, finished with corrosion inhibiting baked enamel in color, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, inverter overload protection and fusible plugs.
   1. Inverter Drive, hermetic.
   2. Variable-speed compressor motor with inverter control and manual-reset high-pressure switch and automatic-reset low-pressure switch.
   3. Refrigerant: R-410A.
   4. Crankcase heater shall be factory mounted on compressor.
   5. Outdoor unit compressor shall have an inverter to modulate capacity. Capacity shall be completely variable with a turndown of 19-8% of rated capacity.
   6. Compressor shall be equipped with internal thermal overloads.
   7. Compressor shall be mounted on vibration isolators to avoid transmission of vibration.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub cooler.
   1. Outdoor coil fins shall have a factory applied corrosion resistant finish.
   2. Outdoor coil shall be protected by an integral metal guard.
   3. Outdoor coil shall include 4 circuits with two position valves for all circuits except the last stage.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Variable Speed Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection. Provided with heavy gauge wire fan guards.

G. Minimum Energy Efficiency: Comply with the latest edition of ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

A. Oil recovery system.

B. Central remote controller to allow temperature setting, on/off and indication of operating condition:
   1. Compressor time delay.
   2. 24-hour time control of system stop and start.
   3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
   4. Fan-speed selection, including auto setting.

C. Schedule timer to set individual operation schedules for indoor units.

D. Isolation valves for cool fan coil and condensing unit.

2.5 LOCAL REMOTE CONTROLLERS

A. Controls up to 16 indoor units as a single group.

B. Allow users to set on/off, operation mode (cool, heat, fan or auto)

C. Allow users to set temperature and fan speed.

D. Seven day time clock operation.

E. Function lock out.

F. Diagnostic display.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb. Coordinate installation of units with architectural, mechanical and electrical work.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounting compressor-condenser components on equipment supports as detailed on Mechanical plans. Anchor units to supports with removable, cadmium-plated fasteners.

D. Install seismic restraints.

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Connect refrigerant pipes with all accessories listed above. Comply with requirements in Section 23 23 00 "Refrigerant Piping". Refrigerant piping is limited to 2-300 ft.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system. All wiring exposed or installed within walls shall be in conduit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

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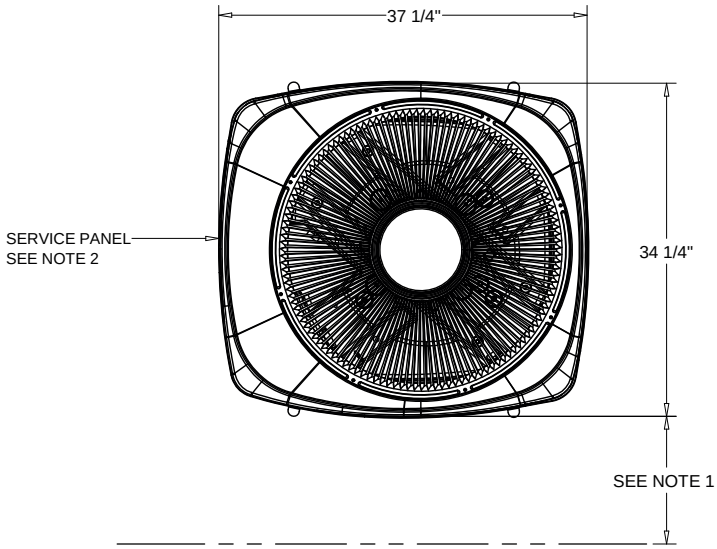
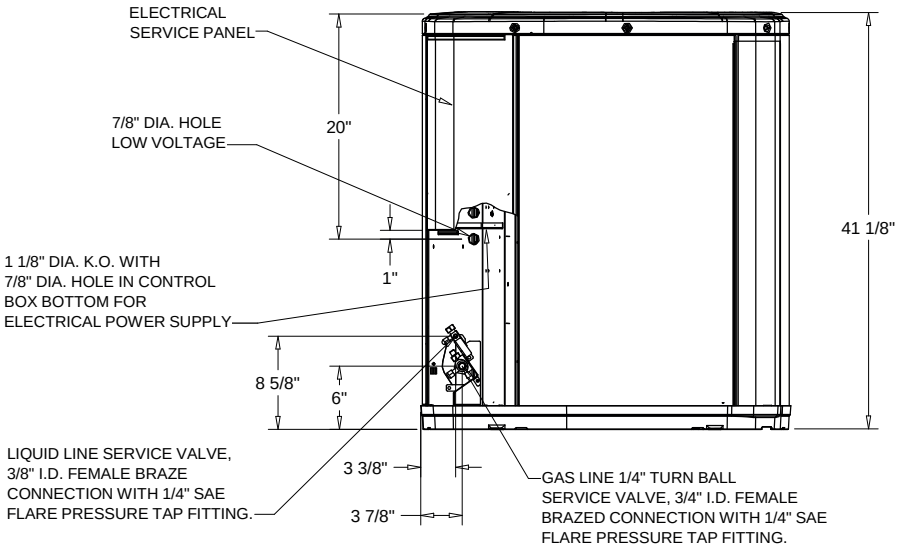


NOTES
1. TOP DISCHARGE AREA SHOULD BE UNRESTRICTED FOR AT LEAST 60" ABOVE UNIT. UNIT SHOULD BE PLACED SO ROOF RUN-OFF WATER DOES NOT POUR DIRECTLY ON UNIT, AND SHOULD BE AT LEAST 12" FROM WALL AND ALL SURROUNDING SHRUBBERY ON TWO SIDES. OTHER TWO SIDES UNRESTRICTED.
2. ELECTRICAL AND REFRIGERANT COMPONENT CLEARANCES PER PREVAILING CODES.



ELECTRICAL / GENERAL DATA

GENERAL		POWER CONN.		COMPRESSOR	
Model:	4TWB4042E	Minimum Circuit Ampacity:	27.0	Number:	1
Unit Primary Voltage:	208	Maximum Circuit Breaker:	45.0	Phase:	1
Unit Secondary Voltage	230	Minimum Protection Rating:	40.0	Rated Load Amps:	19.9
Unit Hertz:	60			Locked Rotor Amps:	109
Unit Phase:	1				

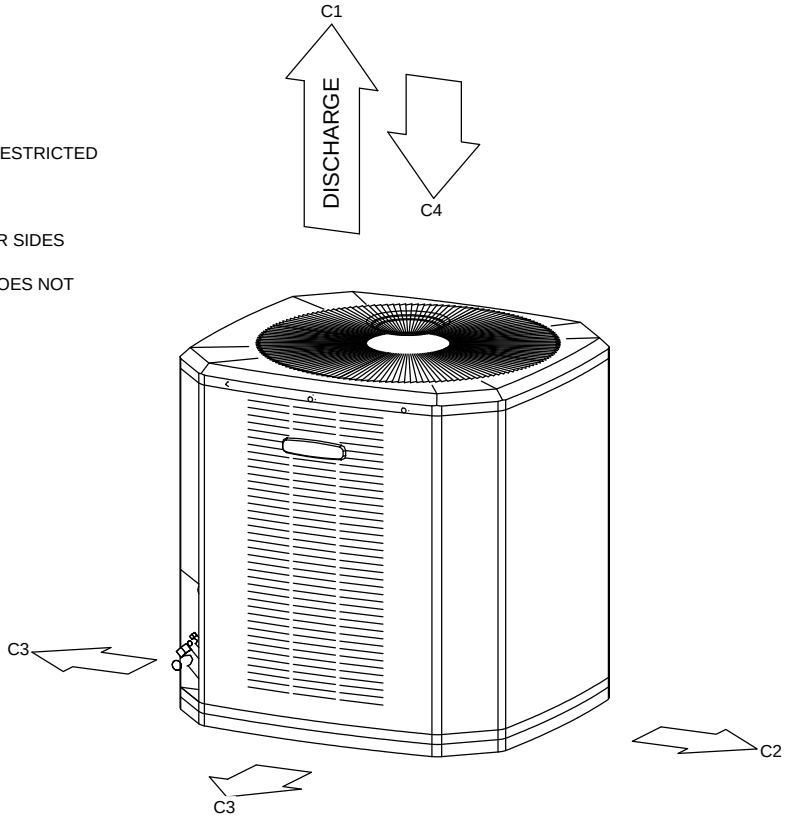
OUTDOOR MOTOR	
Number:	1
Horsepower:	.2
Motor Speed (RPM):	850
Phase:	1
Full Load Amps:	1.0
Locked Rotor Amps:	-

REFRIGERANT	
Type:	R-410A
Charge:	12.1 lb
Line Size O.D. Gas:	3/4"
Line Size O.D. LIQ:	3/8"

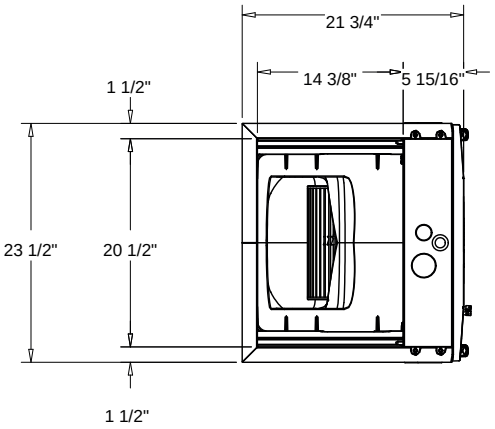
NOTES:
1. Certified in accordance with the Unitary Air-Conditioner equipment certification program which is based on AHRI Standard 210/240.
2. Calculated in accordance with N.E.C. Use only HACR circuit breakers or fuses.
3. Standard line lengths - 60'. Standard lift - 60' Suction and Liquid line.
   For Greater lengths and lifts refer to refrigerant piping software Pub# 32-3312-0)
4. * = 15, 20, 25, 30, 40 and 50 foot lineset available.

WEIGHT	
NET	277.0 lb
SHIPPING	313.0 lb

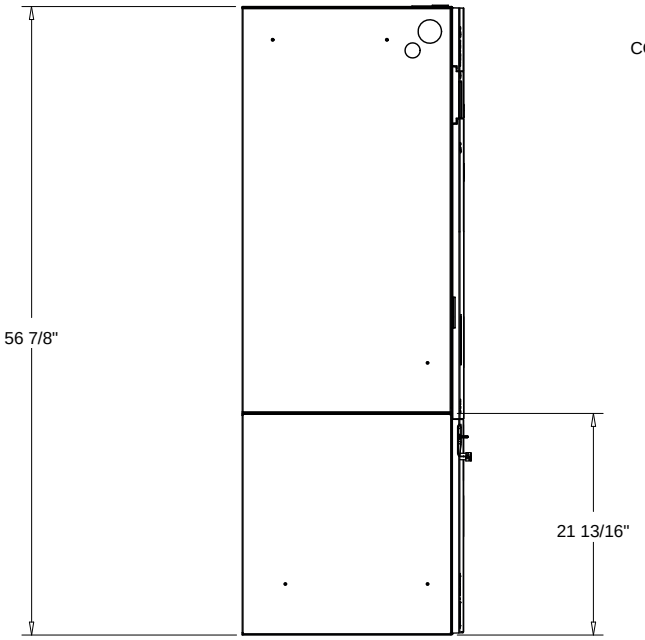
NOTES:
C1. TOP DISCHARGE SHOULD BE UNRESTRICTED FOR AT LEAST 60" ABOVE UNIT
C2. PLACE UNIT FROM WALL
C3. PLACE SHRUBBERY AT LEAST 12" FROM UNIT ON TWO SIDES, OTHER SIDES UNRESTRICTED
C4. PLACE UNIT SO ROOF RUN-OFF DOES NOT FALL DIRECTLY ON UNIT

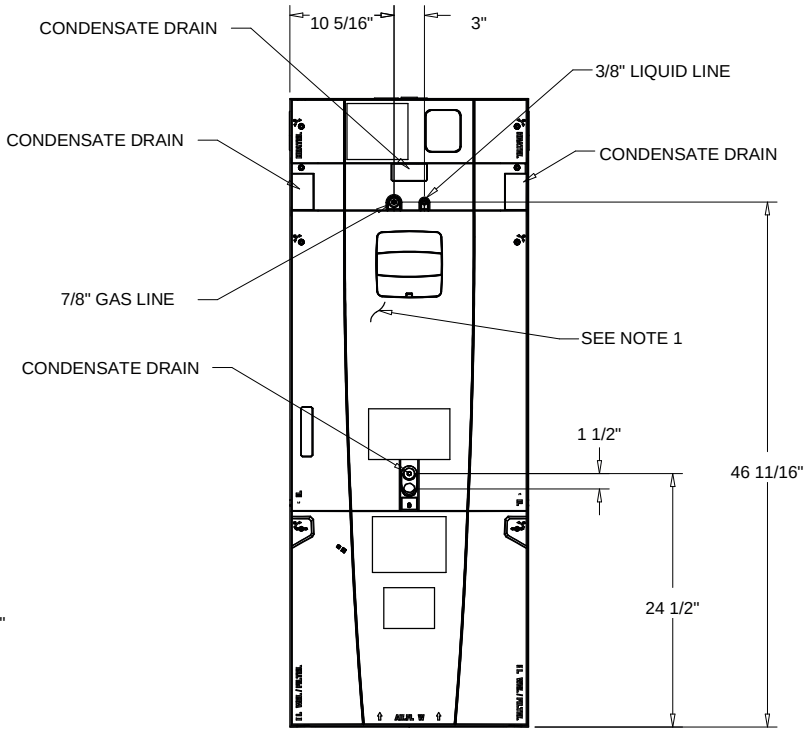


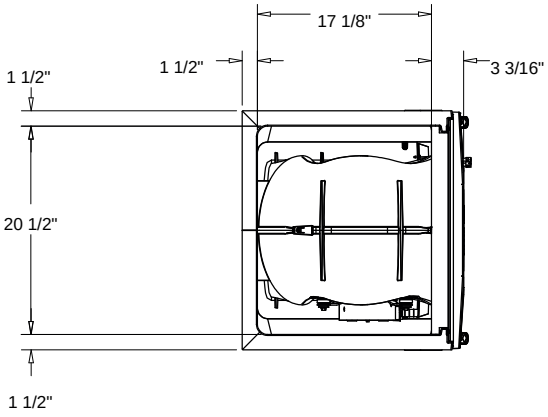
WEIGHT AND CLEARANCE



NOTES:
1. BADGE ROTATION WILL KEEP BRAND IN CORRECT POSITION.
2. NO INTERNAL MODIFICATIONS REQUIRED FOR ANY POSITION.
3. VERIFY WEIGHT, CONNECTION, AND ALL DIMENSION WITH INSTALLER DOCUMENTS BEFORE INSTALLATION
4. GAM5 AIR HANDLERS ARE ALL TWO PIECE CABINETS.
5. SEE WEIGHT AND RIGGING PAGE FOR CONDENSATE DRAIN CONFIGURATION







GAM5A0A42 AIR HANDLER- COOLING

UNIT DIMENSION DRAWING

ELECTRICAL / GENERAL DATA

GENERAL (1)(2)(4)	
Model:	GAM5A0C42M31SA
Unit Primary Voltage:	208
Unit Secondary Voltage:	230
Unit Hertz:	60
Unit Phase:	1

INDOOR MOTOR (1)	
Number:	1
Horsepower:	0.5
Motor Speed (RPM):	1050
Phase:	1
Full Load Amps:	4.1
Locked Rotor Amps:	

FILTERS (3)	
Type:	Throwaway
Furnished:	No
Number:	1
Recommended:	22"x20"x1"

STANDARD (5)	
230 Volt / 208 Volt	
Minimum Circuit Ampacity:	5.0/5.0
Maximum Overload Protection:	15.0/15.0

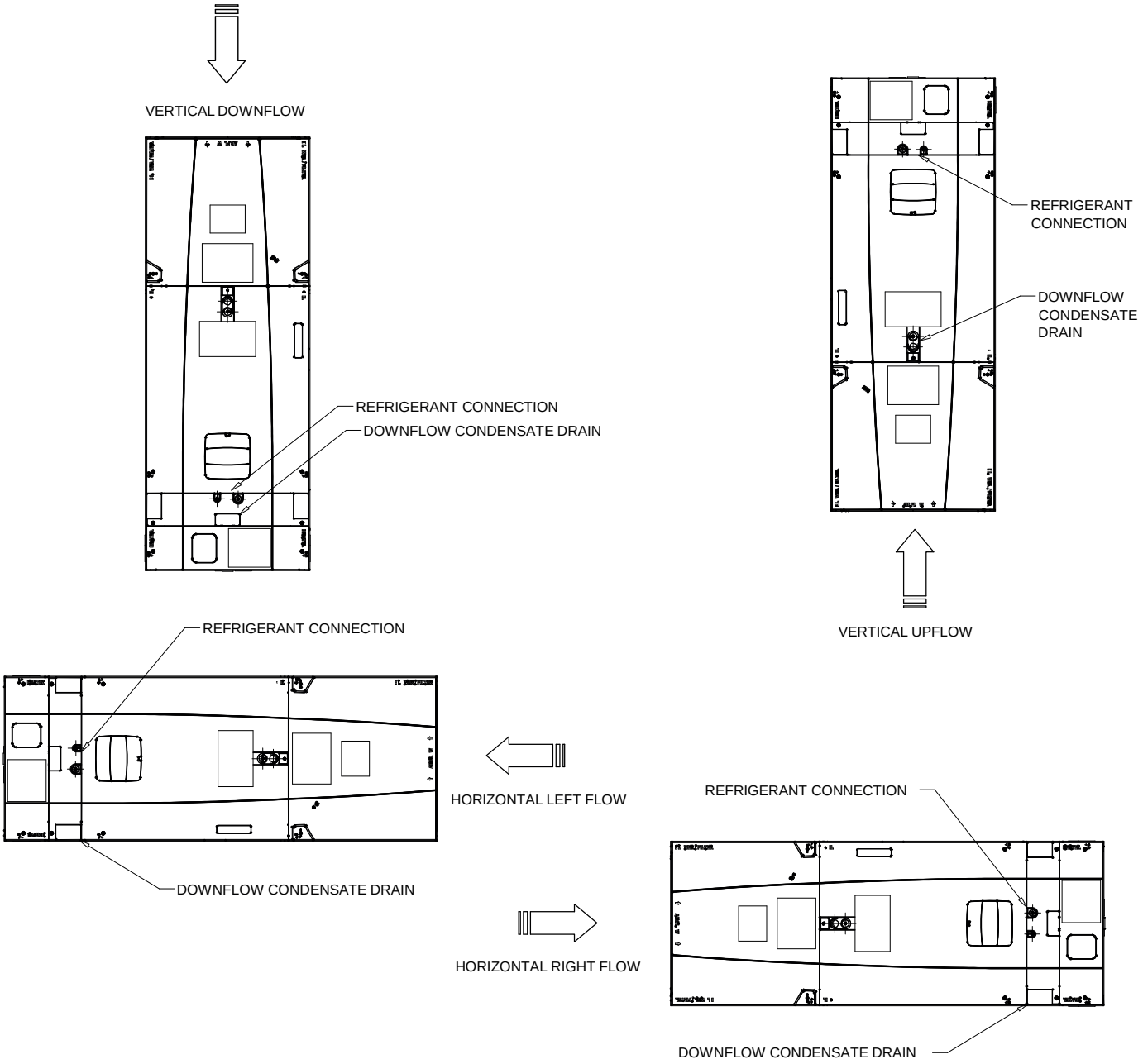
REFRIGERANT	
Type:	R410
REF. Line Connections	Brazed
Coupling or Conn. Size - Gas:	7/8"
Coupling or Conn. Size - Liq.:	3/8"

Weights	
Net:	153.0 lb
Shipping:	163.0 lb

ELECTRIC HEAT	
230 Volt / 208 Volt	
Capacity Circuit #1:	4.80kW / 3.60kW
Capacity Circuit #2:	N/A
Capacity Circuit #3:	N/A
# of Circuit:	1
Phase:	1
Heater Amps Per Circuit Circuit #1:	20/17.30
Heater Amps Per Circuit Circuit #2:	N/A
Heater Amps Per Circuit Circuit #3:	N/A
Minimum Circuit Ampacity Circuit #1:	30.0/27.0
Minimum Circuit Ampacity Circuit #2:	N/A
Minimum Circuit Ampacity Circuit #3:	N/A
Maximum Overload Protection Circuit #1:	30.0/30.0
Maximum Overload Protection Circuit #2:	N/A
Maximum Overload Protection Circuit #3:	N/A

NOTES:

1. These air handlers are a.r.i. certified with various split system air conditioners and heat pumps (ari standard 210/240). refer tothesplit system outdoor unit product data guides for performance data.
2. 3/4" male plastic pipe (ref.: astm 1785-76)
3. Minimum filter size for horizontal applications will be based on airflow selection and will be calculated as follows:
   low velocity filter: face area (sq. ft.) = cfm / 300
   high velocity filter: face area (sq. ft.) = cfm / 500
4. For customer ease of filter maintenance, it is recommended that a properly sized, remote filter and grille be installed for horizontal applications. airflow should not exceed the face value of the filter being used
5. Standard mca and mop without electric heat.

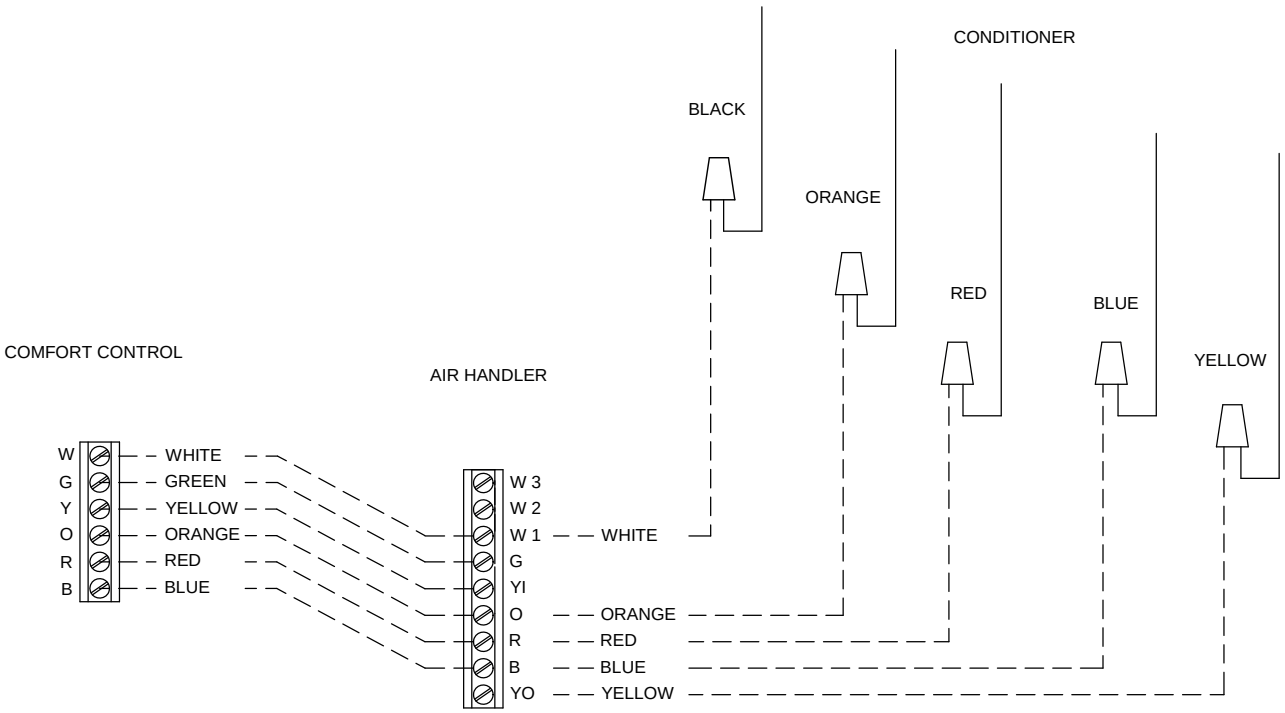


NOTES
1. NO INTERNAL MODIFICATIONS REQUIRED FOR ANY POSITION.
2. BADGE ROTATION WILL BRAND IN CORRECT POSITION.

MINIMUM UNIT CLEARANCE TABLE		
	TO COMBUSTIBLE MATERIALS (REQUIRED)	SERVICE CLEARANCE (RECOMMENDED)
SIDE	0	2"
FRONT	0	21"
BACK	0	0
INLET DUCT	0	0
OUTLET DUCT	0	0

CLEARANCE NOTES:
* 1" FOR THE FIRST 3 FT. OF OUTLET DUCT
WHEN ELECTRIC HEATERS ARE INSTALED EXCEPT
MODELS BAYHTR1405, 1408, AND 1410 ARE APPROVED FOR
0" PLEMUM AND DUCT CLEARANCE IN THE UPFLOW
CONFIGURATION ONLY ON TWE-P MODELS.

NOTES:
1. FOR MULTIPLE STAGES OF ELECTRIC HEAT, JUMPER W1, W2, AND W3 TOGETHER IF COMFORT CONTROL HAS ONLY ONE STAGE OF HEAT
2. YI AND YO CONNECTIONS MUST BE MADE AS SHOWN FOR FREEZE PROTECTION AND INTERNALLY MOUNTED CONDENSATE OVERFLOW CIRCUITS TO WORK PROPERLY
3. INTERNALLY MOUNTED CONDENSATE SWITCH IS OPTIONAL AND MUST BE ORDERED SEPARATELY
4. IF A 3RD PARTY CONDENSATE OVERFLOW SWITCH IS INSTALLED, IT SHOULD BE WIRED IN SERIES BETWEEN YO AND Y TO THE OUTDOOR UNIT



AIR HANDLER HOOK-UP - TWO STAGE HEATPUMP

FIELD WIRING DIAGRAM

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Basic Electrical Requirements, materials and methods common to multiple electrical systems, specifically applicable to all Sections in Division 26.

1.2 REFERENCES

A. CEC-2010 - California Electrical Code, Part 3, CCR Title 24 and 2010 California Fire Code, Part 9, CCR Title 24.

B. NEMA ICS-6-1993 (R2001, R2006) - Industrial Control and Systems: Enclosures.

1.3 DEFINITIONS

A. The meaning of words shall be as defined in the CEC Article 100, Definitions, unless defined otherwise in an individual section.

B. The following specification development organizations are referenced throughout the various specification sections of Division 26:
   1. AASHTO - American Association of State Highway and Transportation Officials.
   2. ADAAG - Americans with Disabilities Act Accessibility Guidelines
   3. ANSI - American National Standards Institute
   4. AQMD - Air Quality Management District
   5. APCD - Air Pollution Control District
   6. ASME - American Society of Mechanical Engineers
   7. ASTM - American Society for Testing and Materials
   8. CBC - California Building Code
   9. CCR - California Code of Regulations Title 24. State Chapters.
   10. CEC - California Electrical Code
   11. CFC - California Fire Code
   12. CMC - California Mechanical Code
   13. CSA - Canadian Standards Association
   14. EIA - Electronic Industries Association
   15. FCC - Federal Communications Commission.
   16. FM - Factory Mutual.
   17. FS - Federal Specifications
   18. ICEA - Insulated Cable Engineers Association
   19. IEC - International Electrotechnical Commission
   20. IEEE - Institute of Electrical and Electronic Engineers
   21. IETA - International Electrical Testing Association
   22. ISA - Instrument Society of America
   23. ISO - International Organization for Standardization
   24. MIL - Military Specifications

25. NACE - National Association of Corrosion Engineers
26. NECA - National Electrical Contractor's Association
27. NEMA - National Electrical Manufacturing Association
28. NETA - International Electrical Testing Association
29. NFPA - National Fire Protection Association
30. NIST - National Institute of Standards and Technology
31. OSHA - Occupational Safety and Health Administration
32. SMACNA - Sheet Metal and Air Conditioning Contractors National Association, Inc.
33. UL - Underwriters Laboratories

1.4 SYSTEM DESCRIPTION

A. Performance Requirements
   1. Furnish and install all materials to provide functioning systems in compliance with performance requirements specified, and any modifications required by reviewed shop drawings and field coordinated drawings.

1.5 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data
   1. Submit product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
   2. Quantity of Submittals Required
      a. Submit four copies of product data.
      b. Three copies will be returned.
      c. If comments are required, comment sheet(s) will be returned with each copy.
      d. One copy will be retained by the Engineer.

C. Shop Drawings
   1. Submit shop drawings grouped to include complete submittals of related systems, products, and accessories in a single submittal.
   2. Quantity of Submittals Required:
      a. Submit one reproducible transparency and one print.
      b. Upon review, transparency will be annotated and returned. Print will be retained by Engineer.
      c. Copies of this transparency will serve as record copies for Engineer.
      d. Additional prints will not be reviewed nor returned.
   3. Corrections or comments made on the shop drawings during review do not relieve the Contractor from compliance with requirements of the drawings and specifications. Shop drawing checking by the Engineer is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for:
      a. Confirming and correlating all quantities and dimensions.
      b. Selecting fabrication processes and techniques of construction.
      c. Coordinating work with all other trades.
      d. Performing work in a safe and satisfactory manner.
      e. Provide equipment that can be installed in the available space with all code clearances. This shall be coordinated prior to ordering any equipment.

D. Samples

1. Submit as directed by the Engineer and as required in each specification section.

E. Quality Control/Control Submittals
1. Submit material control record procedures for approval. Submit records during the project upon request by the Owner's Representative. Submit at the end of the project for record.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements
1. Conform to CEC.
2. Furnish products listed and classified by UL or other independent laboratory acceptable to Owner's Representative as suitable for purpose specified and shown when a listing is available for the type of product.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle and protect products under provisions of Division 01.

B. Maintain material control records for all products for traceability to manufacturer and order number. Have records available for inspection by Owner's Representative.

C. Store material and equipment in an environment similar to the final installation environment.

D. Store and handle material and equipment in accordance with manufacturers' recommendations.

1.8 PROJECT CONDITIONS

A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install Work in locations shown on Drawings, unless prevented by Project conditions.

C. Prepare and submit drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner's Representative before proceeding.

1.9 MAINTENANCE AND SERVICE

A. Maintenance and service shall be provided as part of the Contract during the two year warranty period starting the day that Project Completion is awarded by the Owner's Representative.
1. Contractor shall be responsible for systems and system components as defined in these documents.
2. Scheduled maintenance shall be conducted on a weekly and quarterly basis. Responsibilities for scheduled maintenance are as follows:
a. Weekly - Owner's personnel.
b. Quarterly - Contractor's personnel.
3. All maintenance activity shall be conducted on a schedule that is convenient to the Owner's Representative. All Contractor's personnel shall provide written notice of all visits.

B. Daily operational inspections by Owner shall consist of inspections to determine the operational state of a system. It is not intended that the Owner perform adjustments or modifications for system restoration.

C. Contractor shall provide scheduled maintenance in accordance with the description of services and maintenance schedule.

D. Contractor shall maintain all documents and modify drawings, schedules, and other documents as required to effect documentation which reflects the current system or wiring configuration.

E. Upon termination of the service contract, Contractor shall return all system documents to the Owner's Representative.

F. Contractor shall develop maintenance reports, or logs, which identify maintenance activities on the system. If requested, the reports, or logs, shall be provided to the Owner's Representative on a monthly basis.

G. In the event software is introduced which will enhance the system operation, Contractor shall inform the Owner's Representative of the software, its features, and the cost to upgrade the existing software. If accepted by the Owner's Representative, Contractor shall furnish and install the software and invoice Owner in the amount approved by the Owner's Representative. Contractor to train the Owner staff on new system features or software which may be provided to enhance the systems capability.

H. Insurance requirements shall be maintained through the maintenance and service period.

1.10 SPARE PARTS

A. Spare parts shall be provided and maintained by Contractor to support the maintenance response requirements defined in this document.

B. The spare parts inventory may be comprised of Contractor furnished, Contractor maintained parts.

C. Contractor shall maintain a spare parts inventory as he deems necessary to support the maintenance and service requirements of this section.

D. During the maintenance and service period, Contractor shall maintain a log of all component failures and parts replaced.

E. Six months prior to the expiration of the maintenance and service period, Contractor shall submit the replaced parts log to the Owner's Representative. The Owner's Representative will use the replaced parts log to evaluate the on-site spare parts inventory required for future maintenance by Owner.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment to permit easy access for normal operation and maintenance to switches, motors, drives, pull boxes and receptacles in accordance with CEC Article 110, Requirements for Electrical Installation.

B. Coordinate electrical work with Owner's Representative and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.

C. Check and coordinate the approximate locations of electrical stub-ins, light fixtures, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify the Owner's Representative in writing. The Owner's Representative's decision shall govern. Make modifications and changes required to correct conflicts.

3.2 ADJUSTING

A. Inspect all equipment and put in good working order.

3.3 CLEANING

A. Clean work under provisions of Division 01.

B. Clean all items.

3.4 PROTECTION

A. Protect finished installation under provisions of Division 01.

B. Prior to installation, store items in clean, dry, indoor locations. Store in clean, dry, indoor, heated locations items subject to corrosion under damp conditions.

3.5 PUTTING SYSTEMS IN OPERATION - START UP

A. Operate all systems in good working order for a period of 5 consecutive days, at time period agreed to by Owner's Representative, prior to inspection.

END OF SECTION

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SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600V AND BELOW)

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Conductors (600V and below).
2. Wiring connectors and connections.
3. Pulling lubricant.

B. Related Sections
1. Section 26 05 00 - Common Work Results for Electrical.
2. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

A. UL 486A-486B-2003 - Wire Connectors.

B. UL 510-2005 - Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Certify compliance with CEC Article 110 - Requirements for Electrical Installation.

C. Quality Assurance/Control Submittals
1. Test Reports
a. Submit certified megger test results.

1.4 QUALITY ASSURANCE

A. QUALIFICATIONS
1. Manufacturer: Company specialized in manufacturing products specified in the Section with a minimum of 5 years experience.

1.5 PROJECT CONDITIONS

A. Existing Conditions
1. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
2. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

B. Field Measurements
1. Verify that field measurements are as shown on Drawings.

PART 2 PRODUCTS

2.1 CONDUCTORS (600V AND BELOW)

A. Description: Single conductor insulated wire.

B. Conductor: Copper

C. Insulation Voltage Rating: 600 volts.

D. Conductor Identification: Color code all conductors in accordance with CEC Article 310 - Conductors for General Wiring comply with temperature requirements of CEC 110-14(c).
1. Color code all feeders and branch circuits with the following colors.
2. Use the following colors in lighting and power wiring:

	120/240 VOLT
Phase A	Black
Phase B	Red
Neutrals	White
Ground	Green or Bare

3. Color coding of ends only will be acceptable for feeder phase conductors.
4. Wire marker sleeves permanently marked with wire/circuit designation may be used in lieu of color coding for control wiring.

E. Insulation:
1. Type THHN/THWN or XHHW insulation for feeders and branch circuits larger than 4 AWG;
2. Type THHN/THWN insulation for feeders and branch circuits 6 AWG and smaller.
3. Type SFF-2 for fixture wires or circuit runs in fixtures.

F. Stranding:
1. #8 AWG and larger; stranded, Class B.
2. Totally within panels or cabinets; stranded, Class B
3. Hinged wiring; extra flexible stranding, Class C.
4. Other situations; solid.

G. Equipment Grounding Conductors:
1. Stranded copper conductors, size as required by CEC.
2. Comply with CEC Articles 210 - Branch Circuits, 215 - Feeders, and 250 - Grounding.

2.2 WIRING CONNECTORS

A. Spring Wire Connectors:
1. 3M Model Scotchlok or Hyflex.
2. Buchanan.
3. Burndy.
4. Elastimold.
5. Ideal Model Wingnut or Wirenut.
6. Thomas & Betts.

B. Compression Connectors:

1. Type with prestressed insulation to equal insulation of wire being installed.
2. Conform to UL 486A-486B.

C. Power Conductors Splicers:
1. Blackburn.
2. Burndy “Hylug”.
3. Ilsco.
4. O.Z. Gedney.

D. Insulating Tape.
1. Conform to UL 510.

E. Cable Ties.
1. Scotchflex #760.
2. Thomas & Betts “Tyrap”.

2.3 PULLING LUBRICANT

A. Specifically approved for pulling wire/cable in accordance with the wire/cable manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verifications of Conditions
1. Verify that interior of building has been protected from weather.
2. Verify that mechanical work likely to damage wire has been completed.
3. Verify conduit and raceway systems are completed.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Application;
1. Use conductor not smaller than 12 AWG for power and lighting circuits.
2. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet. Use same size wire for entire circuit, except for taps.
3. Install all wiring in raceway.
4. Two or three branch circuits may be carried on one neutral leg as permitted by CEC.

C. Pulling wire;
1. Verify conduit is clean before pulling cable.
2. Utilize pull rope for pulling in cable.
3. Pull all conductors into raceway at same time.
4. Do not exceed cable manufacturer’s recommendations for maximum pulling tensions and minimum bending radii.
5. Utilize pull boxes and junction boxes for pulling cable.

D. Connections;
   1. Neatly train and lace wiring inside boxes, equipment, and panelboards.
   2. Clean conductor surfaces before installing lugs and connectors.
   3. Make splices, taps, and terminations to carry full capacity of conductors with no perceptible temperature rise.
   4. Use copper split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
   5. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
   6. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
   7. Tighten screws to the value recommended by the manufacturer.
      a. In the absence of manufacturer's recommendations for torque settings, tighten screws to the values shown in UL 486A-486B.
   8. Provide and use terminals for control wiring terminations.

3.4 INTERFACE WITH OTHER WORK

A. Identify wire and cable under provisions of Section 26 05 53.

B. Identify each conductor with its circuit number or other designation indicated in Contract Documents.

C. Mark properly torqued connections with a line, black ink.

3.5 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

D. Megger test and record all feeder conductors.
   1. Replace conductors failing test.
   2. Test replaced conductors in same manner.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Materials and methods for grounding systems and equipment.
2. Grounding electrodes and conductors.
3. Equipment grounding conductors.
4. Bonding.
5. Grounding well.

B. Related Sections
1. Section 26 05 00 - Common Work Results for Electrical.

1.2 SYSTEM DESCRIPTION

A. The following shall be acceptable grounding electrodes:
1. Concrete-encased electrode.
2. Ground ring.
3. Rod electrode.
4. Metal Underground Pipe.
5. Metal Frame of Building.

1.3 PERFORMANCE REQUIREMENTS

A. Grounding System Resistance:
1. Building grounding electrode: 10 ohms.
2. Separately Derived Sources grounding electrode: 10 ohms.
3. Non-Current carrying metal parts: 25 ohms.
4. Grounds not covered above: 25 ohms.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Certify compliance with CEC Article 110 - Requirements for Electrical Installations.

C. Quality Assurance/Control Submittals
1. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
2. Manufacturer’s Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

D. Closeout Submittals
1. Project Record Documents: Accurately record actual locations of grounding electrodes.

PART 2 PRODUCTS

2.1 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 3/4 inch.

C. Length: 10 feet.

2.2 MECHANICAL CONNECTORS

A. Acceptable Manufacturers:
1. Burndy.
2. Thomas & Betts.

B. Material: Bronze.

2.3 EXOTHERMIC CONNECTIONS

A. Manufacturers:
1. Burndy.
2. Cadweld.
3. Lyncole.

2.4 WIRE

A. Material: Stranded copper.

B. Foundation Electrodes: 2/0 AWG.

C. Grounding Electrode Conductor: as indicated or per CEC Article 250, whichever is larger.

2.5 GROUNDING CLAMPS

A. Manufacturers:
1. Burndy.
2. Thomas & Betts.
3. O.Z. Gedney.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

A. Install Products in accordance with manufacturers' instructions.

B. Bonding
1. Provide bonding to meet requirements of CEC.

2. Bond together metal siding not attached to grounded structure; bond to ground.
3. Bond together all metallic conduit, boxes, cabinets and enclosures.

C. Grounding Conductors
1. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder circuit raceway and within each motor feeder raceway. Terminate each end on suitable lug, bus, or bushing.
2. Provide separate grounding conductor for circuits installed in flexible steel conduit. Terminate each end on a suitable lug, bus or bushing.
3. Where branch circuits are installed entirely within metallic raceway system, the raceway system may use the equipment grounding electrode as allowed by CEC.
4. Ground all conduit systems, cabinets, equipment, motor frames, etc., in accordance with CEC and applicable codes.

3.3 FIELD QUALITY CONTROL

A. Site Tests
1. Notify Owner's Representative five days before inspection and testing.
2. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.
3. Remove main bonding jumper at main service panelboard and at each separately derived system and test for infinite resistance between neutral and ground systems. Reconnect bonding jumper(s).
4. Record test results in accordance with 26 05 00 and submit.

B. Inspection
1. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

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SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Equipment supports.
   2. Raceway supports.
   3. Anchors and fasteners.

B. Related Sections
   1. Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

A. ASTM A36/A36M-2008 - Carbon Structural Steel.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Hangers and supports shall have minimum safety factor of five (5), based on ultimate tensile or compressive strength, as applicable, of material used.
   2. Anchors shall be applied in accordance with the ANCHOR CAPACITY TABLE following paragraph 3.2.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Design Data
   1. Indicate hanger and support framing and attachment methods.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide corrosion resistance that provides as a minimum the same protection as the products being supported.

B. Provide materials, sizes and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire equal to full capacity of raceway in calculations for supports.

C. Anchors and Fasteners.
   1. Sheet Metal Screws: Steel.
   2. Machine Screws, Bolts, Nuts, and Washers: Steel.
   3. Precast Inserts: Suitable for the purpose.

4. Anchor bolts, expansion type (stainless steel).
    a. Phillips Red-Head.
    b. Hilti Kwik-Bolt.
    c. WEJ-IT
5. Cast-in-Place Anchors: Suitable for the purpose (hot-dip galvanized except cadmium plated in dry locations).
6. Beam Clamps: Steel.

D. Raceway Supports
1. Conduit Straps Used with Rigid Steel Conduit: One hole malleable iron, cadmium plated.
2. Conduit Straps Used with Other Than Rigid Steel Conduit: One or two hole steel, cadmium plated.
3. Clamp Backs: Steel, cadmium plated.

E. Channels
1. Acceptable Manufacturers
    a. Unistrut.
    b. Powerstrut.
    c. B-line.
2. Material
    a. 12 gauge steel, 1-5/8 inches by 1-5/8 inches when not attached to building surface.
    b. 14 gauge steel, 1-5/8 inches wide by 13/16 inches deep when connected directly to building surface.
    c. Hot-dip galvanized except cadmium plated in dry locations.
3. Fittings: By channel manufacturer.

F. Hanger Rods:
1. Material: 1/4 inch minimum hot-dip galvanized after fabrication.

G. Structural Steel:
1. Material: ASTM A36/A36C.
2. Finish:
    a. Dry Locations: Shop coat of rust inhibiting primer.
    b. Otherwise hot-dipped galvanized after fabrication.

H. Pipe/Conduit Hangers: Hot dipped galvanized steel or malleable iron.

PART 3 EXECUTION

3.1 INSTALLATION

A. General
1. Install products in accordance with manufacturer's instructions.
2. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.
3. Do not drill or cut structural members without approval of Owner's Representative.

B. Anchors
1. Concrete - Precast inserts, cast-in-place anchors or expansion type anchor bolts.
    a. When installing drilled-in anchors in non-prestressed reinforced concrete, avoid the reinforcing bars.

b. When installing drilled-in anchors into prestressed concrete (pre- or post-tensioned), locate tendons by using a non-destructive method prior to installation. Maintain a minimum clearance of one-inch between the reinforcement and the drilled-in anchor.

2. Sheet Metal - Sheet metal screws or machine bolts, nuts and washers.
3. Structural Steel Members - Beam clamps, machine screws, bolts, nuts and washers.

C. Supports
1. Fabricate supports from structural steel or steel channel. Rigidly weld or bolt members to present a neat appearance with adequate strength and rigidity.
2. Vertical adjustment on threaded rods shall be with 2 nuts on each end for positioning and locking.

D. Conduit
1. In damp or wet locations, space conduit support directly from concrete or metal structure out at least 1/4 inch using straps with spacers or, if three (3) or more conduits are located in a parallel run, they shall be spaced out from the wall approximately 5/8 inch to 1 inch by means of channel.
2. Runs of individual conduit suspended from the floor or ceiling shall be supported with pipe hangers. Where three (3) or more conduits are suspended from the floor/ceiling, suitable racks shall be constructed from channel material with suitable fittings.
3. Space supporting points no greater than required by CEC.

E. Raceway Other Than Conduit
1. Support from structure in accordance with manufacturers' instructions.

F. Sleeves
1. Set sleeves in position in formwork. Provide reinforcing around sleeves.
2. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.
3. Where raceway penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal.

3.2 FIELD QUALITY CONTROL

A. All expansion anchors shall have 50 percent of the bolts (alternate bolts in any group arrangement) proof tested in tension and certified by a recognized testing agency at the values indicated in the following table, except where shown otherwise in the Contract Documents. If there are any failures, the immediately adjacent bolts must then also be tested. Anchor capacities shall not exceed 80 percent of the values in the published ICC-ES report.

ANCHOR CAPACITY (3,000 PSI MINIMUM STONE AGGREGATE CONCRETE)							
	1/2 inch	5/8 inch	3/4 inch	7/8 inch	1 inch	1-1/4 inches	UNITS
IN TENSION	680	960	1,360	1,900	2,700	3,600	LBS
IN SHEAR	1,170	1,680	2,420	3,500	5,020	6,700	LBS
TYPE OF TEST:							
DIRECT PULL-TENSION, LBS.	1,360	1,920	2,720	3,800	5,400	7,200	LBS
MINIMUM EMBEDMENT	3	3-3/4	4-1/2	5-1/4	6	7-1/2	INCHES

END OF SECTION

SECTION 260534

OUTLET AND JUNCTION BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Pull and junction boxes.

1.2 SUBMITTALS

A. Submit under provisions of Division 1.

B. Closeout Submittals
   1. Project Record Documents: Accurately record actual locations and mounting heights of all boxes.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Furnish products listed and classified by UL as suitable for purpose specified and shown.
   2. Compliance with CEC with particular attention to Article 110.

1.4 PROJECT CONDITIONS

A. Field Measurements
   1. Verify field measurements are as shown on the Drawings.
   2. Boxes are indicated in approximate locations unless dimensioned. Verify locations prior to rough-in.
   3. Coordinate mounting heights and locations of boxes mounted above, below, in, or on counters, benches and backsplashes.
   4. Coordinate cutting of masonry to achieve neat installation.
   5. In framed ceilings, coordinate locations and sizes of required access doors.

PART 2 PRODUCTS

2.1 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Surface-Mounted: NEMA 250, Type 4; flat-flanged.
   1. Material: Galvanized cast iron or steel.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 INSTALLATION

A. General
   1. Provide boxes as indicated, and as required by the CEC.
   2. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
   3. Do not install flush mounting boxes back-to-back in walls.
      a. Provide minimum 24 inches separation between boxes in acoustic and fire-rated walls and 6inch separation between boxes in other locations.
      b. Install flush mounting box without damaging wall insulating or reducing its effectiveness.
   4. At access panel in ceilings, install boxes not more than 6 inches horizontally from panel opening or from removable recessed luminaries.

3.2 APPLICATION

A. Interior
   1. Finished Areas: Provide flush-mounted boxes.

END OF SECTION

SECTION 260535

RACEWAY FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Rigid metal conduit.
2. Intermediate metal conduit.
3. Flexible metal conduit.
4. Electrical metallic tubing.
5. Fittings.

B. Related Documents and Sections
1. Section 26 05 00 - Common Work Results for Electrical.
2. Section 26 05 29 - Hangers and Supports for Electrical Systems.
3. Section 26 05 34 - Outlet and Junction Boxes for Electrical Systems.
4. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

A. ANSI C80.1-2005 - Electrical Rigid Steel Conduit (ERSC).

B. ANSI C80.3-2005 - Steel Electrical Metallic Tubing (EMT)

C. NEMA FB 1-2007 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

D. UL 1-2005 - Flexible Metal Conduit.

E. UL 6-2007 - Electrical Rigid Metal Conduit - Steel.

F. UL 514B-2004 - Conduit, Tubing, and Cable Fittings.

G. UL 797-2007 - Electrical Metallic Tubing - Steel.

H. FS-A-A-55810-1996 - Conduit, Metal, Flexible.

I. FS-A-A-50552-1995 - Fittings, For Cable, Power, Electrical and Conduit, Metal, Flexible.

J. FS-A-A-50553A-2005 - Fittings for Conduit, Metal Rigid (Thick-wall and Thin-wall).

1.3 DESIGN REQUIREMENTS

A. Conduit Size: As indicated. When not indicated or when equipment has been substituted, size per CEC except no smaller than 3/4-inch.

1.4 SUBMITTALS

A. Submit under provisions of Division 01.

B. Certify compliance with CEC Article 110 - Requirements for Electrical Installation.

1.5 AS-BUILT DOCUMENTS

A. Submit under provisions of Division 01.

B. Accurately record actual routing of conduits larger than 2 inches in diameter.

1.6 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 PRODUCTS

2.1 RIGID METAL CONDUIT

A. Rigid Steel Conduit: ANSI C80.1, UL 6.
   1. Stamp each length with manufacturer's name or trademark and U/L label.

2.2 FLEXIBLE METAL CONDUIT

A. Interlocked Steel Construction: UL 1, FS-A-A-55810.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Galvanized Steel Tubing: ANSI C80.3 and UL 797.

B. Maximum size shall be 2 inches.

2.4 FITTINGS

A. Acceptable Manufacturer
   1. Thomas and Betts, (T&B).
      a. For reference, Thomas & Betts series numbers are listed below.
   2. Appleton.
   3. Crouse-Hinds.
   4. O.Z. Gedney.

B. Standards
   1. Metallic: NEMA FB1 and UL 514B ferrous.
      a. Flexible: FS-A-A-50553A.
   2. Non-metallic: NEMA TC3.

C. Locknuts:
   1. Hardened Steel or malleable iron construction, electro zinc plated, capable of insuring positive bond to enclosure.
      a. Non-bonding: T & B Series 142.
      b. Bonding: T & B Series 107.
      c. Crouse-Hinds.
      d. Appleton.

D. Bushings:
   1. Insulated: T & B Series 223.
   2. Insulated Metallic Bushing: T & B Series 1223.
   3. Insulated Grounding and Bonding Bushing: T & B Series 3871.
   4. Crouse-Hinds.
   5. Appleton.

E. Couplings:
   1. Threaded Rigid Metal Conduit Couplings: By conduit manufacturer for the purpose.
   2. Threadless Coupling: “Erickson” Type; T & B Series 676.
   3. Expansion Type: permit 3/4 inch movement any direction.
      a. Exposed: Weatherproof with external bonding jumper.
      b. Embedded: Watertight with internal bonding jumper.
   4. Crouse-Hinds.
   5. Appleton.

F. Connectors:
   1. Threaded Hubs: Electro zinc coated with nylon insulated throat and oil/moisture resistant recessed sealing ring, raintight.
      a. Non-bonding: T & B series 371.
      b. Bonding: T & B Series 371 with 107 series bonding locknut.
   2. EMT Connectors, Raintight: T & B Series 5223.
   3. EMT to Rigid Metal Conduit Connector: Raintight - T & B Series 531.
   4. Flexible metal conduit connector - Insulated throat, suitable as grounding means. T & B Series 3115.
      a. Non-External Bonding - T & B Series 5333.
      b. External Bonding - T & B Series 5333GR.
   5. Crouse-Hinds.
   6. Appleton.

G. Nipple: “Chase” Type, Insulated; T & B Series 1943.

2.5 CONDUIT BODIES

A. Standards - NEMA FB-1 and FS-A-A-50553A.

B. Ferrous with threaded hubs and gasketed cover.

2.6 SEALANT

A. Internal to fittings.
   1. Approved by manufacturer for application.
   2. Manufacturer:
      a. Crouse Hinds Chico A-P and Chico X Fiber.

b. O.Z. Gedney.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Installation Standards:
1. Install conduit in accordance with NECA “Standard of Installation.”
2. Ground and bond conduit.
3. Identify conduit under provisions of Section 26 05 53.
4. Where conduit systems penetrate or parallel fire and/or smoke rated walls, ceilings, roofs or floors, maintain the fire rating integrity. Comply with Section 07 84 00.
5. Within finished areas of building, install all conduits concealed.
6. Exposed overhead conduit may be used in areas with exposed metal structure, Switchgear Rooms, Mechanical Equipment Rooms, Electric Closets, and Equipment Rooms only.
7. Locate boxes in accordance with Section 26 05 34 before installing conduit.

B. Routing:
1. Arrange conduit to maintain headroom and present neat appearance.
2. Route other conduit parallel and perpendicular to walls.
3. Thoroughly clean threads of oil, tailings and paint threads of galvanized conduits that are installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound before assembling.
4. Do not notch or penetrate structural members for passage of raceways except with prior approval of the Owner’s Representative.

C. Fitting:
1. Cut conduit square using saw or pipe cutter; de-burr cut ends.
2. Bring conduit to shoulder of fittings; fasten securely.
3. Install no more than equivalent of four 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 2 inch size.
4. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic zone 4, control and expansion joints.
5. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
6. Make joints in threaded conduit watertight with white nonleaded compound applied to male threads only.
    a. Cut square, ream smooth, and properly thread filed joints to receive couplings.
    b. Do not use running threads. Fit all conduit ends at switch and outlet boxes with approved lock nuts and bushing forming approved tight bond with box when screwed tightly in place.
7. Remove moisture and debris from conduit before wire is drawn into place. Tightly plug ends of conduit with plastic inserts until wire is pulled.
8. Neatly seal openings around conduits, where they pass through exterior walls or roof.
9. Provide escutcheon plates at exposed wall, ceiling and floor conduit penetrations.

D. Bends:
1. Make changes in direction of runs with symmetrical bends or cast metal fittings. Make bends and offsets of the longest practical radius. Avoid field-made bends and offsets

where possible, but where necessary, make with an acceptable hickey or conduit bending machine. Do not heat metal raceways to facilitate bending.

2. Make bends in parallel or banked runs of raceways from the same center or centerline so that bends are parallel and of neat appearance. Factory elbows may be used in parallel or banked raceways if there is a change in the plane of the run and the raceways are of the same size. Otherwise, make field bends in parallel runs.
3. Make no bends in flexible conduit that exceed allowable bending radius of the cable to be installed or that significantly restricts the conduit's flexibility.

3.2 PRODUCT APPLICATION - RACEWAY - GENERAL LOCATIONS

A. Dry Locations - Concealed:
   1. Rigid metal conduit.
   2. Flexible metal conduit.
   3. Electrical metallic tubing.
   4. Connections and Fittings:
      a. Above lay-in tile ceilings, make connections to lay-in type fixtures with 1/2-inch flexible metal conduit.
         1) Include No. 12 branch and grounding conductors.
         2) Arrange conduit and box systems for easy removal of lay-in ceiling.

B. Dry Locations - Exposed.
   1. Rigid metal conduit.
   2. Flexible metal conduit - 1 foot maximum length.
   3. Electrical metallic tubing.

3.3 PRODUCT APPLICATIONS - CONNECTIONS

A. Rigid Metal Conduit:
   1. At building expansion joints, use expansion type fittings.
   2. Where an expansion type fitting is not required, use a threaded rigid metal conduit coupling or "Erickson" type coupling as appropriate.
   3. Make connections to NEMA 12 boxes with a threaded hub.
   4. Make connections to a threadless opening with locknuts on the inside and outside of the box. The conduit end shall be fitted with an insulating bushing. In wet locations, a sealing gasket shall be provided between the outside locknut and the box.
   5. Bonding type locknuts shall be used where the raceway and associated fittings are part of the equipment grounding system.
   6. Insulated grounding and bonding bushings shall be used to terminate service conduits, rigid metal conduit used as the grounding electrode conductor enclosure, where assurance of electrical continuity between isolated sections of raceways is required in accordance with CEC and where a bonding jumper around unpunched knockouts is required in accordance with CEC.
   7. Terminate in sealing type fittings when leaving refrigerator and freezer boxes and when leaving hazardous areas.
   8. Repair any marred galvanized finish to maintain the same level of corrosion protection.

B. Flexible Metal Conduit:
   1. Terminate with a flexible metal conduit connector. Use a locknut in unthreaded boxes.

C. Electrical Metallic Tubing:
   1. At building expansion joints, use expansion type fittings.

2. Where an expansion type fitting is not required, use an EMT coupling to connect EMT sections.
3. Make connections with EMT connectors.

D. System-to-System Connections:
1. Make EMT to rigid metal conduit connections with an EMT to rigid metal conduit connector.
2. Make a box-to-box connection with a “chase” type nipple and locknut.

3.4 PREPARATION FOR PULLING IN CONDUCTORS

A. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions. Raceways that are not usable because of being crashed or obstructions shall be replaced. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

B. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors. Provide a permanent removable cap over each end of each empty raceway.

3.5 TESTING & INSPECTION

A. Do not cover up conduit work until inspected. Notify Owner’s Representative at least 3 days before inspection is desired.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Wire markers.

1.2 REFERENCES

A. Refer to Requirements of Section 26 05 00.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Furnish products listed and classified by UL as suitable for purpose specified and shown.
   2. Compliance with the CEC and in particular, Article 110.

PART 2 PRODUCTS

2.1 WIRE MARKERS

A. Manufacturers:
   1. Brady.
   2. E-Z Code by T&B.
   3. Pan-Code by Panduit.
   4. Plymark by Plymouth and Bishop.
   5. ScotchCode by 3M.
   6. Ideal.

B. Description:
   1. Vinyl cloth, self laminating vinyl, heat shrink sleeving, or tube type markers.
   2. Legend:
      a. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
      b. Control Circuits: Control wire number indicated on shop drawings.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface Preparation
   1. Degrease and clean surfaces to receive nameplates, wire markers, conduit and electrical markers.

3.2 APPLICATION

A. Wire Markers.
   1. Provide for each conductor at panelboard, gutter, pull box, junction box, convenience outlet, cabinet, and each load connection.
   2. For feeder and branch circuits, use circuit numbers indicated on the Drawings. For control circuits, use circuit numbers indicated on the shop drawings.

END OF SECTION

SECTION 260574

OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Enclosed molded case circuit breakers.
   2. Fuses.
   3. Fused switches.

B. Related Sections
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 28 16 - Enclosed Switches and Circuit Breakers.

1.2 REFERENCES

A. FS W-C-375D-2006 - Circuit Breakers, Molded Case, Branch Circuit and Service.

B. UL 489 - Molded-Case Circuit Breakers. Molded Case Switches, and Circuit-Breaker Enclosures.

C. NEMA KS 1-2001- Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

D. UL 512-1993 - Fuseholders.

1.3 SUBMITTALS

A. Submit product data under provisions of Division 01.

B. Product Data
   1. Include circuit breaker ratings, trip current and let-through current curves, outline dimensions, and terminal lug sizes.

C. Quality Assurance/Control Submittals
   1. Manufacturers' Instructions
      a. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Use devices listed by Underwriters' Laboratories, Inc., and suitable for specific application.
   2. Comply with the California Electrical Code.

1.5 MAINTENANCE

A. Extra Materials
   1. Submit extra materials under provisions of Division 01.
   2. Fuses: Furnish 5 spare fuses of each type and rating installed.
   3. Fuse Pullers: Furnish 5 fuse pullers.

PART 2 PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

A. Circuit Breaker: UL 489.

B. Manufacturers
   1. Square D class 600.
   2. Westinghouse Seltronic.
   3. General Electric Q-Line.

C. Service Conditions:
   1. Temperature: 120 degrees F maximum.
   2. Altitude: 5,000 feet maximum.

2.2 CONFIGURATION

A. Configuration: Instantaneous automatic tripping.

B. All devices shall be UL listed and meet NEMA Standards Publication AB1. Breakers covered under this Specification may be installed in switchboards, panelboards, motor control centers, combination motor starter, and individual enclosures. Three (3) position “on” “off” and “tripped”. “Tripped” condition to be clearly indicated. All poles open and close simultaneously.

C. Circuit breakers shall be quick-make and quick-break on manual or automatic operation. The handle mechanism shall be trip-free to prevent holding contacts closed against a short circuit sustained overload. The contacts shall be of the high-pressure butt type and shall be made of a silver-alloy material.

D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip; and adjustable short time trip.

E. Molded Case Circuit Breakers: UL 489; bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled. Plug-in circuit breakers are not permitted.

F. Provide approved “Lock-Off” devices for all circuit breakers serving lighting circuits without local switching.

G. Provide approved “Lock-On” devices for all circuit breakers serving essential circuits, including Fire Alarm, Time Clocks, and Heat Trace.

H. Do not use tandem circuit breakers.

I. Provide shunt trip mechanism on breakers where indicated.

J. Ground fault circuit interrupter circuit breakers:
   1. Operate on differential transformer principle; rated 20A, 120V, or 240V, Class A fault-trip sensitivity of 5 milliamperes, U/L approved, with built-in testing switch on ON-OFF switch.
   2. Provide in panelboards in lieu of standard circuit breakers to serve circuits where specifically indicated.

K. Insulated case type providing adjustable inverse time overload, adjustable instantaneous short circuit, adjustable short time delay, and adjustable ground fault protection by means of a solid state trip element with two-step stored energy mechanism. Provide interchangeable rating plug. Rate for application at 100 percent of frame size.
   1. Electrically operated where indicated. Provide motor driven operator for charging mechanism with open, close and charge push buttons.
   2. Make manually operated breakers field convertible to electrically operate by adding the motor operator.

L. Provide ground fault sensing system with electrical reset on breakers where indicated (type GFR).

2.3 RATINGS

A. Ratings: UL 489; as follows:
   1. Voltage: 240 volts.
   2. Poles: as shown on the Drawings.
   3. Minimum interrupting rating of molded-case circuit breakers shall be as follows: Interrupting Rating System:

Voltage	Amps Frame	Amps Interrupting Capacity
120/240	up to 31	10,000
120/240	40 to 100	22,000
120/240	125 to 400	42,000

   4. Interrupting rating of circuit breaker shall not be less that the rating shown on the Drawings for the panelboard in which it is installed.

2.4 TERMINAL LUGS

A. Size: UL 489. As scheduled.

2.5 ENCLOSURE

A. Enclosure: UL 489. 1

B. Fabricate enclosure from steel.

C. Finish using manufacturer’s standard enamel finish.

2.6 MANUFACTURERS - FUSES

A. ITE Siemens.

B. Gould.

C. Bussman.

D. Littlefuse.

2.7 FUSES

A. UL Class RK-5 fuses: Dual-element time-delay and current-limiting rejection types fuses; UL Class RK-5 listed for 200,000 RMS AIC symmetrical, 0-600A.
   1. Manufacturers
      a. Bussmann “Fusetron”, 250 V FRN-RK and 600 V FRS-RK.
      b. Gould “TRI-ONIC” 250 V TR-R, 600 TRS-R.
      c. Littlefuse “SLO-BLO” 250 V FLN-R, 600 V FLS-R.
   2. Use for motor feeder and branch circuit devices where fuses are shown.

2.8 MANUFACTURERS - FUSIBLE SWITCHES

A. General Electric.

B. Cutler-Hammer

C. Square D.

2.9 FUSIBLE SWITCHES

A. Panelboard type suitable for mounting in switchboards or panelboards as indicated.
   1. 200,000 AIC, 30 thru 600A, type FDP and 800 thru 1200A, type CBC with fuses.
   2. Ground fault protection system where indicated. Provide current sensor, shunt trip and control power transformer.

B. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: UL 512. Designed to accommodate Class R fuses, type as specified.

C. Fusible switches shall be of the quick-make, quick-break, visible blade type and shall be UL listed and horsepower rated. Phase sequence and circuit numbering shall be uniform. Temperature rise and current carrying capacity of busses and parts shall be in accordance with NEMA Standards and CEC requirements.

D. Components shall possess sufficient mechanical strength and rigidity to safely withstand any stresses imposed by shipping, erection, or short circuits.

E. Identification nameplates shall be provided in accordance with the Article entitled “Identification of Circuits and Equipment.”

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
   1. Verify that surfaces are ready to receive work.
   2. Verify field measurements are as shown on Drawings.
   3. Verify that required utilities are available, in proper location, and ready for use.
   4. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install enclosed devices where shown on Drawings, in accordance with manufacturer's instructions.

B. Install individually enclosed as specified in other sections or indicated. Use NEMA 1 enclosure unless shown otherwise.

C. Equipment and devices by same manufacturer.

3.3 FIELD QUALITY CONTROL

A. Site Tests
   1. Test each circuit breaker to UL 489.
   2. Perform several mechanical ON-OFF operations on each device.
   3. Verify circuit continuity on each pole in closed position.
   4. Determine that device will trip on overcurrent condition, with tripping time to UL 489 requirements.
   5. Include description of testing and results in test report.

B. Inspection
   1. Perform field inspection under provisions of Division 01.
   2. Inspect each circuit breaker to UL 489.
   3. Inspect visually several mechanical ON-OFF operations on each device.

3.4 ADJUSTING

A. Adjust work under provisions of Division 01.

B. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in circuit.

C. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

END OF SECTION

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SECTION 260800

ELECTRICAL COMMISSIONING

PART 1 GENERAL

1.1 SUMMARY

A. Work included: Labor, materials and equipment necessary to complete the start-up and commissioning of the electrical systems, including but not limited to:
   1. Interior and exterior lighting and lighting control systems.

B. Related Work: Consult all other Sections, determine the extent and character of related Work and properly coordinate Work specified herein with that specified elsewhere to produce a complete installation.
   1. Division 1: Commissioning Requirements
   2. Division 22: Plumbing Commissioning.
   3. Division 23: HVAC Commissioning.

C. Perform commissioning of electrical systems as directed by the Commissioning Authority in accordance with the Contract Documents. The Contractor shall coordinate all commissioning activities with the Commissioning Authority.

D. Work required in this Section will add to the requirements of work specified in other Division 26 Sections.

E. Electrical commissioning requires the participation of all parties related to the Division 26 contract to ensure that systems are operating in a manner consistent with the Contract Documents. The parties shall consist of, but not be limited to the following:
   1. Contractor.
   2. Special systems Subcontractors or Distributors.
   3. Independent Testing Agency.
   4. Factory-authorized service representatives.

F. Additionally, there is participation required from parties outside of Division 26 contract to ensure that their systems are operating or monitoring in accordance with a sequence of operation consistent with the Contract Documents. The parties shall consist of, but not be limited to the following:
   1. Division 21: Fire Sprinkler System - For monitoring and alarm annunciation of sprinkler system components via the fire alarm system.
   2. Division 23 & 25: HVAC and Controls - To ensure that under emergency power system operations all systems function per the sequence of operation.
   3. Division 23: HVAC - For control of fire/smoke damper system via the fire alarm system per the sequence of operation.

G. The commissioning responsibilities applicable to each of the parties indicated above are as follows:
   1. One representative from each of the above parties shall attend a commissioning scope meeting and all other meetings necessary to facilitate the commissioning process.
   2. Contractor shall provide the Commissioning Authority with normal cut sheets and Shop Drawing submittals of all commissioned equipment.

3. Provide additional requested documentation, prior to normal O&M manual submittals, to the Commissioning Authority for development of startup and functional testing procedures.
    a. Typically this will include detailed Manufacturer installation and startup, operating, troubleshooting and maintenance procedures, full factory testing reports (if any) and full warranty information with the responsibilities of the County to keep the warranty in force clearly identified. In addition, the installation, startup and checkout materials that are shipped with the equipment, including field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.
    b. The Commissioning Authority may request further documentation necessary for the commissioning process.
4. Contractor shall assist in clarifying the operation and control of commissioned equipment in areas where the Specifications, Drawings or equipment documentation is not sufficient for writing detailed testing procedures.
5. Develop a full startup and initial checkout plan using Manufacturer's startup procedures and the equipment verification and checklists for all commissioned equipment. Submit to Commissioning Authority for review and approval prior to startup.
6. During the startup and initial checkout process, execute the electrical related portions of the prefunctional checklist for all commissioned equipment.
7. Perform and clearly document all completed startup system operational checkout procedures, providing a copy to the Commissioning Authority.
8. Address current architectural/engineering punch list items before functional testing.
9. Ensure that the appropriate technicians are available and present to execute the startup and functional testing of commissioned equipment for the duration required to complete the necessary tests, adjustments and problem solving.
10. Perform functional testing under the direction of the Commissioning Authority for specified equipment. Assist the Commissioning Authority in interpreting the monitored data, as necessary.
11. Provide assistance to the Commissioning Authority in preparing the building integration test procedures.
12. Correct deficiencies as interpreted by the Commissioning Authority and retest the equipment.
13. Prepare O&M manuals according to the Contract Documents, including clarifying and updating to correspond with as-built conditions.
14. Provide training of the County's operating personnel as specified.

H. The commissioning process does not take away from or reduce the responsibility of the installing Contractor to provide a finished and fully functioning installation.

1.2 REFERENCES

A. The system shall be tested in strict accordance with the latest edition of the following applicable Specifications and standards and any other applicable standards, except as otherwise indicated or specified:
1. National Fire Protection Association (NFPA).
2. California Electrical Code (CEC).
3. International Electrical Testing Association, Inc. (NETA).
4. American National Standards Institute, Inc. (ANSI).
5. National Electrical Manufacturer Association (NEMA).

6. Institute of Electrical and Electronic Engineers (IEEE).
7. Insulated Cable Engineers Association (ICEA).
8. Occupational Safety and Health Administration (OSHA).
9. Factory Mutual (FM) Standards.

1.3 DEFINITIONS

A. Commissioning Authority: The County's independent representative hired to provide technical verification that the project meets the intended design/ criteria per the contract documents. The Commissioning Authority generally provides the services of a Project Manager, Engineers and Inspectors to perform their required scope.

B. Commissioning Schedule: Is a checklist itemizing all equipment to be commissioned, which specifically tracks and verifies the construction progress including submittals, factory tests, equipment arrival, equipment installation, test procedures, checklists, field testing, training and O&M manuals.

C. Prefunctional Testing:
1. Verification and Checklist: Is a summary verification checklist indicating equipment conformance with that specified and reviewed in submittal process, equipment nameplate, site preparation, installation, terminations, etc. prior to equipment startup.
2. Pre-startup: The required initial power-on checks and procedures prior to operating of the equipment. This is the initial startup test performed in conjunction with the manufacturer's recommended start-up procedures. Startup used to establish basic performance parameters and to verify performance data.

D. Functional Testing: Testing to verify equipment or system operation, parameters, electrical characteristics, visual and mechanical inspection, continuity, calibration, etc. as defined in the individual Sections of these Specifications.
1. Start-up:
2. Electrical Testing:

E. Building Integration Test: Testing to verify equipment or system integration with other building systems for overall sequence of operation, performance parameters, etc. to insure different systems operate together per the design intent.

1.4 SYSTEM DESCRIPTION

A. Commissioning is a systemic process of ensuring that all building systems perform interactively according to the design intent and the County's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, submittals, control system calibration, equipment checklist, startup, functional testing, building integration tests, O&M manuals and training.

B. Commissioning on this Project is intended to achieve the following specific objectives according to the Contract Documents:
1. Verify that applicable equipment and systems are installed according to the Manufacturer's recommendations, to industry accepted standards and in compliance with the Specifications, and that they receive adequate operational checkout by installing Contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on Project site is complete.

4. Verify that the County's operating personnel are adequately trained.

C. Commissioning process:

1. The County shall provide the services of a Commissioning Authority to develop the commissioning plan and to direct, review and approve the commissioning Work.
2. The following is an overview of the anticipated commissioning tasks during construction:
   a. Commissioning during construction shall begin with a scope meeting conducted by the Commissioning Authority where the commissioning process is reviewed with all commissioning team members.
   b. Additional meetings shall be required throughout construction, scheduled by the Commissioning Authority with necessary parties attending, to plan, scope, coordinate, schedule activities and resolve problems.
   c. Equipment documentation shall be submitted to the Commissioning Authority during normal submittal process, including detailed startup procedures.
   d. The Contractor shall assist the Commissioning Authority in the preparations of the Equipment Commissioning Schedule with list of equipment to be commissioned, location, and target dates for submittals, factory tests, arrival, installation, verification/pre-startup, functional test, training, and O&M manuals.
   e. The Commissioning Authority shall work with the Contractors in developing startup plans and startup documentation formats.
   f. The checkout and performance verification shall proceed from simple to complex; from component level to equipment to systems and inter-system levels with verification/checklists being completed before functional testing.
   g. The Contractors, under their own direction, shall execute and document the equipment verification and pre-startup checklists. The Commissioning Authority shall document that the equipment verification and pre-startup checklists were completed according to the approved plans. This may include the Commissioning Authority witnessing the checklist process.
   h. The Contractors, along with the Commissioning Authority as a witness, shall execute and document the startup and functional testing. The Commissioning Authority shall document that the startup and functional testing were completed according to the approved plans.
   i. The Commissioning Authority develops building integration test procedures for review by the Contractors.
   j. The building integration test procedures are executed by the Contractors, under the direction of and documented by the Commissioning Authority.
   k. Items of non-compliance in material, installation, startup, testing, etc shall be corrected at the Contractor's expense and the system retested.
   l. The Commissioning Authority reviews the O&M documentation submitted by the Contractor for completeness.
   m. The Commissioning Authority reviews, pre-approves and coordinates the training process provided by the Contractor and verifies that it was completed.

1.5 SUBMITTALS

A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
   1. Provide a complete list of equipment to be commissioned per the requirements of the Division 26 Specifications.
   2. Manufacturer's written instruction manuals applicable to commissioned equipment to include special inspection, detailed startup procedures and testing requirements.
   3. Upon completion of equipment verification and pre-startup checklist, have all parties sign-off on checklist form and submit to Commissioning Authority.
   4. Provide Commissioning Authority with startup plan for all equipment to be commissioned.
   5. Upon completion of startup and functional testing for commissioned equipment or systems, have form signed-off by all parties and provide test form to the Commissioning Authority.
   6. Submit schedule for training of all commissioned equipment for coordination and approval by County's operating personnel.

B. Provide qualifications for independent Testing Agency.

1.6 QUALITY ASSURANCE

A. Provide testing equipment and accessories that are free of defects and are certified for intended use.

B. Provide testing equipment with current calibration labels.

C. Independent Testing Agency:
   1. Testing firm shall be a financially stable organization and able to function as an unbiased testing authority, professionally independent of Manufacturers, Suppliers and installers of equipment or systems evaluated by the Testing Agency.
   2. Test firm shall also be a member of the International Electrical Testing Association (NETA), specializing in the testing of equipment or apparatus specified in this Division with a minimum of 5 years experience.
   3. Testing firm shall be regularly engaged in testing of electrical equipment, devices, installations and systems.
   4. Testing firm shall meet Federal Occupational Safety and Health Administration (OSHA) requirements for accreditation of independent testing laboratories.
   5. Testing firm shall use technicians who are regularly employed by the firm for testing services.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. The Contractor shall provide all standard testing equipment required to perform startup, initial checkout, required functional testing and commissioning. Also, the Contractor shall provide two-way radios to facilitate communications during commissioning.

B. Special equipment, tools and instruments (only available from vendors, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included.

C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the specified tolerances. All equipment should be calibrated according to the Manufacturer's recommended intervals.

PART 3 EXECUTION

3.1 MEETINGS

A. Within 90 days of commencement of construction, the Commissioning Authority will schedule, plan and conduct a commissioning scope meeting with the entire commissioning team in attendance. The Commissioning Authority will distribute meeting minutes to all parties. Information gathering from this meeting will allow the Commissioning Authority to prepare and finalize the commissioning plan, which will also be distributed to all parties.

B. Other meetings will be planned and conducted by the Commissioning Authority as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Contractors. The Commissioning Authority will plan these meetings and will minimize unnecessary time being spent by Contractors. These meetings may be held monthly, until the final three months of construction when they may increase in frequency to one per week.

3.2 EXAMINATION

A. Inspect commissioned equipment and confirm that it is clean and ready for operation. All shipping tags removed, nameplate installed and equipment manuals in place.

B. Verify that startup plan and equipment verification/startup checklist are completed and approved for commissioned equipment prior to beginning functional testing.

C. Verify that startup and functional testing are complete prior to starting the building integration test.

3.3 PREPARATION

A. Provide required personnel with tools and equipment necessary to perform functional testing.

B. Provide equipment factory representative for startup and commissioning Work as necessary or as required by the Specifications.

C. Provide certified independent Testing Agency personnel for startup and commissioning Work as required by the Specifications.

D. Provide any necessary temporary power provisions, load banks, diesel fuel, equipment and sundries to complete startup and commissioning Work.

3.4 REPORTING

A. The Commissioning Authority will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

B. Testing or review approvals and non-conformance and deficiency reports are made regularly with the required action by the Contractor.

3.5 EQUIPMENT VERIFICATION AND PRE-STARTUP CHECKLISTS

A. The following procedures apply to all systems and all equipment to be commissioned.

B. Contractor will perform equipment verification and pre-startup checklist to ensure that the equipment and systems are in compliance with that specified, submitted and reviewed, and per the Manufacturers written instructions for installation. The checklist for given equipment must be completed and signed-off by all parties prior to formal functional testing of equipment.

C. The Commissioning Authority shall witness, at their discretion, the equipment verification and pre-startup checklist. The primary role of the Commissioning Authority in this process is to ensure that there is written documentation that equipment installation meets the requirements of the contract documents prior to further testing. Parties responsible for checklists are identified in the commissioning scope meeting and in the checklist forms.

D. Equipment verification:
   1. The Contractor shall verify the equipment condition and conformance to the submittal when it arrives on site.
   2. The Contractor shall maintain a record of installation and coordination to verify the proper installation of equipment and system.
   3. Nameplate information shall be verified against that of the equipment submittal.

E. Pre-startup checklist:
   1. The Contractor shall complete the pre-startup checklist items outlined in the Specification along with any items recommended by the manufacturer.
   2. Checklist shall be completed and reviewed by the Commissioning Authority.
   3. All parties shall sign-off on the checklist when complete and prior to commencing equipment startup.

3.6 STARTUP AND FUNCTIONAL TESTING

A. At the conclusion of the Commissioning equipment verification and startup checklist, and sign-off by all parties, the system and/or equipment will be released for startup and functional testing.

B. The following procedures apply to all systems and equipment to be commissioned.

C. The Contractor will perform the startup and functional testing to be witnessed by the Commissioning Authority. The testing for a given system or equipment must be successfully completed prior to formal acceptance or proceeding to building integration test.

D. Startup:

1. The Contractor and Commissioning Authority shall develop a startup protocol to identify the procedure for starting new equipment, scheduling startup tests and the minimum requirements to start equipment. In general the startup protocol shall include the following requirements:
    a. Equipment shall not be energized for startup until the equipment verification and pre-startup checklist is signed-off by all parties, signifying the equipment readiness for startup test.
    b. Startup tests shall be conducted to verify the basic equipment operation is satisfactory and to prepare equipment for functional testing.
    c. The Contractor will verify the completion of preliminary steps, (checklists, schedule manufacturer's representative, completion of necessary controls, etc) and advise team when the equipment is ready. The startup test shall be scheduled and conducted using the Test Agency (or other designated party) recording required data as well as the initial test readings when applicable.
    d. Manufacturers shall be present for all items requiring manufacturer's startup. The Contractor copies the manufacturer's startup and initial checkout procedures from O&M manuals and includes with checklist.
    e. Items on the manufacturer's startup sheet do not need to be completed if these same items also appear on the Commissioning checklist.

E. Functional testing:
1. Functional testing will be complete and approved by the Commissioning Authority prior to substantial completion. This does not mean all items on the test must have been passed, but the essential function for safety and operating control must be verified as meeting the design intent.
2. Objective:
    a. The objective of the functional testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient are identified and corrected, improving the operation and functioning of the systems.
    b. Each system shall be operated through all modes of operation where there is a specified system response. Verification of each sequence in the sequence of operation is required. Proper responses to such modes and conditions shall also be tested.
3. The Commissioning Authority shall direct and verify functional tests unless this responsibility is specifically assigned to the Contractor.
4. The Contractor shall verify sequences and operations in the functional test procedures prior to notifying the Commissioning Authority the system is ready for functional testing.
5. Non-conformance:
    a. The Commissioning Authority will record the results of the functional test on the test forms. All deficiencies or non-conformance issues shall be noted and reported to the Contractor on a standard non-compliance form.
    b. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Authority. In such cases the deficiency and resolution will be documented on the procedure form.
    c. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Commissioning Authority will not be pressured

into overlooking deficient Work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Contractor.

d. As tests progress and a deficiency are identified, the Commissioning Authority shall discuss the issue with the executing Contractor:

1) When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:

a) The Commissioning Authority documents the deficiency and the Contractor's response with their intentions to correct and continues on with the testing. After the day's Work, the Commissioning Authority submits the non-compliance reports to the Contractor. The Contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and submits it back to the Commissioning Authority.

b) The Commissioning Authority reschedules the test and the test is repeated.

2) If there is a dispute, regarding whether it is a deficiency or determining who is responsible:

a) The deficiency shall be documented on the non-compliance form with the Contractor's response and a copy given to the Contractor.

b) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the Architect/Engineer. Final acceptance authority is with the Project Manager.

c) The Commissioning Authority documents the resolution.

d) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and submits it to the Commissioning Authority.

e) The Commissioning Authority reschedules the test and the test is repeated.

3.7 BUILDING INTEGRATION TEST

A. The test procedures for the building integration test shall be developed and prepared by the Commissioning Authority with the assistance of the Contractor.

B. Integrated building tests are intended to verify the operation of all building system's under condition to simulate as closely as possible actual building operations.

C. Interactive test of all Division 26 systems and/or equipment in conjunction with other effective Division of Work simultaneously to simulating anticipated building operating conditions and parameters, in varying modes of operation, primarily to verify continuous operation and baseline operation data as a building whole.

D. Resolution of deficiencies will follow the same general procedure as used for functional testing. In the case of integrated tests identification of deficiencies and determination of solution will occur on a daily basis.

3.8 TRAINING

A. The Contractor shall be responsible for training coordination, scheduling and ultimately to ensure that the training is completed in accordance with the Specifications.

B. The Commissioning Authority shall be responsible for overseeing and approving the content and adequacy of the training of County personnel for commissioned equipment.

C. The Contractor shall have the following training responsibilities:

1. Provide the Commissioning Authority with a training plan two weeks before the planned training.
2. Provide designated County personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
3. Training shall normally start with classroom sessions, followed by hands-on training on each piece of equipment or system, which shall illustrate the various modes of operation.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manuals, Specifications or sequence of operation, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or Manufacturer's representative shall provide the instructions and hands-on training on each major piece of equipment or system. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific equipment or system is required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the O&M manuals and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
    a. Use of printed installation, operation and maintenance instruction material included in the O&M manuals.
    b. A review of the written O&M instructions emphasizing safe and proper operating procedures, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown and emergency procedures.
    c. Discussion of relevant safety issues and concerns. Discussion of warranties and guarantees.
    d. Common troubleshooting problems and solutions.
    e. Explanatory information included in the O&M manuals and location of all plans and manuals in the facility.
    f. Discussion of any peculiarities of equipment or system installation or operation.
8. Training shall occur after functional testing is complete, unless approved otherwise by the Commissioning Authority.

END OF SECTION

SECTION 260923

AUTOMATIC LIGHTING CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Work included: Labor, materials and equipment necessary to complete the installation required for the item specified under this Division, including but limited to:
   1. Occupancy sensor switches. 2. Photoelectric switches.

B. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 REFERENCES

A. Comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
   1. Federal Specification (FS):
      FW W-P-455A; Plate, Wall Electrical.
   2. Underwriter's Laboratories, Inc. (UL):
      UL 514A; Metallic Outlet Boxes.
      UL 773A; Nonindustrial Photoelectric Switches for Lighting Control.

1.3 SUBMITTALS

A. Submit in accordance with the requirements of Section 260010: Basic Electrical Requirements, the following items:
   1. Data/catalog cuts for each product and component specified herein, listing all physical and electrical characteristics and ratings indicating compliance with all listed standards.
   2. Describe system operation, equipment, dimensions and indicate features of each component.
   3. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
   4. Submit manufacturer's installation instructions.
   5. Complete bill of material listing all components.
   6. Warranty.

B. Dimensions and configurations of lighting control equipment shall conform to the space allocated on the drawings. The Design Builder shall submit a revised layout if equipment furnished varies in size from that shown on drawings for the County's Representative's approval.

1.4 QUALITY ASSURANCE

A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.

B. Only products and applications listed in this Section may be used on the project unless otherwise submitted.

1.5 WARRANTY

A. Units and components offered under this Section shall be covered by a one year parts and labor warranty for malfunctions resulting from defects in materials and workmanship. Warranty shall begin upon acceptance by the County.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:
   1. Occupancy sensors switches:
      a. The Wattstopper.
      b. Mytech.
   2. Photoelectric switches:
      a. Tork.

B. Substitutions: Under provisions of Section 260010: Basic Electrical Requirements.

2.2 OCCUPANCY SENSOR SWITCHES

A. General:
   1. Occupancy sensors shall comply with the latest edition of the California Building Energy Efficiency Standards, California Building Code, Part 6 and be certified by The California Energy Commission. All sensors shall be listed in the most current directory of Certified Occupancy Sensing Devices or be on file with the CEC.
   2. Occupancy sensors shall be dual technology type ultrasonic/infrared as specified herein with voltage and wattage rating equal to the lights being controlled.
   3. All sensors shall have an adjustable time delay for turning off lights and a sensitivity adjustment.
   4. Ceiling mounted sensors shall operate on low voltage as supplied by control unit. Control unit shall contain power supply and relays for switching loads.
   5. Units shall be furnished to cover the areas being controlled. No allowance shall be given for providing sensors improperly sized for the square footage of the controlled area.

B. Color: Device color shall be as selected by County's Representative, unless otherwise noted.

C. Wall mounted single level control sensors:
   1. Sensor shall be dual technology type ultrasonic/infrared type with single level switching capability and coverage up to 900 square feet.
   2. Operation shall be automatic "ON" and manual or automatic "OFF".
   3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 4 minutes.
   4. Load capacity of 0 to 1800 watts at connected voltage.
   5. For use in small utility closets where dual level switching is not indicated.

D. Wall mounted dual level control sensors:
   1. Sensor shall be dual technology type ultrasonic/infrared type with dual level switching capability and coverage up to 1000 square feet.
   2. Operation shall be automatic "ON" and manual (in two levels) or automatic (full) "OFF".
   3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.
   4. Load capacity of 50 to 1000 watts at connected voltages.
   5. Integral photocell, 2 circuit, compatible with electronic bi-level switching ballast. Provide

with ambient light control adjustment.

6. For use in offices where dual level switching is indicated.

E. Ceiling mounted single-directional sensors:

1. Sensor shall be dual technology type ultrasonic/infrared type single-directional with coverage up to 900 square feet.
2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.
3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.
4. Load capacity of 20 amps per power or slave pack at connected voltage.
5. Power pack consisting of Class 2, 24V output transformer and relay in single housing, capable of powering up 2 sensors and mounted inside standard 4 inch square box.
6. For use in small office areas.

F. Ceiling mounted omni-directional sensors:

1. Sensor shall be dual technology type ultrasonic/infrared type Omni-directional with coverage up to 1000 square feet.
2. Operation shall be automatic "ON" and automatic "OFF". Provide with a manual override switch.
3. Time delay adjustment from 30 seconds to 30 minutes. Set adjustment at 10 minutes. Set sensitivity adjustment at maximum.
4. Load capacity of 15 amps per power or slave pack at connected voltage.
5. Power pack consisting of Class 2, 24V output transformer and relay in single housing, capable of powering up to 2 sensors and mounted inside standard 4- inch square box

2.3 PHOTOELECTRIC SWITCH - OUTDOOR

A. Housing: Weatherproof, die cast aluminum with U.V. stabilized acrylic cell window and threaded base for connection to 1/2" conduit.

B. Sensor: Cadmium sulfide type.

C. Voltage: 277 volts, 60 Hz.

D. Load rating: 2300 watts minimum.

E. Time delay: 15 seconds minimum, 2 minutes maximum.

F. Turn-on level: Adjustable from 2 to 50 footcandles.

G. Ambient temperature: Minus 40 degrees F to plus 150 degrees F, ambient temperature compensated snap action switch with cadmium oxide contacts, normally closed at night.

H. Failure mode: Switch shall be rated for 5000 operations minimum at rated load. Failure of any component shall cause the switch to close.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Design Builder shall thoroughly examine site conditions for acceptance of automatic lighting control equipment installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.2 INSTALLATION

A. Install automatic lighting control equipment in accordance with manufacturer's written instruction, as shown on the drawings and as specified herein.

3.3 OCCUPANCY SENSOR SWITCHES

A. Set time delays in sensors in accordance with County's directions.

B. Where substituted occupancy sensors are used, it shall be the responsibility of the Design Builder to place sensors in the proper place and with proper alignment to cover to all the area intended in the contract documents.

C. Provide one power pack with each ceiling mounted occupancy sensor, whether shown or not on plans, unless wiring details or plans indicate otherwise.

D. Where drawings indicate ceiling mounted slave units, provide 3 #14 in 1/2" conduit from power pack to slave unit and connect so that input from either master or slave sensor will turn lights on.

E. Install wall mounted devices with the vertical centerline plumb and alleges of device flush against adjacent wall surfaces. Mount devices at 42 inches above finished floor unless otherwise noted.

3.4 OUTDOOR PHOTOELECTRIC SWITCHES

A. Prior to rough-in, verify switch location relative to site conditions that could adversely affect operation. Relocate switch as required for satisfactory operation.

B. Orient photocell toward north. If north orientation cannot be obtained, orient the cell toward west.

C. Adjust photocell cover in accordance with the County's representative's directions.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's field service: Electrical Design Builder shall arrange and pay for the services of a factory-authorized service representative to supervise the initial start- up, pretesting and adjustment of the automatic lighting control equipment.

B. At least three weeks prior to any testing, notify the County's Representative so that arrangement can be made for witnessing test, if deemed necessary. All pretesting shall have been tested satisfactorily prior to the County's Representative's witnessed test.

C. Prefunctional testing:
   1. Visual and mechanical inspection:
      a. Inspect for physical damage, defects alignment and fit.
      b. Perform mechanical operational tests in accordance with manufacturer's instructions.
   2. Electrical Design Builder shall provide all necessary programming assistance to set up and program the automatic lighting control equipment.

D. Design Builder shall replace at no costs to the County all devices which are found defective or do not operate within factory specified tolerances.

3.6 CLEANING

A. Upon completion of project prior to final acceptance the Design Builder shall thoroughly clean the automatic lighting control equipment. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION

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SECTION 262416

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Lighting and appliance branch circuit panelboards.

B. Related Documents and Sections
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 74 - Overcurrent Protective Devices.

1.2 REFERENCES

A. ANSI/UL 50-1995 - Enclosures for Electrical Equipment.

B. ANSI/UL 67-1993 - Panelboards.

C. NEMA PB 1-2006 - Panelboards.

D. NEMA PB 1.1-2007 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.3 DEFINITIONS

A. Lighting and Appliance Branch Circuit Panelboards: As defined in the CEC, Article 408.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop Drawings:
   1. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
   2. Identify panels by alphanumeric designation with branch circuit breaker sizes and types indicated in panel schedule or one-line-diagram.

C. Closeout Submittals
   1. Operating and Maintenance Data
      a. Provide operating and maintenance instructions.

1.5 MAINTENANCE

A. Extra Materials
   1. Keys: Furnish 6 each type to Owner’s Representative.

PART 2 PRODUCTS

2.1 MANUFACTURERS - PANELBOARDS

A. General Electric.

B. Siemens.

C. Square D.

D. Cutler-Hammer.

2.2 LIGHTING AND APPLIANCE BRANCH - CIRCUIT PANELBOARD

A. Description
1. Industrial/Commercial grade.
2. Voltage Class: 120V/240V as required for application.
3. Current ratings: As indicated, 225 Amps minimum.

B. Comply with provisions of:
1. ANIS/UL 50.
2. ANSI/UL 67.
3. NEMA PB-1.

C. Enclosure
1. Flush or surface mounted as indicated.
2. Code gauge galvanized steel, NEMA 3R.
3. Painted gray over rust inhibiting primer.
4. Wiring gutters at top, sides and bottom. Minimum dimensions, 8 inches at top and bottom, 4 inches on sides.
5. Width: 20 inches minimum, unless otherwise indicated.
6. Doors
   a. Provide for every panel.
   b. Keyed; Key identically.
   c. Provide double doors for panels over 30 inches
   d. Provide vault handle and three point catches for doors over 36 inches in height.

D. Trim
1. Trim and hardware of all cabinets shall be of a matching type.
2. Recessed cabinet fronts shall consist of a flush sheet steel frame with hinged steel door. Face of the frame shall be at least 3/4 inches larger than cabinet on all sides and shall be set with frame flange lapping finish wall. Fronts shall be prime coated for painting adjacent surfaces.
3. Surface mounted cabinet fronts shall consist of an enclosing sheet steel frame with a hinged steel door. Frame shall completely cover front of cabinet and shall have no sharp projections.
4. Concealed hinges.
5. Circuit directory.

E. Interior

1. Bus; copper, as indicated, 225 amps minimum.
2. Insulation; glass-filled polyester.
3. Nameplate
    a. Manufacturer.
    b. Order number.
    c. Panelboard type.
    d. System voltage.
    e. Bus amperage.
    f. Short circuit bracing rating.
    g. UL label.
    h. Service entrance label (if applicable).
4. Provide an individual lug for each branch requiring a neutral connection.
5. Interrupting Rating: Per Utility requirements but no less than 10,000 Amps symmetrical for 240V applications.
6. Bracing; 50,000 Amps.

F. Branch Protective Devices
1. As indicated and in compliance with Section 26 05 74.
    a. All breakers shall be bolt on type.
2. Provisions for future breakers shall be at the bottom of the panel.

G. Ground Bus: Copper.

H. Special Features
1. Provide blocking clips on circuit breakers as required or shown.
2. Provide barriered space for mounting contactors and control devices with a hinged door and lock, where shown or required.
3. Provide neutral bars with terminal for all active, spare, and inactive circuits.
4. Provide feed-thru lugs or sub-feed lugs for 2 and 3 section panels.
5. Equip bus bars for panelboard with main lugs, main fused switch or main circuit breaker, capacity as required or indicated.
6. Provide special features such as split bus, lighting contactors, extra-width gutters as required.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards plumb and when recessed, flush with wall finishes, in conformance with NEMA PB 1.1. Provide all backing for equipment support. Fasten all free-standing equipment to concrete slab. Mounting bolts on floor mounted panels shall extend into pads only and shall not be in direct contact with building structural members.

B. Height: 6 feet.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

E. Stub five empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

F. Label panels on front with 1/2 inch high white-filled letters on black phenolic nameplates.

3.2 FIELD QUALITY CONTROL

A. Site Tests
   1. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Inspection
   1. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Wall switches.
   2. Receptacles.
   3. Device plates and decorative box covers.

B. Related Sections
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 35 - Raceway for Electrical Systems.

1.2 REFERENCES

A. NEMA WD 1-1999 (R2005) - General Color Requirements for Wiring Devices.

B. NEMA WD 6-2002 - Wiring Devices - Dimensional Requirements.

1.3 SUBMITTALS

A. Submit under provisions of Division 01.

B. Certify compliance with CEC Article 110 - Requirements for Electrical Installations.

C. Product Data
   1. Provide manufacturer's catalog information showing dimensions, colors and configurations.

D. Quality Assurance/Control Submittals
   1. Manufacturer's Instructions
      a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory requirements contained in Section 26 05 00.
      b. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.4 MAINTENANCE

A. Extra Materials
   1. Provide two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. Hubbell.
   2. Lutron.
   3. Pass and Seymour.
   4. Leviton.

B. Description: NEMA WD 1, heavy-duty, AC only general-use snap switch, specification grade.

C. Device Body: Ivory plastic with toggle handle; unless otherwise indicated in the Contract Documents.

D. Voltage Rating: 120-277 VAC.

E. Current Rating: 20 amperes.

F. Ratings: Match branch circuit and load characteristics.

G. Typical Switches: Rocker type, smooth-action, architecturally styled.
   1. Single-pole: Leviton # 5621-2.
   2. Three-way: Leviton #5623-2.

2.2 RECEPTACLES

A. Manufacturers:
   1. Arrow-Hart.
   2. Pass & Seymour.
   3. Leviton.

B. Description: NEMA WD 1; heavy-duty general-use receptacle.

C. Device Body: Ivory, unless otherwise indicated, plastic.

D. Configuration: NEMA WD 6; type as specified and indicated.

E. Refer to symbol legend, Leviton Nos. listed unless otherwise noted.

F. Receptacle Outlet; Duplex: 20A, 125V, 2 pole, 3 wire grounding, NEMA 5-20R; Leviton Model 5362.

G. GFCI Type Duplex Receptacle Outlet: Built-in ground-fault circuit interruption, 5-mA sensitivity, with indicator and reset button; UL listed; standard model for ground-fault protection at individual location; feed-through model for ground fault protection of "downstream" conventional receptacles.

H. Device plates for concealed wiring: Same manufacturer as wiring devices, to suit device covered, single or ganged, in one piece with beveled edges that match faces of plates.
   1. Cast Metal Plates for Surface Type Boxes: Corrosion resistant cast ferrous metal, designed for application.
   2. Thermoplastic Device Cover Plates: Nylon wallplate with matching metal mounting screws. Same manufacturer as device.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
   1. Verify conditions under provisions of Division 01.
   2. Verify outlet boxes are installed at proper height.
   3. Verify wall openings are neatly cut and will be completely covered by wall plates.
   4. Verify floor boxes are adjusted properly.
   5. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
   6. Beginning installation means installer accepts existing conditions.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install switches and receptacles as shown on the Drawings. The final location of all devices is dictated by Architectural Elevations and Drawings. The Architectural Elevations take precedence over the electrical drawings for device location and elevation.

B. Install products in accordance with manufacturers' instructions.

C. Install products in accordance with CEC.

D. Install devices plumb and level.

E. Install switches with OFF position down.

F. Install receptacles with grounding pole on bottom.

G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

H. Connect wiring devices by wrapping conductor around screw terminal.

I. Use jumbo size plates for outlets installed in masonry walls.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

K. Center outlets with regard to paneling, furring, trim, etc.

L. Where several outlets occur in a room, symmetrically arrange them.

M. Set outlets plumb or horizontal and extending to finished surface of wall, ceiling or floor as case may be without projecting beyond same.

N. Install wall switch 42 inches above finished floor.

O. Install convenience receptacles in locations not specified above at 18 inches above floor.

3.4 CONSTRUCTION

A. Interface with Other Work
   1. Coordinate locations of outlet boxes provided under Section 26 05 35 to obtain mounting heights specified unless otherwise indicated on Drawings. All dimensions are to the center of the item.

3.5 FIELD QUALITY CONTROL

A. Site Tests
   1. Operate each wall switch with circuit energized and verify proper operation.
   2. Verify that each receptacle device is energized.
   3. Test each receptacle device for proper polarity.

B. Inspection
   1. Inspect each wiring device for defects.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION

SECTION 262729

EQUIPMENT WIRING SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Electrical connections to equipment specified under other sections.

B. Related Sections
   1. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment.
   2. Section 23 05 13 – Common Motor Requirements for HVAC Equipment.
   3. Section 26 05 00 - Common Work Results for Electrical.
   4. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600V and Below.
   5. Section 26 05 35 - Raceway for Electrical Systems.
   6. Section 26 27 26 - Wiring Devices.

1.2 REFERENCES

A. NEMA WD 1-1999 (R2005) - General Color Requirements for Wiring Devices.

B. NEMA WD 6-2002 - Wiring Devices - Dimensional Requirements.

1.3 SUBMITTALS

A. Submit under provisions of Division 1.

B. Certify compliance with CEC Article 110 - Requirements for Electrical Installations.

C. Quality Assurance/Control Submittals
   1. Manufacturer's Instructions
      a. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements contained in 26 05 00. Include instructions for storage, handling, Protection, examination, preparation, installation, and starting of Product.

1.4 SEQUENCING AND SCHEDULING

A. Sequence work under provisions of Division 1.

B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.

C. Determine connection locations and requirements.

D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

E. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Construction: Conform to NEMA WD 1. Provide plug equivalent in quality to receptacles provided under Section 26 27 26.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

C. Cord Construction: CEC, Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations. Minimum construction shall be 3 conductor, 12 AWG conductors.

D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
   1. Verify that equipment is ready for electrical connection, wiring, and energization.
   2. Conduit system fitting shall be in accordance with Section 26 05 35.
   3. Wiring and cabling shall be in accordance with Section 26 05 19.
   4. Boxes shall be furnished and fitted in accordance with Section 26 05 34.

3.2 INSTALLATION

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Provide and install conduit in accordance with Section 26 05 35.

C. Provide and install wire in accordance with Section 26 05 19.

D. Provide and install boxes in accordance with Section 26 05 34.

E. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.

F. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

G. Provide and install receptacle outlet in accordance with Section 26 27 26, where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

H. Provide and install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

I. Provide and install disconnect switches, controllers, control stations, and control devices as indicated.

J. Modify equipment control wiring with terminal block jumpers as indicated.

K. Provide interconnecting conduit and wiring between devices and equipment where indicated.

L. Electric Fan: Provide junction box attached to the underside of the prefabricated truss and trim at the ceiling.

3.3 CONSTRUCTION

A. Interface with Other Work

3.4 FIELD QUALITY CONTROL

A. Site Tests
   1. Demonstrate correct equipment operation to the Owner's Representative.

END OF SECTION

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SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Disconnect switches.

B. Related Sections
1. Section 26 05 00 - Common Work Results for Electrical.
2. Section 26 05 74 - Overcurrent Protective Devices.

1.2 REFERENCES

A. Submit under provisions of Division 1.

B. Closeout Submittals
1. Project Record Documents: Accurately record actual locations and mounting heights of all boxes.

1.3 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data
1. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

C. Quality Assurance/Control Submittals
1. Manufacturer's Instructions
a. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

D. Closeout Submittals
1. Operating and Maintenance Data: See Division 01.

1.4 MAINTENANCE

A. Extra Materials
1. Spare fuses, 10 percent or minimum of 3 of each type and rating of installed fuses.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - DISCONNECT SWITCHES

A. General Electric.

B. Siemens.

C. Square D.

D. Cutler-Hammer.

2.2 CIRCUIT DISCONNECT SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Designed to accommodate Class R fuses.
   1. Provide fuses in accordance with Section 26 05 74.

B. Non-fusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: NEMA KS 1; Type 1 indoor, 3R outdoor or type 4 where indicated. Baked enamel over rust-inhibiting primer.

2.3 MOTOR DISCONNECT SWITCHES

A. Provide disconnect for motors as indicated. Disconnects shall be horsepower rated, padlockable, heavy duty; Square D type, Heavy duty; Westinghouse Type H-600; Federal Pacific Class 1240; or approved equal, fused or nonfused as indicated, NEMA 1 indoors; NEMA 3R outdoors conforming to UL 98.
   1. Provide fuses in accordance with Section 26 05 74.
   2. Size fuses per motor manufacturer's recommendations.

B. Disconnects for small single-phase motors shall be a horsepower rated, padlockable, manual starter, with overloads, Westinghouse Type B101, Square D, Class 2510, Federal Pacific Class 4003, NEMA 1 indoors or NEMA 3R outdoors conforming to UL 98.

2.4 IDENTIFICATION OF DISCONNECT MEANS

A. Comply with CEC 110-22.

PART 3 EXECUTION

3.1 INSTALLATION

A. General
   1. Install disconnect switches where indicated in the Contract Documents.

B. Install fuses in fusible disconnect switches.

C. Install in accordance with manufacturer's instructions

END OF SECTION

SECTION 263100

PHOTOVOLTAIC COLLECTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. The work covered by this Section consists of furnishing all labor, supervision, tools, materials, equipment and performing all work necessary to furnish and install Photovoltaic (PV) system.

B. Related Sections
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600V and Below).

1.2 SUBMITTALS

A. Submittals shall conform to Section 26 05 00 and Division 1 of this specification.

B. Product Data
   1. Manufacturer's literature describing the product.
   2. Submit calculations supporting the battery and charger proposed.

C. Shop Drawings
   1. Elevation and plan view of the arrays showing overall dimensions and arrangement.
   2. PV schematic and wiring diagrams identifying the external connection points.

D. Quality Assurance/Control Submittals
   1. Operating and Maintenance Manuals:
      a. Operating and maintenance manuals including all shop drawings, parts lists and installation instructions.

E. Closeout Submittals
   1. Warranty Information
      a. Written warranty of PV arrays.

PART 2 PRODUCTS

2.1 PV ARRAYS

A. PV Array manufactured by Sunpower (Basis of Design): Substitution to comply with Section 01 25 00 – Product Substitution.

B. Inverter manufactured by Power One. (Basis of Design): Substitution to comply with Section 01 25 00 – Product Substitution.

PART 3 EXECUTION

3.1 INSTALLATION

1. Installation as shown in the drawings.
2. Anchor to framing and structural supports per manufacturer's recommendation.
3. Support in accordance with Section 26 05 29.
4. Fit conduits in accordance with Section 26 05 33 and as indicated.
5. Connect low voltage wiring as indicated.
6. Identify wiring in accordance with Section 26 05 53.
7. Ground and bond in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

1. Site Tests
2. Test each component for proper operation.

END OF SECTION

IMPORTANT SAFETY INSTRUCTION

AURORA PVI-5000/6000-TL

BCM.00163.0_AA

QUICK INSTALLATION GUIDE

Power-One® Renewable Energy Solutions

Quick Installation Guide

AURORA PVI-5000/6000-TL

This Quick Installation Guide is offered in addition to the full Technical Manual which can be found on the CD accompanying this guide and the Power-One Renewable Energy website at: http://www.power-one.com.

The installation is to be done according to the applicable local code regulations (National Electric Code (NEC), Canadian Electric Code (CEC), and/or other local codes and regulations).

This Quick Installation Guide applies to the following AURORA® UNO Inverter transformerless models:

PVI-5000-OUTD-US, PVI-5000-OUTD-US-A
PVI-6000-OUTD-US, PVI-6000-OUTD-US-A

All model dimensions are 41.4"H x 12.8"W x 8.6"D and weigh 59.5 lbs (27 kg).The -A model includes an Integrated PV AFCI Type 1 device for arc fault detection (AFD section 12) mounted on the rail in the wiring box (Figure 2). Wiring connections are the same for both models unless specified.

SAVE THESE INSTRUCTIONS - KEEP IN A SAFE PLACE!

This is a list of special safety symbols used in this guide. The symbol usage is as follows:

CAUTION: Indicates directions which must be understood and followed in order to avoid potential safety hazards, including equipment damage or personal injury.

DANGEROUS VOLTAGE: The product works with high voltages. During inverter operation, parts will be energized at voltage levels.

HOT TEMPERATURE: Some surfaces may become hot. Do not touch the product while it is in operation.

UL 1741 Standard for Safety for Inverters, Converters, Controllers and nterconnection System Equipment for use with Distributed Energy Resources. CSA-C22.2 No. 107.1-01 - General Use Power Supplies.

ELECTRICAL CONNECTION WARNINGS - The PV source conductors must be Listed PV wire per NEC 690.35. PV output conductors shall consist of sheathed (jacketed) multi-conductor cables or installed in an approved raceway and must be isolated from the enclosure and system grounding, as required by NEC 690.35 and is the responsibility of the installer.

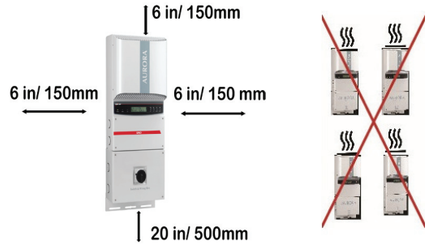
An external DC switch must be used if not integrated in the inverter. All models listed above have an integrated DC switch.

The inverter shall be connected only to a dedicated branch circuit provided with the maximum branch OCPD listed in the Technical data sheet, section **14**. To reduce the risk of fire, connect only to a circuit provided with 25A, 30A, 35A for PVI-5000-OUTD-US(-A) or 30A, 35A, 40A for PVI-6000-OUTD-US(-A) maximum branch circuit overcurrent protection in accordance with the NEC (ANSI/NFPA 70).

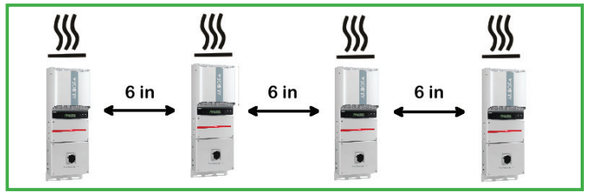
The installer and/or operator must protect the installation from access by the public and/or highlight with signs or notices the hazards of the equipment.

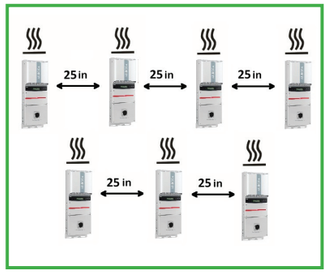
1. SELECT INSTALLATION LOCATION

Select a well-ventilated location sheltered from direct sun radiation or any other heat source (other inverters). Choose a location that allows unobstructed airflow around the inverter. Maintain minimum clearance distances shown.



For multiple inverter installations, position the inverters side-by-side or in a staggered arrangement so heat dissipation does not affect other inverters; maintain minimum clearances shown.



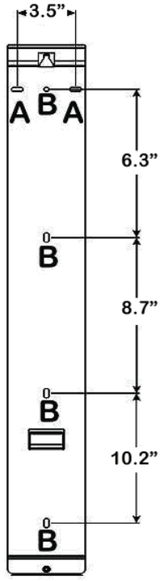


Package contents include:

1 AURORA Inverter
1 Mounting bracket
1 Hardware bag containing:
- **2** - Terminal connectors
- **4** - 6.3 x 70mm screws
- **4** - S x 10 wall plugs
- **1** - Red cable AWG #10
- **1** - Black cable AWG # 10
- **1** - 6 x 10mm machine screw
- **1** - 6mm flat washer
- **1** - Torx 20 wrench

1 Quick Installation Guide
1 CD with Software, Warranty, and full Technical Manual

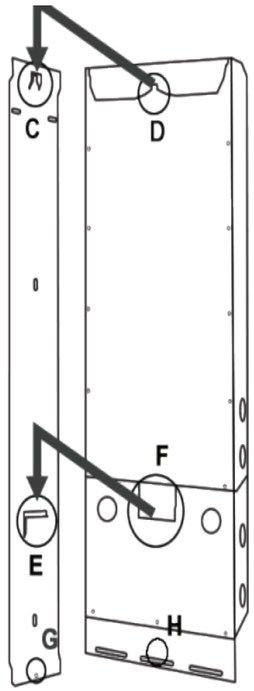
2. WALL MOUNTING



Using the mounting bracket as a template, locate and mark the desired mounting location.

Mount bracket to wall using four screws (provided) through holes **B**. Two additional screws can be used in position **A** if necessary.

Orient the bracket so the hooks **C** face out and up.



Hang the inverter on the bracket by lifting up and over the mounting plate, engaging the brackets **C-D** and **E-F** on the back.

Secure chassis bottom using machine screw and washer (provided) through center bottom hole **H**, engaging threaded insert in the bracket **G**. Add additional screws as necessary through bottom flange securing to mounting surface.

3. SWITCHBOX WIRING DETAIL

All -S and -A models have an integrated DC disconnect switch rated 600V/25A per contact. Maximum array DC voltage input to each MPPT circuit is 600 Vdc under any condition.

The switch disconnects the DC current from the PV panels in the "OFF" position. The inverter will stop producing power, but DOES NOT disconnect the AC from the grid.

Label	Description
A	DC conduit entry plastic threaded plugs trade size 3/4", 1"
B	AC conduit entry plastic threaded plugs trade size 3/4", 1"
C	DC Disconnect Switch
D	Signal cable opening with plastic threaded plug, 1/2" trade size
E	AC power cable opening with plastic threaded plug; trade size 1"
F	DC power cable opening with plastic threaded plug; trade size 3/4", 1"
H	Cover screws (4)
J	AC grid output terminals, NOTE 1
K	AC main ground, NOTE 2
L	Array PE ground, NOTE 1
M	AFD board (**-A only**)
MPPT1 and MPPT2 DC array input, Note 1	

NOTE 1: DC array wiring and ground terminals are spring pressure type and accommodate a wire size range of 16-6 AWG. AC output terminals are spring pressure type and accommodate a wire size range of 14-4 AWG.

NOTE 2: AC ground terminals are spring pressure type and accept 16-4 AWG wire.

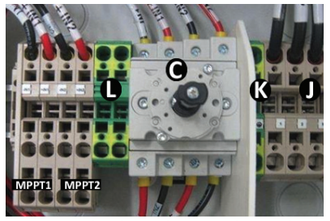


Figure 1: Switch and wiring box external/ internal view

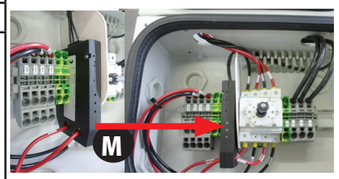


Figure 2: Switch and wiring box with AFD mounted on din rail -A model only (label M) AFD/ internal view

4. DC ARRAY CONNECTIONS - INDEPENDENT MODE

The inverter can be configured with two independent maximum power point tracking (MPPT) channels (Figure 3) or as a single channel with one MPPT by paralleling the two channels (Figure 4 and Figure 5). Switch S1 (Figure 6), is used to select parallel (**PAR**) or independent (**IND**) input mode.

To access the switchbox wiring and Switch S1, loosen the four captive screws on the front covers using the Torx wrench provided.

Before removing front covers, DC switch must be in the OFF position.

Using DC knockouts (Figure 1), connect raceway from the PV array conduits to the DC array. Pull array wiring through and connect to String 1 and String 2 as shown in Figure 3.

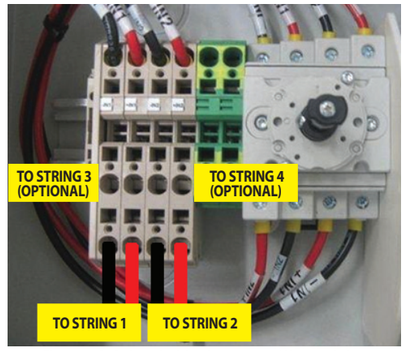
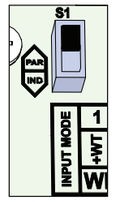


Figure 1: Switch and wiring box external/ internal view



Input Mode Switch S1 in IND (down) default position

Switch S1, located on the inverter connection board, Figure 6, is set in IND position (DOWN) by default.

Connect array to String 1 and String 2 input positions shown, running separate wires for POS and NEG for each array. Up to four strings can be connected in the INDEPENDENT mode.

To connect four strings, String 3 and String 4 are connected in addition to 1 and 2, running separate wires for POS and NEG for each array.

The maximum allowable input short circuit current limit of the PV array for each MPPT input channel is 22Adc.

Array equipment grounding must be installed per the requirements of the NEC and is the responsibility of the installer. The transformerless design requires that the PV array to be floating with respect to ground per NEC 690.35.

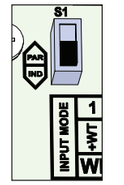
5. DC ARRAY CONNECTIONS - PARALLEL MODE

PARALLEL TWO INPUTS WHEN:

The current from PV array exceeds 22 Adc or the array power exceeds limit for single channel (section **14**). Refer to section **4** to access the switchbox wiring and and connect raceway from the PV array conduits to the DC array. Place switch S1 in the PAR position (UP) to configure inverter in parallel mode.

For -S versions only, in the switchbox, parallel the two MPPT inputs of terminal [–IN1 and –IN2] and [+IN1 and +IN2],using the two #10 AWG jumper wires (provided with inverter), 1 black and 1 red, connecting the input as shown in Figure 4.

For -A versions only, in the inverter box, parallel the two MPPT inputs of terminal [–IN1 and –IN2] and [+IN1 and +IN2] , using the two #10 AWG jumper wires (provided), 1 black and 1 red, connecting the input as shown in Figure 5.



Input Mode Switch S1 in PAR (UP) position

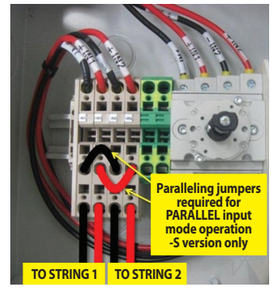


Figure 4: Parallel connection of DC array in the switchbox -S version

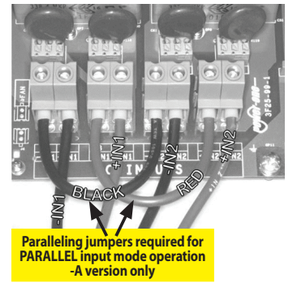


Figure 5: Parallel connection of DC array in the inverter box -A version

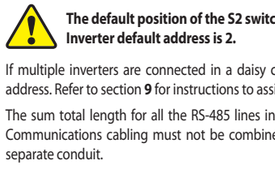


Figure 6: Inverter connection board

Label	Inverter Connection Board Details
P	Input Mode Selector Switch S1
Q	External alarm Out Terminals
R	RS-485 Terminal Block*
S	RS-485 RJ45 Connector**
T	RS-485 Line Termination Resistor Switch S2

*** REM-Remote control not available for -A model; terminal +R not accessible with AFD**

**** DO NOT CONNECT pin #4 when cabling units with AFD installed.**

6. AC GRID CONNECTIONS

Power-One DOES NOT provide AC output overcurrent protection; it is the responsibility of the end user to provide protection for the AC output circuit.

The AC grid wiring is connected through the inverter switchbox. Run an approved raceway between inverter and external AC disconnect switch. Make conduit entry through openings **B** or **E** shown in Figure 1. Connect AC wiring to switch box terminal block J and the main AC ground cable to switchbox terminal block **K**.

Table 1, (which is also found on a label in the switchbox), shows AC wiring connections according to the AC grid type; connect wiring to the numbered terminals based on selected grid type.

Size conductors per NEC Article 310; Use 90°C copper wire only. Terminal block accommodates wire size range of 14-4 AWG.

GRID STANDARD		L1 / L3 / L2			L1 / N / L2			L1 / L3 / N / L2		
		208V~ 3PH – Δ – 3W			240V~ SPLIT-PHASE			277V~ 3PH – Y		
TERMINAL		1	2	3	1	2	3	1	2	3
WIRE		L1*	L2*	-	L1	L2	N	N	L1*	-
AWG #		4-8			4-10			4-10		

Table 1: Grid standard

The default 240V-SPLIT-PHASE connection requires the grid Neutral to be connected for proper operation.

Before connecting the inverter to the grid, the grid type must be selected if it differs from the default 240V-SPLIT-PHASE setting. See Section 9 for instructions to change the default.

*** IMPORTANT: If several AURORA inverters are installed to a three-phase AC GRID, always distribute the inverters between the phases in order to reduce power imbalance between the phases. Always refer to the local standards.**

7. SIGNAL WIRING CONNECTIONS

Wiring for the RS-485 communication system and hardwired control options are routed through the switchbox (openings **D** of Figure 1) and into the main inverter chassis for termination. Alarm and monitoring connections are shown as items **Q** and **R** in Figure 6. If the terminal blocks are used, the signal RTN, +T/R and –T/R have to be cabled.

RS-485 cable must be NRTL certified and provided with additional protection by means of a non-metallic tubing. Use Belden #3106A (or eq.) cable for the RS-485 signals (RTN, ±T/R); ensure the ±T/R pair is connected through the cable twisted pair. Strip 1/4" insulation from all wires and connect to terminal block as indicated in Figure 7.

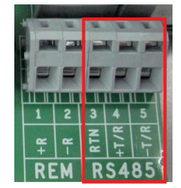
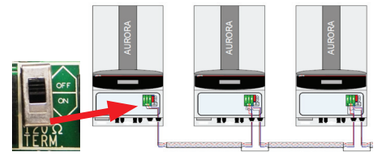


Figure 7: Signal wiring terminal block

Systems with multiple inverters require the RS-485 cable to be daisy chained inverter-to-inverter and there will be up to two RS-485 cables entering the inverter.

If a daisy chain connection is required for AFD installed inverters (-A models) use standard multiconductor RS-485 cable and connect the three RS-485 leads (-RTN, +T/R, -T/R) USING ONLY THE TERMINAL BLOCK. Do not use RJ45 connectors with AFD installations.

Locate Switch S2 on the inverter board (Figure 6, label **T**). Confirm the switch is up in the OFF position for every inverter in the chain except for the last inverter, which must be turned ON.



Last inverter in Daisy Chain needs to have the switch S2 pushed down into the ON position (Termination resistor active).

The default position of the S2 switch in the OFF position. Inverter default address is 2.

If multiple inverters are connected in a daisy chain, each unit must be assigned a different RS-485 address. Refer to section **9** for instructions to assign addresses using the display menu.

The sum total length for all the RS-485 lines in the system must be less than 1000m (~1100 yards). Communications cabling must not be combined into the AC or DC power conduits; run these in a separate conduit.

8. LED INDICATORS AND LCD

A two-line Liquid Crystal Display (LCD) located in the center of the front panel (Figure 8) provides inverter operating status and statistics, service messages, and alarm and fault indicators.

Three LED indicator lights on the left side of the display show system status:

- **POWER LED** (green) indicates the inverter is operating normally.
- **ALARM LED** (yellow) indicates a fault condition has been detected; a description will appear in the two-line display.
- **GFI LED** (red) indicates the inverter has detected a ground fault in the DC side of the PV system.

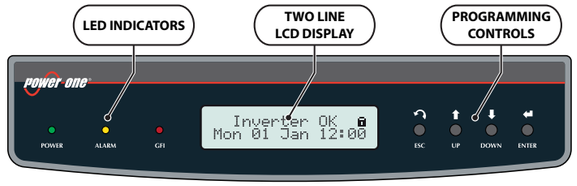


Figure 8: LED Indicators, controls, and two-line display

During operation the display cycles through available data points, updating every five seconds. Screens may be scrolled manually by pressing the UP and DOWN programming control keys (Figure 8).

Pressing the ESC key gives access to three main menus: ***Statistics - Settings - Info.***

Use the UP and DOWN keys to scroll between the menus and press ENTER to make a selection. To return to the preceding menu, press the ESC key.

The ***Statistics***, ***Settings*** and ***Info*** menus can be accessed with just the array connected. Some parameters (e.g. current, voltage, power, partial energy, lifetime energy etc.) are available only after grid connection.

Based on individual installations, the following parameters may need to be configured *prior to initial grid connection:*

Based on individual installations, the following parameters may need to be configured prior to initial grid connection:

- The RS-485 bus address for daisy chain (Section **9**),
- AC grid type if different from default (Section **9**),
- Adjustments to default frequency and disconnection time (Section **10**).

Complete descriptions of the data available on the display menus can be found in the full manual on the CD accompanying this guide or on the Power-One website.

9. SETTING RS-485 ADDRESS AND GRID TYPE

When multiple units have been connected in a daisy chain, the individual address will need to be assigned ***prior to grid connection*** using the display menu. The grid default type, 240V Split Phase, can also be changed ***prior to grid connection*** using the display menu.

With only the array connected, set the inverter's DC disconnect switch to ON. GREEN POWER LED will flash and YELLOW ALARM LED will be steady. The LCD will read *"Missing Grid"*. Press ESC to open the menus. Use the DOWN key to scroll to *Settings*, and press ENTER.

The Settings menu requires an access password.

Upon selecting ***SETTINGS*** the password screen will display; the default password is **0000**.

Pressing ENTER four times loads four zeroes on the display and opens the submenu (Figure 9).

The LCD has two visible text lines and the UP and DOWN control keys are used to scroll through the menu items. An arrow on the left side of the display highlights the current selection. Move the arrow UP or DOWN to the desired selection and press ENTER to access the associated submenu (Figure 9). To return to the preceding menu, press the ESC key.

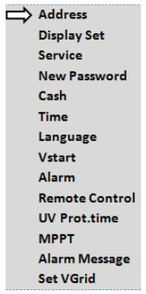
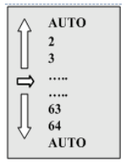


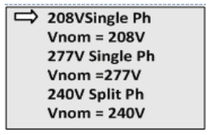
Figure 9: Settings submenus

Address and ***Set Vgrid*** are described below for use in installation. Complete descriptions of the submenus can be found in the full manual.

Address: Scroll to Address and press Enter to open the submenu. Address values are assigned manually using any value in the range [2 to 64]. Press the UP and DOWN keys to scroll through numbers and ENTER to select. Auto address = 1 and can be used only once; default address is set at 2.



Set VGrid: Scroll DOWN to Set VGrid and press ENTER to open the submenu. To choose a grid connection different from the 240V Split-phase default, use the UP or DOWN key to move the arrow to the desired selection and press ENTER. A second display screen will open; press ENTER to confirm selection or ESC to cancel.



12. ARC FAULT DETECTION -A MODELS ONLY

For –A models only, an autotest circuit is included in the module design of Power-One's DC ARC FAULT DETECTOR and INTERRUPTOR (AFDI) solution. The AFDI performs a self-test when the system is started, (ie every morning when sunlight is sufficient for grid connection). The inverter display shows the results of the self-test as described in section **11**.

During normal operation, (while the inverter in connected to the grid), the input current is continually measured and analyzed. If a DC arc fault is detected, the inverter is disconnected from the AC grid and the error message ***"ARC FAULT E050"*** will be shown on the inverter display.

Press and hold the ESC key for three seconds to clear the error which will start the self-test. If self-test results are OK (section **11**), the inverter will re-connect to the AC grid. If the DC arc fault is still present, the self test will result in error message ***"AF Self Test E053"***. Refer to the Troubleshooting section in the full technical manual for possible solutions to clear the error.

When the AFD protection trips continously an electrical arcing has taken place. In this case Power-One recommends a complete and accurate check of DC connections.

The AF self test can be manually started anytime using the disconnect procedure below:

1. Turn off the inverter (switching off both DC and AC switches) and,
2. Turn on both the DC and AC switches waiting for display communication of self-test result.

Once the inverter has been wired and connected to the grid, use the following procedures to disconnect:

1. Disconnect from the AC Grid by turning OFF the external AC switch or turning OFF the Over Current Protection Device (circuit breaker).
2. Disconnect the inverter from the PV array by turning OFF the external DC disconnect switch.

NOTE: ***When possible, turn off the AC switch first, however, there is no specific order for turning off the two switches.***

WARNING: After shutdown, wait at least 10 minutes before removing guards or covers in order to allow devices inside the unit to cool and any electrostatic charges and parasitic voltages to be discharged.

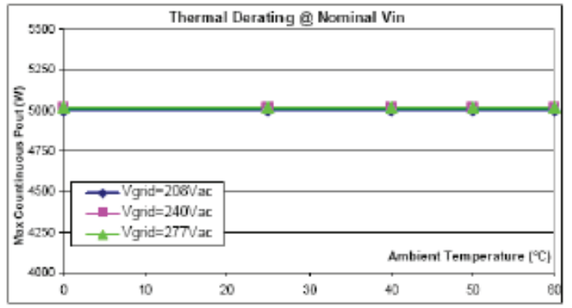
When removing the inverter covers, always check voltage levels at the DC input terminals and the AC output cables to ensure no hazardous voltages are present.

13. POWER DERATING

An inverter not in direct sunlight will output its maximum rated power up to at least 40C (almost 120F). Power reduction and temperature at which it occurs depend on many operating parameters other than ambient temperature, such as input voltage, grid voltage, and power available from the photovoltaic modules. The inverter can decrease power output during certain periods of the day according to these parameters.

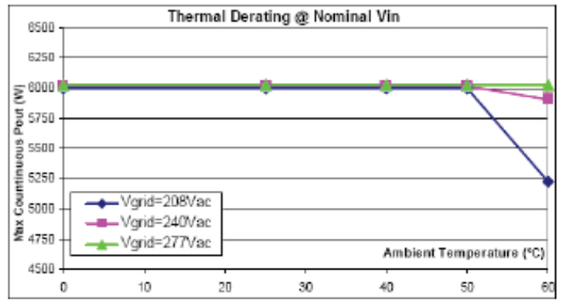
PVI-5000-OUTD-US

Operating ambient temperature at full power (without derating): -25 °C...+ 60 °C



PVI-6000-OUTD-US

Operating ambient temperature at full power (without derating): -25 °C...+ 60 °C



10. ADJUSTMENT OF DISCONNECT PARAMETERS

To adjust frequency and disconnect times to meet local utility requirements, modifications are made using the Aurora Manager-TL software. The software, with instructions to download and install on a PC, can be found on the CD included with this inverter. If an internet connection is available, check the product page at www.power-one.com/renewable-energy to download the most recent version of the software.

Prior to connecting to the grid, with the inverter's DC disconnect switch set to ON, a computer, with Aurora Manager-TL software installed, should be connected to the inverter via an RS-485-USB adapter (not included). The USB driver files and instructions for installation can be found on the CD included with the inverter or Power-One website. PC-inverter connection cable required is standard USB 2.0 cable, terminals type A and B.

p-1 Launch the application from the computer desktop icon. At ***Select Mode*** screen, enter the address assigned a single inverter and press ***Start***. For multiple inverters press ***Scan*** to search ***All Inverters***.

Grid parameters will be displayed. Default settings cause automatic disconnection from the grid in 160ms when line frequency is outside the range of 59.3 Hz < f < 60.5 Hz. ***Press the Write button*** to change values of desired parameters to those required by the local utility.

After frequency and disconnect time values have been adjusted, turn DC power OFF and ON to save new data. Changes to parameters must be made to meet the requirements of the local utility. Entry of improper values could cause inverter to shut down.

Cond.	Simulated utility source		Max.time (sec) at 60Hz[a] before cessation of current to the simulated utility
	Voltage (V)	Frequency (Hz)	
A	<0.50 V_{nor} [b]	Rated (60Hz)	0.16 (Fixed)
B	0.50 V_{nor} [b] ≤ V < 0.88 V_{nor} (Adjustable)	Rated (60Hz)	2 (Fixed)
C	1.10 V_{nor} [b] < V<1.20 V_{nor} (*) (Adjustable)	Rated (60Hz)	1 (Fixed)
D	1.20V_{nor} ≤ V (*)	Rated (60Hz)	0.16 (Fixed)
E	Rated	f > 60.5 Hz (Default) (Adj. 60.2 to 63.0 Hz)	0.16 (Default) (Adj. 0.16 to 300 sec)
F	Rated	f < 59.3 Hz (Default) (Adj. 59.8 to 57.0 Hz)	0.16 (Default) (Adj. 0.16 to 300 sec)
G	Rated	f< 57.0 Hz	0.16 (Fixed)
H	Rated	f > 63.0 Hz	0.16 (Fixed)

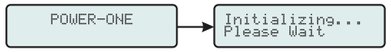
Table 2: Voltage/Frequency tolerances for Utility Interaction required by UL1741

11. START-UP AND GRID CONNECTION

The procedure for START-UP is as follows:

- Set the inverter's DC disconnect switch to ON.
- Set the AC disconnect switch to the inverter to ON.

Once both disconnects are closed, the inverter starts the grid connection sequence. These screens are initially displayed at start-up:



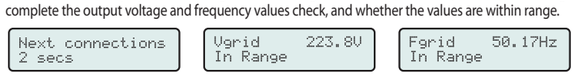
While the system checks for grid connection (Missing Grid) to be established, the ALARM LED turns steady YELLOW and the POWER LED flashes GREEN.

When waiting for sunlight (Waiting Sun) the POWER LED turns steady GREEN. As soon as conditions are met, the inverter is connected to the grid.

For –A versions ONLY, the display shows the AFD board self-test running and results upon connection. If the self-test results are OK, the inverter will continue to Next connections.

If a potential problem on the AFD board is detected, the self-test will result in error. Refer to the Troubleshooting section in the full technical manual for possible solutions to clear the error.

All versions will display the following screens during connection: the time (seconds) remaining to complete the output voltage and frequency values check, and whether the values are within range.



A final display screen for insulation resistance (RISO) is displayed. If all items described above test OK, the inverter is connected to the grid and displays the message, ***"Inverter OK"***, along with the date and time.

Clock malfunctioning, or other non-function related faults that do not interfere with operation, may be shown instead of the date and time.

14. TECHNICAL DATA TABLE

TECHNICAL DATA	VALUES	PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Nominal Output Power	W	5000			6000		
Maximum Output Power	W	5000			6000		
Rated Grid AC Voltage	V	208	240	277	208	240	277
Input Side (DC)							
Number of Independent MPPT Channels		2			2		
Maximum Usable Power for Each Channel	W	4000			4000		
Absolute Maximum Voltage (Vmax)	V	600			600		
Start - Up Voltage (Vstart)	V	200 (adj. 120-350)			200 (adj. 120-350)		
Full Power MPPT Voltage Range	V	200-530			200-530		
Operating MPPT Voltage Range	V	0.7xVstart-580			0.7xVstart-580		
Maximum Current (idcmax) for both MPPT in Parallel	A	36			36		
Maximum Usable Current per Channel	A	18			18		
Maximum Short Circuit Current Limit per Channel	A	22			22		
Number of Wire Landing Terminals Per Channel		2 Pairs			2 Pairs		
Array Wiring Termination		Terminal block, Pressure Clamp, AWG8-AWG4					
Output Side (AC)							
Grid Connection Type		1Ø/2W	Split-Ø/3W	1Ø/2W	1Ø/2W	Split-Ø/3W	1Ø/2W
Adjustable Voltage Range (Vmin-Vmax)	V	183-228	211-264	244-304	183-228	211-264	244-304
Grid Frequency	Hz	60			60		
Adjustable Grid Frequency Range	Hz	57-60.5			57-60.5		
Maximum Current (Iacmax)	A_{RMS}	27	23	20	30	28	24
Power Factor		> 0.995			> 0.995		
Total Harmonic Distortion At Rated Power	%	< 2			< 2		
Contributory Fault Current**	A_{pk}/A_{RMS}	36.25/25.63	36.5/25.81	31.75/22.45	36.25/25.63	36.5/25.81	31.75/22.45
Grid Wiring Termination Type		Terminal block, Pressure Clamp, AWG8 - AWG4					
Protection Devices							
Input		Yes					
Reverse Polarity Protection		Varistor, 2 for each channel					
Over-Voltage Protection Type		Pre start-up Riso and dynamic GFDI (Requires Floating Arrays)					
PV Array Ground Fault Detection							
Output		Meets UL 1741/IEEE1547 requirements			Meets UL 1741/IEEE1547 requirements		
Anti-Islanding Protection		Varistor, 2 (L1 - L2 / L1 - G)			Varistor, 2 (L1 - L2 / L1 - G)		
Over-Voltage Protection Type		30	40	35	30		
Maximum AC OCPD Rating	A	35	25				
Efficiency							
Maximum Efficiency	%	97.1			97.1		
CEC Efficiency	%	96	96.5	96	96	96.5	96.5
Operating Performance							
Stand-by Consumption	W_{NS}	< 8			< 8		
Night time consumption	W_{NS}	< 0.6			< 0.6		
Communication							
User-Interface		16 characters x 2 lines LCD display					
Remote Monitoring (1xRS485 incl.)		AURORA UNIVERSAL (opt.)					
Wired Local Monitoring (1xRS485 incl.)		PVI-USB-RS485_232 (opt.), PVI-DESKTOP (opt.)					
Wireless Local Monitoring		PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.)					
Environmental							
Ambient Air Operating Temperature Range	°F (°C)	-13 to +140 (-25 to +60)			-13 to +140 (-25 to +60)		
Ambient Air Storage Temperature Range	°F (°C)	-40 to 176 (-40 to +80)			-40 to 176 (-40 to +80)		
Relative Humidity	% RH	0-100 condensing			0-100 condensing		
Acoustic Noise Emission Level	db (A) @1m	< 50			< 50		
Maximum Operating Altitude without Derating	ft(m)	6560 (2000)			6560 (2000)		
Mechanical Specifications							
Enclosure rating		NEMA 4X			NEMA 4X		
Cooling		Natural Convection			Natural Convection		
Dimensions (H x W x D)	in (mm)	41.4 x 12.8 x 8.6 (1052 x 325 x 218)					
Weight	lb (kg)	< 59.5 (27.0)			< 59.5 (27.0)		
Shipping Weight	lb (kg)	< 78 (35.4)			< 78 (35.4)		
Mounting System		Wall bracket			Wall bracket		
Conduit Connections		Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4" 3 places side, front, rear)			Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4" 3 places side, front, rear)		
DC Switch Rating (Per Contact)	A/V	25 / 600			25 / 600		
Safety							
Isolation Level		Transformerless (Floating Array)			Transformerless (Floating Array)		
Safety and EMC Standard		UL 1741, CSA - C22.2 N. 107.1-01			UL 1741, CSA - C22.2 N. 107.1-01		
Safety Approval		cCSA$_{us}$			cCSA$_{us}$		
Warranty							
Standard Warranty	years	10			10		
Extended Warranty	years	15 & 20			15 & 20		
Available Models							
Standard - With DC Switch - Floating Array		PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Standard - With DC Switch - Floating Array and Arc Fault Detection (AFD)		PVI-5000-OUTD-US-A			PVI-6000-OUTD-US-A		

*** All data is subject to change without notice** ****Inverter can apply that much current – Breaker will open**

BCM.00163.0_AA

AURORA® UNO
Photovoltaic Inverters

PVI-5000/6000-TL

Technical Manual

Power-One
Renewable Energy Solutions LLC
3201 East Harbour Drive
Phoenix, AZ 85034

Contents

PART 1 INTRODUCTION & SAFETY

1.1 INTRODUCTION

This manual contains important instructions for the Power-One AURORA® UNO Inverter transformerless models indicated on the front cover of this manual that shall be followed during installation and maintenance of the inverter.

THE INSTALLER MUST READ THIS DOCUMENT IN ITS ENTIRETY BEFORE INSTALLING OR COMMISSIONING THIS EQUIPMENT.

1.1.1 PURPOSE

The purpose of this document is to support the qualified technician, who has received training and/or has demonstrated skills and knowledge in construction, to install and maintain this Power-One AURORA® UNO Photovoltanic (PV) Inverter.

This manual does not cover any details concerning equipment connected to the inverter such as the solar modules. Information concerning the connected equipment is available from the respective manufacturer.

1.1.2 MAINTENANCE AND SERVICE

Maintenance and service procedures must comply with the manufacturer's documentation, which includes this manual, written warranty information and where applicable, a master supplier agreement (MSA). For more detailed information, see Maintenance, Part 6. Call Power-One Customer Service at 877-261-1374 for a list of qualified service contractors.

1.1.3 FIGURES AND IMAGES IN THIS MANUAL

The photos in this manual may differ slightly from the final model shipped and the color of the components may not match those illustrated; however the information is still applicable.

1.1.4 WARRANTY INFORMATION

After inspecting the AURORA UNO Inverter, it is necessary to fill out the warranty information on this unit and submit it to Power-One. Submitting this information will register the unit with the manufacturer and the owner will receive technical updates regarding this Power-One photovoltaic inverter.

Warranty Conditions can be found on the Power-One Renewable Energy website located in the download section of the AURORA UNO inverter product page.

1.1.5 ADDITIONAL INFORMATION

More information on Power-One's AURORA UNO Inverter can be found at www.power-one.com.

1.2 SAFETY

IMPORTANT SAFETY INSTRUCTIONS!

SAVE THESE INSTRUCTIONS – KEEP IN A SAFE PLACE!

1.2.1 WARNINGS IN THIS DOCUMENT

This is a list of special safety symbols used in this manual that highlight potential safety risks and/or useful information. These symbols are as follows:

Symbol	Usage
	**DANGER** Indicates a hazardous situation that can result in deadly electric shock hazards, other serious physical injury, and/or fire hazards.
	**WARNING** Indicates directions which must be fully understood and followed in entirety in order to avoid potential safety hazards including equipment damage, or personal injury. The reader should stop, use caution and fully understand the operations explained before proceeding.
	**WARNING DANGEROUS VOLTAGE** The product works with high voltages. All work on the AURORA Inverter must follow the described documentation and must comply with all prevailing codes and regulations associated with high voltages. During inverter operation, parts will be energized at voltage levels.
	**WARNING HOT TEMPERATURE** Some surfaces may become hot. Do not touch the product while it is in operation.
	UL 1741 Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources. CSA CSA-C22.2 No. 107.1-01 - General Use Power Supplies.

1.2.1.1 *EQUIPMENT SAFETY WARNINGS*

In addition to the safety and hazard symbols, the following symbols are also used in this installation guide:

	System earth conductor (main grounding protective earth, PE)
	Alternating Current (AC) Value
	Direct Current (DC) Value
ø	Phase
	Grounding (earth)

The equipment has various labels. Those with a yellow background refer to safety concerns. Be sure to read all labels before beginning installation of the equipment. If any questions arise as to the meaning or intent of these notices, please contact Power-One Technical Support at 1-877-261-1374.

1.2.1.2 *General Installation Warnings*

The AURORA UNO Transformerless Inverter is designed and tested according to international safety requirements; however, certain safety precautions must be observed when installing and operating this inverter. Read and follow all instructions, cautions and warnings in this installation manual. If questions arise, please contact Power-One Technical Support at 1-877-261-1374.

All operations regarding transport, installation and start-up, including maintenance must be carried out by qualified, trained personnel and in compliance with all prevailing local codes and regulations.

1.2.1.3 *Assembly Warnings*

Prior to installation, inspect the unit to ensure absence of any transport or handling damage, which could affect insulation integrity or safety clearances; failure to do so could result in safety hazards.

Assemble the inverter per the instructions in this manual. Use care when choosing installation location and adhere to specified cooling requirements.

Unauthorized removal of necessary protections, improper use, incorrect installation and operation may lead to serious safety and shock hazards and/or equipment damage.

1.2.1.4 *Electrical Conection Warnings*

This grid-tied inverter system operates only when properly connected to the AC utility grid. Before connecting the services of the AURORA grid-tied inverter to the AC utility grid, contact the local power distribution company to receive the appropriate approvals. This connection must be made only by qualified technical personnel.

Wiring methods used should be in accordance with the National Electric Code, ANSI/NFPA 70 (NEC), Canadian Electric Code (CEC), and/or other local codes and regulations.

WARNING: To reduce the risk of fire, connect only to a circuit provided with 25A, 30A, 35A for PVI-5000-OUTD-US(-A) or 30A, 35A, 40A for PVI-6000-OUTD-US(-A) maximum branch circuit overcurrent protection in accordance with the National Electric Code (ANSI/NFPA 70). See Maximum AC OCPD requirement in Appendix, Table 7-1.

The AURORA UNO inverter should be connected only to a dedicated branch circuit

Power-One DOES NOT provide AC output overcurrent protection; it is the responsibility of the end user to provide protection for the AC output circuit..

All photovoltaic source and output circuit conductors shall have disconnects complying with the NEC, Section 690, Part III. A DC switch should be inserted when not integrated in the inverter. The –S and –A models have an integrated DC switch.

1.2.2 SAFETY INSTRUCTIONS

Warning – These servicing instructions are for use by qualified personnel only.
To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions.

Danger - Be sure all flammable materials including construction items are away from the unit. Do not install the inverter in or near potentially explosive areas.

CAUTION - The AURORA is designed without an isolation transformer and is intended to be installed per NFPA 70, 690.35 with an ungrounded PV array. These models have no grounded input conductors.

The installer and/or operator must properly protect the installation from access by the public and/or highlight with signs or notices the potential hazards of the equipment, e.g., magnetic fields, hazardous voltages, high temperatures, possibility of discharges, generic hazard, etc.

1.2.2.1 *General Information*

The equipment has been manufactured in accordance with the strictest accident-prevention regulations and supplied with safety devices suitable for the protection of components and operators. . Inform the manufacturer about non-standard installation conditions.

Maintenance operations must be carried out according to the Maintenance section in Part 6 of this manual.

It is essential to provide operators with correct information. They must therefore read and comply with the technical information given in the manual and in the attached documentation.

The instructions given in the manual do not replace the safety devices and technical data for installation and operation mounted on the product. They do not replace the safety regulations enforced in the country of installation and common sense rules.

Do not use the equipment if any operating anomalies are found. Avoid temporary repairs.

All repairs should be carried out using only qualified spare parts, which must be installed in accordance with their intended use and by a licensed contractor or authorized Power-One Service representative.

Liabilities arising from commercial components are delegated to their respective manufacturers.

1.2.2.2 *Thermal Hazard*

WARNING - Depending upon ambient temperatures during operation and immediately following shut down, surface temperatures on the cooling fins (heat sink) and some areas of the chassis may be extremely hot to the touch.

Prior to touching any part of the inverter use care to ensure surfaces and equipment are at touch-safe temperatures and voltages before proceeding.

The customer and/or installer must appropriately instruct all personnel who may come near the equipment, and highlight, if necessary with notices or other means, the hazardous areas or operations: magnetic fields, hazardous voltages, high temperatures, possibility of discharges, generic hazard, etc.

Anytime the inverter has been disconnected from the AC utility grid, use extreme caution as some components can retain charge sufficient to create a shock hazard and may need time to dissipate the charge. To minimize occurrence of such conditions, comply with all corresponding safety symbols and markings present on the unit and in this manual.

1.2.2.3 *Location Of Safety Notices*

Note the location of safety notices on the AURORA UNO Inverter for notification and protection. They are located on both side panels of this unit.

Labels must not be hidden with external objects or parts such as rags, boxes, or other such equipment. They should be cleaned periodically and always maintained in view.

1.2.2.4 *Clothing and Protective Devices*

Appropriate Personal Protective Equipment (PPE) must be worn at all times when servicing this equipment under any conditions which may subject personnel to hazardous voltages or temperatures that are not touch-safe.

All operations on the equipment should be performed with properly electrically insulated instruments.

1.2.3 APPROPRIATE USAGE

The AURORA Inverter is a photovoltaic inverter that converts direct current of a connected PV array into alternating current and feeds that power into the AC utility grid.

This AURORA Inverter is designed for outdoor use, but can be used indoors if installed to specified environmental and mounting parameters stated in this manual, and adherence to the National Electric Code. (See Environmental Conditions below and General Installation Conditions in section 2.2.1 for more information.)

1.2.3.1 *Conditions of Use*

This inverter utilizes a transformerless design and requires connected array(s) to be floating with respect to ground; it can be used only with photovoltaic modules that do not require one of the terminals to be grounded.

The DC and AC operating currents **MUST NOT** exceed the limits documented in the technical specifications.

The inverter is certified for use only with photovoltaic arrays connected to its input channel(s). Do not connect batteries or other types of power sources.

The inverter can be connected to the utility grid in qualified countries only.

The inverter can only be used if all the technical requirements in this manual are observed and applied.

1.2.3.2 *Environmental Conditions*

Adverse environmental conditions can lead to a reduction in performance. The equipment should be installed outdoors, but only in environmental conditions indicated in this manual. Care must be taken to provide adequate ventilation if installed indoors.

1.2.3.3 *Improper or Prohibited Use*

The following actions are dangerous, not consistent with acceptable practice and will negate the product warranty if implemented:

- Installing the equipment in environments with flammable conditions.
- Using the equipment with safety devices not working or disabled.
- Using the equipment or parts of the equipment by connecting it to other machines or equipment, unless otherwise expressed.
- Modifying areas that are operator restricted and/or altering parts of the equipment in order to vary the performance or change its protection.
- Cleaning with corrosive products that may corrode parts of the equipment or with products that might generate electrostatic charges.
- Using or installing the equipment or parts of it without having read and correctly interpreted the contents of this manual.
- Blocking airflow to the cooling fins (e.g., warming or drying rags) on the unit or accessory parts is dangerous and could compromise the inverter operation due to overheating.

1.3 ARC FAULT DETECTION (AFD)

The 2011 National Electric Code (NEC) and 2013 Canadian Electric Code (CEC) includes a new condition that requires a photovoltaic system with a DC voltage greater than 80V, and which is on a building or whose DC conductors enter a building, must be equipped with a Listed device which can detect a DC arc fault and interrupt the circuit. This functionality is commonly referred to as a DC AFCI.

Power-One's DC ARC FAULT DETECTOR and INTERRUPTOR (AFDI) solution is based on Digital Signal Processor (DSP) technology. The AFDI module has two independent channels, designed to accommodate the two independent MPPT channels associated with all Aurora String inverters, and has two current sensors and associated circuitry to identify the presence of a series DC arc fault at the input of either inverter MPPT channel.

The DC AFDI module performs a self-test every time the system is started and the inverter display shows the result, which can only be pass or fail. If it fails, an error code will be displayed and the inverter will not connect to the grid. If it passes, the inverter connects and operates normally.

If a DC arc fault is detected during normal operations, the inverter disconnects from theAC grid. The DC arc fault error is indicated on the inverter display screen and lock out of inverter operation is initiated until the fault is manually reset.

Refer to section 5.2, ARC FAULT DETECTION SELF-TEST ERRORS (-A MODELS ONLY)**, for display error messages and instructions to reset fault conditions or manually start the self-test procedure.**

1.4 AVAILABLE VERSIONS

This document applies only to the following **transformerless** inverter models which can be divided into three groups according to their rated output power of 5.0 kW or 6.0 kW. For inverters of equal output power, the differences between models are the presence of Arc Fault Detection. A description of the two models can be found in Table 1-1.

5.0 kW	**PVI-5000-OUTD-US** **PVI-5000-OUTD-US-A**	• **Unit Weight: 59.5 lbs/27 kg** • **Shipping Weight: 78 lbs/35.4 kg** • **Dimensions H x W x D):** **41.4" x 12.8" x 8.6"/** **1052mm x 325mm x 218mm**
6.0 kW	**PVI-6000-OUTD-US** **PVI-6000-OUTD-US-A**	

Table 1-1: Available versions

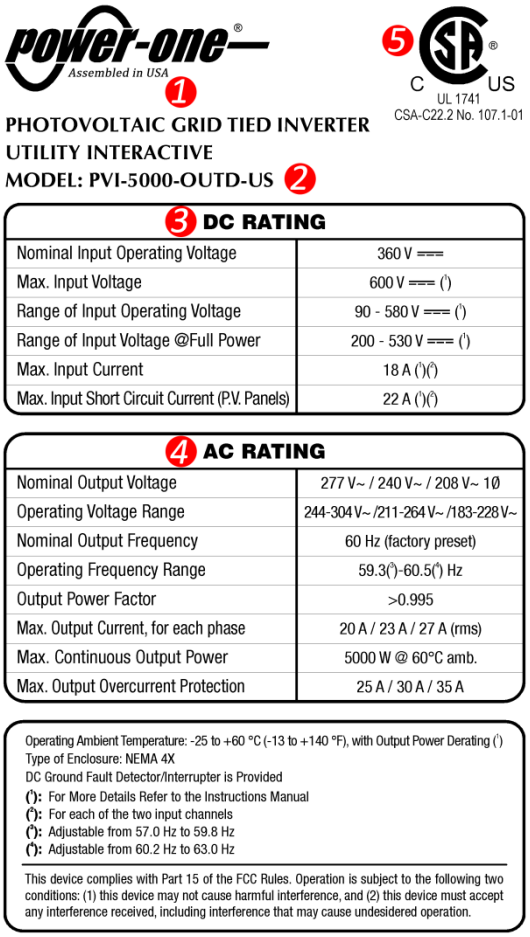
PVI-5000/6000-OUTD-US	Wiring box with integrated DC Disconnect Switch
PVI-5000/6000-OUTD-US-A	Wiring box with integrated DC Disconnect Switch and Integrated PV AFCI Type 1 device for arc fault detection (AFD)***Section 1.3**

1.4.1 PRODUCT NAMEPLATE

The product namplate is affixed to the inverter and provides the following information:

1. Product origin
2. Model name
3. DC input data
4. AC ouput data
5. Certification

Technical data reported in this manual does not substitute the data mentioned on the labels affixed to the equipment.


power-one®
Assembled in USA
1
5
C SA US
UL 1741
CSA-C22.2 No. 107.1-01
PHOTOVOLTAIC GRID TIED INVERTER
UTILITY INTERACTIVE
MODEL: PVI-5000-OUTD-US 2

3 DC RATING

Nominal Input Operating Voltage	360 V ⎓
Max. Input Voltage	600 V ⎓ (1)
Range of Input Operating Voltage	90 - 580 V ⎓ (1)
Range of Input Voltage @Full Power	200 - 530 V ⎓ (1)
Max. Input Current	18 A (1)(2)
Max. Input Short Circuit Current (P.V. Panels)	22 A (1)(2)

4 AC RATING

Nominal Output Voltage	277 V~ / 240 V~ / 208 V~ 1Ø
Operating Voltage Range	244-304 V~ /211-264 V~ /183-228 V~
Nominal Output Frequency	60 Hz (factory preset)
Operating Frequency Range	59.3(3)-60.5(4) Hz
Output Power Factor	>0.995
Max. Output Current, for each phase	20 A / 23 A / 27 A (rms)
Max. Continuous Output Power	5000 W @ 60°C amb.
Max. Output Overcurrent Protection	25 A / 30 A / 35 A

Operating Ambient Temperature: -25 to +60 °C (-13 to +140 °F), with Output Power Derating (1)
Type of Enclosure: NEMA 4X
DC Ground Fault Detector/Interrupter is Provided
(1): For More Details Refer to the Instructions Manual
(2): For each of the two input channels
(3): Adjustable from 57.0 Hz to 59.8 Hz
(4): Adjustable from 60.2 Hz to 63.0 Hz

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesidered operation.

Figure 1-1: Sample nameplate for PVI-5000-OUTD-US

1.4.2 PRODUCT LABEL

The product label shown below is affixed to the inverter and provides the following information:

1) Manufacturer code
2) Model code
3) Serial number
4) Week/Year of production

Figure 1-2: Sample product label

The labels attached to the equipment must NOT be removed, damaged, stained, etc. They are not to be hidden with external objects or parts such as rags, boxes, or other such equipment. They should be cleaned periodically and always maintained in view.

1.4.3 CONDITIONS OF WARRANTY

Warranty conditions are described in a certificate supplied with the equipment. The term of warranty coverage begins the day of final commissioning or six months after the date of purchase, which ever comes first. It is required of the purchaser to report to Power-One the date of commissioning.

With regard to upholding the warranty, this manual references actions that are required and other actions that are recommended. Required actions are those items which must be fulfilled in order to maintain the warranty. Recomendations are suggested by Power-One as best practices but their implementation or adherance to these items are not required under the terms of the warranty.

The warranty is understood to be valid if the user observes what is described in this manual. Any conditions deviating from those described must be explicitly agreed upon in writing.

After inspecting the TRIO Inverter, fill out the warranty information and submit it to Power-One. Submitting this information will register the unit with the manufacturer and the owner will receive technical updates.

Warranty exclusions can be found on the Power-One Renewable Energy website in the download section of the AURORA TRIO product page.

PART 2 UNPACK AND SELECT INSTALLATION LOCATION

2.1 GENERAL CONDITIONS

DO NOT stack with equipment or products other than those indicated.

2.1.1 TRANSPORTATION AND HANDLING

Transportation of the equipment, especially by road, must be carried out by suitable ways and means for protecting the components (in particular, the electronic components) from violent shocks, humidity, vibration, etc. During handling, do not make any sudden or fast movements that can create dangerous swinging.

2.1.2 LIFTING

Power-One packages and protects individual components using suitable means to make their transport and subsequent handling easier. Due to the weight and complexity of this equipment, Power-One recommends the process of loading and unloading of this equipment be done by an experienced or specialized staff knowledgeable in material handling.

The inverter weight is about 60lbs/27kg and is susceptible to tipping. It requires two or more persons to mount to bracket. Use proper lifting techniques to avoid personal injury.

Where indicated or where there is a provision, eyebolts or handles can be inserted and used as lifting points. Do not lift several units or parts of the equipment at the same time, unless otherwise indicated.

2.1.3 INCOMING INSPECTION

It is the customer's responsibility to examine the condition of the unit shipped. Upon receipt of Power-One's AURORA UNO Inverter, please perform the following check:

- Inspect the shipping container for any external damage.
- Inventory the contents against the listing of Table 2-1 and verify receipt of all items. Use care not to discard any equipment, parts, or manuals.
- Call the delivering carrier if damage or shortage is detected.
- If inspection reveals damage to the inverter, contact the supplier, or authorized distributor for a repair/return determination and instructions regarding the process.

Table 2-1: Package Contents

QTY	Description	QTY	Description
	Aurora Inverter	1	Bag containing hardware:
1	Inverter Mounting plate	4	6.3 x 70 screws
1	Quick Installation Guide	4	S x 10 wall plugs
1	Certificate of Warranty	1	Red Cable AWG 10
1	CD-ROM containing: Communication Software, Technical Manual, WarrantyTerms and Conditions	1	Black Cable AWG 10
		1	6 x 10mm machine screw
		5	6mm flat washer
		1	Torx 20 wrench

2.2 SELECT INSTALLATION LOCATION

2.2.1 GENERAL INSTALLATION CONDITIONS

The installation must be done by qualified installers and/or licensed electrician according to the applicable local code regulations (National Electric Code, Canadian Electric Code and other).

The installation must be carried out with the equipment disconnected from the grid (power disconnect switch open) and with the photovoltaic panels shaded or isolated.

2.2.1.1 *Environmental Check*

- See Technical Data in Appendix, Part 7 to check the environmental parameters to be observed (degree of protection, temperature, humidity, altitude, etc.).
- Do not install inverter where it could be exposed to direct sunlight to avoid unwanted power reduction due to an increase in the internal temperature of the inverter.
- Do not install in small closed spaces where air cannot circulate freely.
- Due to acoustical noise (about 50dBA at 1 m) from the inverter, do not install in rooms where people live or where the prolonged presence of people or animals is expected.
- To avoid overheating, always make sure the flow of air around the inverter is not blocked.
- Do not install in places where gases or flammable substances may be present.

2.2.2 INSTALLATION POSITION

Install on a wall or strong structure capable of bearing the weight. Select a well-ventilated location sheltered from direct sun radiation.

Choose a location that allows unobstructed airflow around the inverter. Do not install in small closed rooms where air cannot circulate freely.

Install in safe place where all switch handles and controls remain easy to reach and meet height requirements of the applicable electrical code. Install at eye level so the display and status LEDs can be easily seen.

Ensure sufficient working area in front of the inverter to allow removal of the wiring box cover and easy access for servicing the inverter.

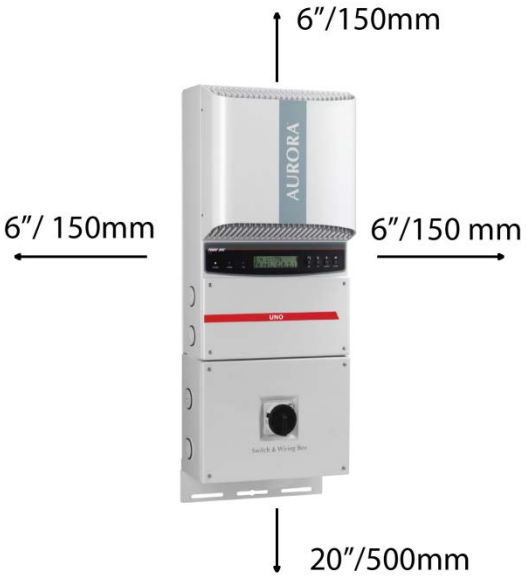


Figure 2-1: Minimum Clearances around the AURORA Inverter

For multiple-inverter installations, position the inverters side-by-side or in a staggered arrangement so heat dissipation does not affect other inverters. Maintain minimum clearances shown.

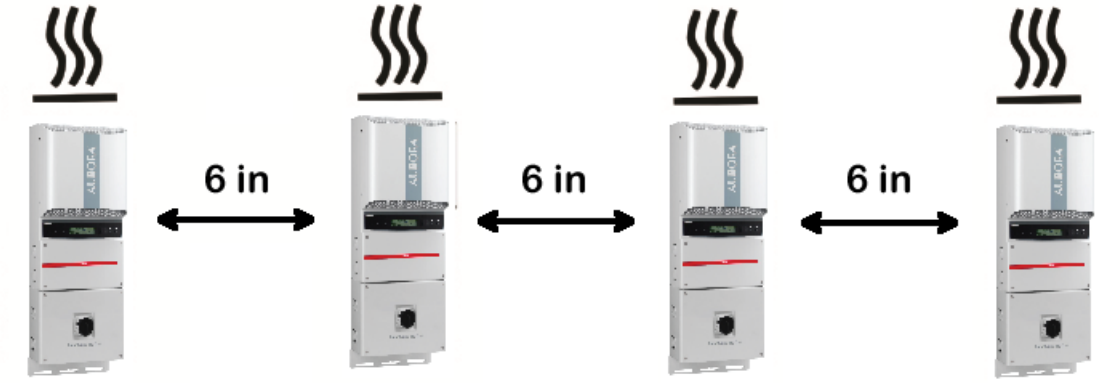
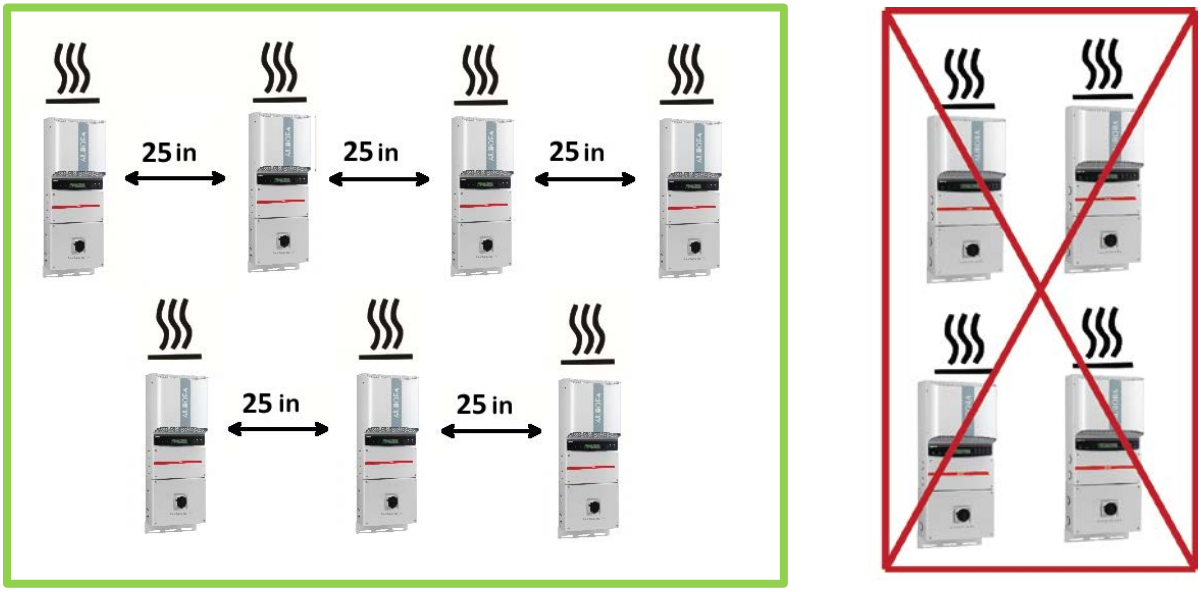


Figure 2-2: Side-by-side arrangement with minimum clearances around the AURORA Inverter



Acceptable Arrangement **Unacceptable Arrangement**

Figure 2-3: Staggered arrangement avoiding heat from other inverters

Tilted mounting (±5° from vertical) is acceptable, but will reduce heat dissipation and may result in self-derating. When possible, mount the AURORA UNO Inverter vertically. For other mounting orientations consult with Power-One.

Do not mount the AURORA Inverter where exposed to direct sun radiation or any other heat source. This includes heat generated by other AURORA Inverters; otherwise, the inverter will self-protect, resulting in derated power output.

When the ambient temperature rises above 113°F/ 45°C the inverter may self-derate the output power. For full power of AURORA UNO Inverter (no derating), be sure the airflow through the heat sink is clear. Blockages will result in less than expected power output.

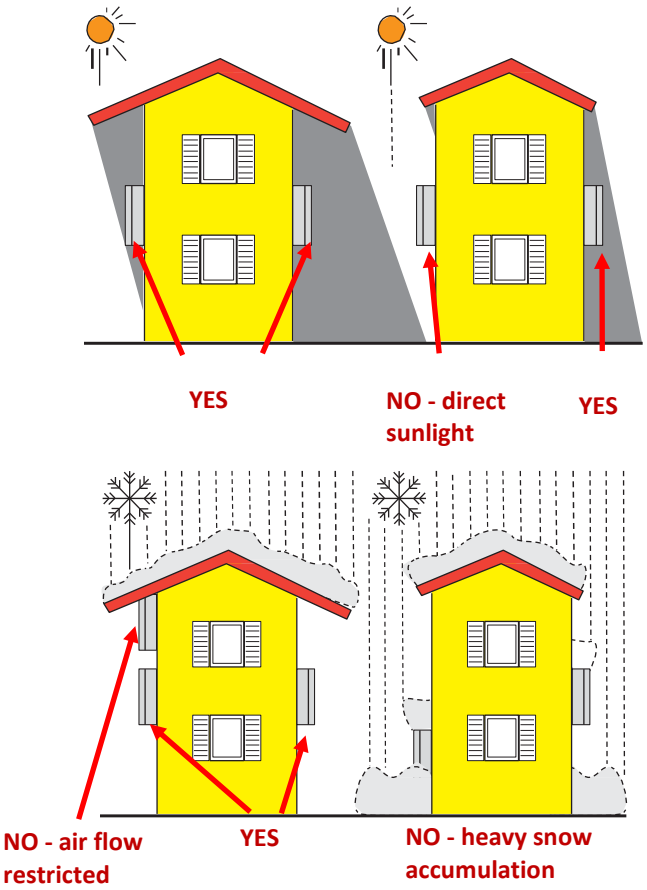


Figure 2-4: Outdoor installation examples

PART 3 MOUNTING & WIRING

3.1 WALL MOUNTING

The Aurora inverter should be mounted vertically as shown in Figure 2-1 and Figure 2-4 above. Always follow the relative mounting instructions provided in this section.

Included in the shipping package is a mounting kit with four screws and four wall plugs provided for mounting the metal bracket to a concrete wall. The screws should be mounted in the four holes present in the bracket (shown as position B in Figure 3-1 below). If needed to ensure stability of the inverter, use two additional screws in the two holes shown as position A below.

If the installation is done on a concrete wall, the wall plugs provided should be used and the mounting holes in the wall should have a 10mm diameter and 75mm depth. When the wall is made of a different material (other than concrete) the installation should be done using adequate mounting material. Power-One recommends always using stainless steel screws.

Follow the steps below for mounting the Aurora inverter.

Step 1: Using the mounting bracket as a template, locate and mark the desired mounting location.

Step 2: Using the four screws provided, level and mount the bracket to the surface using mounting holes **B**. Two additional screws can be used in **A** if necessary.

Step 3: Orient the bracket such that the hooks in position **C** face outward and upward.

Step 4: Hang the inverter on the mounted bracket by lifting the unit up and over the mounting plate. Guide the inverter and switchbox brackets engaging the brackets **C-D** and **E-F** on the back of the inverter.

Step 5: Secure chassis bottom using the machine screw and washer provided through center hole **H.** Engage the threaded insert in the bracket **G**. Add additional screws as necessary through bottom flange securing to mounting surface.

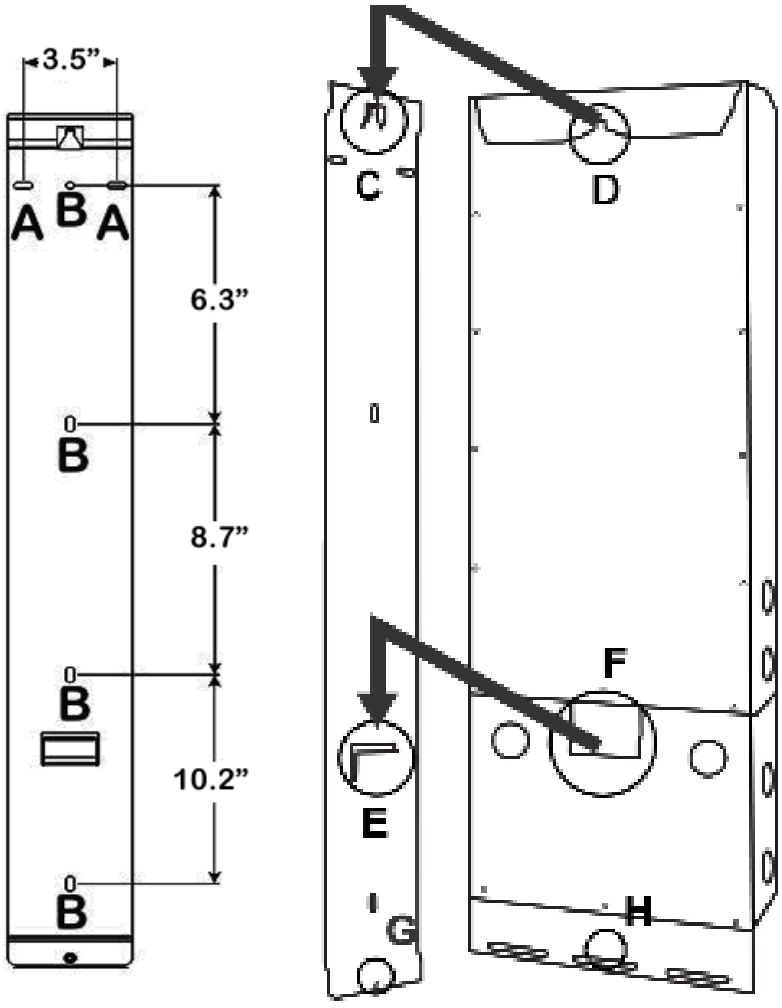


Figure 3-1: Bracket and Mounting Details

3.2 WIRING DETAILS

This section is dedicated to initial installation wiring of the AURORA Inverter and assumes the unit has been physically mounted in its final location, but not yet wired.

If the inverter has been previously wired and connected to the PV array and/or the AC grid, refer to Part 4: Operations for disconnection procedures.

Failure to comply with these instructions can result in safety hazards and may lead to possible injury to personnel and/or equipment damage.

3.2.1 CONSIDERATIONS BEFORE PERFORMING ELECTRICAL CONNECTIONS

All field wiring connected to signal circuits (WIND, ALARM, REM & RS485) should be routed inside the chassis and secured such that it cannot contact either the AC or DC wiring. It is prudent to use a UL/CSA certified cable (e.g., Belden #3106A), and it is good practice to protect the external run of this cable by means of a suitable raceway.

On the AC output side an automatic magnetothermic switch should be inserted between the Aurora inverter and the distribution grid. The models in this manual have an integrated DC switch which is rated for 25A/600V.

WARNING: Always respect the nominal ratings of voltage and current defined in the Appendix, (Part 7) when designing your system. Observe the following considerations in designing the photovoltaic system:

- **Maximum array DC voltage input to each MPPT circuit: 600 Vdc under any condition.**
- **The maximum allowable input short circuit current limit of the PV array for each MPPT input channel is 22Adc.**
- **To reduce the risk of fire, connect only to a circuit provided with 25A, 30A, 35A for PVI-5000-OUTD-US(-A) or 30A, 35A, 40A for PVI-6000-OUTD-US(-A) maximum branch circuit overcurrent protection in accordance with the National Electric Code (ANSI/NFPA 70). See Maximum AC OCPD requirement in Appendix, Table 7-1.**

3.2.2 Removing the Front Covers

To access the wiring terminals in the inverter and switchbox, the inverter cover and switchbox cover must be removed. Refer to Figure 3-2 below.

- To remove the front cover of the **inverter** compartment, loosen the four captive screws indicated using the Torx screwdriver provided.
- To remove the front cover of the **switchbox,** loosen the four captive screws indicated using the Torx screwdriver provided in the box with the inverter.
- When connection operations are completed and the unit is connected, re-install the front covers and tighten the cover screws with at least 1.5Nm (13.2 in-lbs) torque to ensure proper waterproof sealing.

Figure 3-2: Front Access Panel Location

WARNING: Before removing front covers, the DC switch must be in the OFF position.

3.2.3 AURORA SWITCH BOX DESCRIPTION

To access the wiring components inside the switchbox , loosen the four cover panel captive screws s and remove the cover panel.

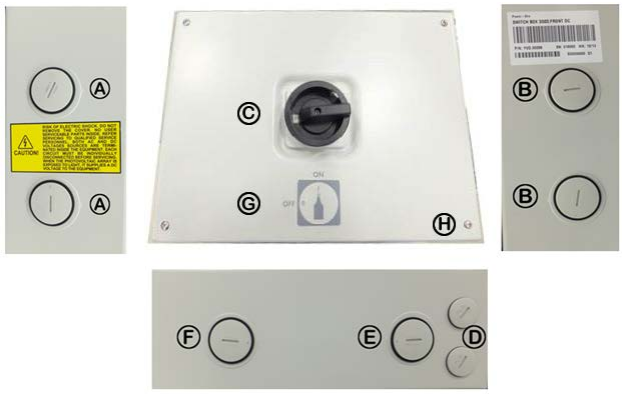


Figure 3-3: DC switchbox with front switch external chassis view

Figure 3-4: DC switchbox with bottom switch external chassis view

Table 3-1: Switchbox External Parts Summary

Label	Description	Label	Description
A	DC power cable KO's; trade size 3/4", 1"	E	AC power cable opening with plastic threaded plug; trade size 1"
B	AC power cable KOs; trade size ¾", 1"	F	DC power cable opening with plastic threaded plug; trade size ¾"/ 1"
C	DC Disconnect Switch	G	Silkscreen ON/OFF legend
D	Signal cable opening with plastic threaded plug, ½: trade size	H	Cover screws (4)

The DC disconnect switch disconnects the DC PV panel current from the photovoltaic panels when the switch is in "OFF" position. The inverter will stop producing power, but it *DOES NOT* disconnect the AC from the grid.

To disconnect the inverter from the AC grid, an AC switch (not included in this AURORA Inverter's switchbox) must be disconnected.

It is the responsibility of the installer to provide external disconnect switches and Overcurrent Protection Devices (OCPD) as required by National Electric Codes and other prevailing regulations.

The DC switch is a four-pole device rated at 25A/contact. If operating in the parallel mode, feed both sets of input terminals to ensure the total input current is divided between the two sets of switch contacts to guarantee the switch current specifications are not exceeded.

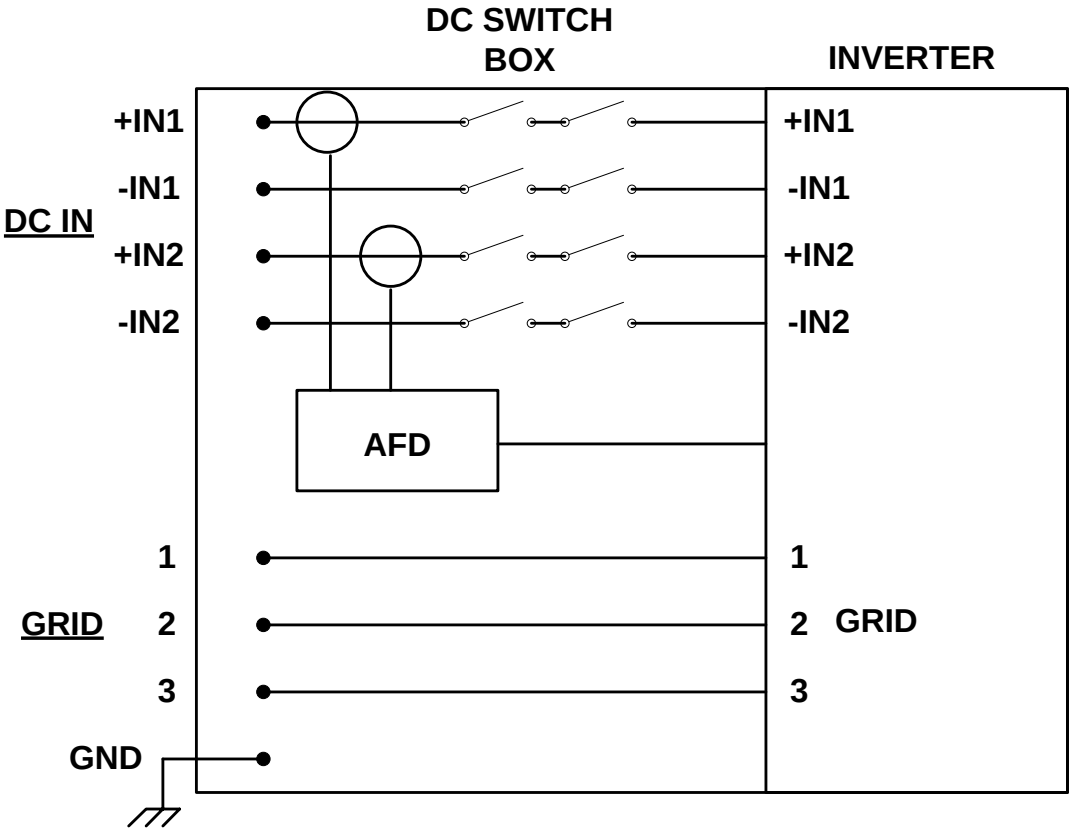


Figure 3-5: Switch Box DC Electrical Schematics - **AFD available on –A models only*

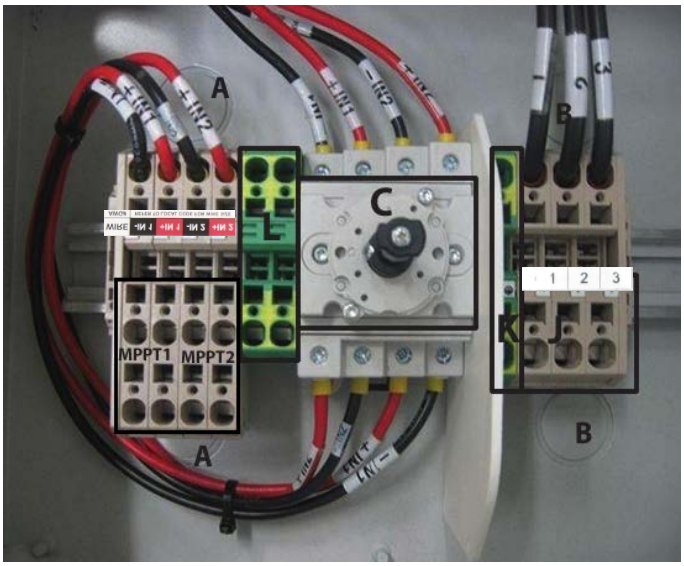


Figure 3-6: Front switch – wiring box details

Figure 3-7: Bottom switch – wiring box details

The -A versions include an Arc Fault Detector (AFD) mounted on the rail in the wiring box.

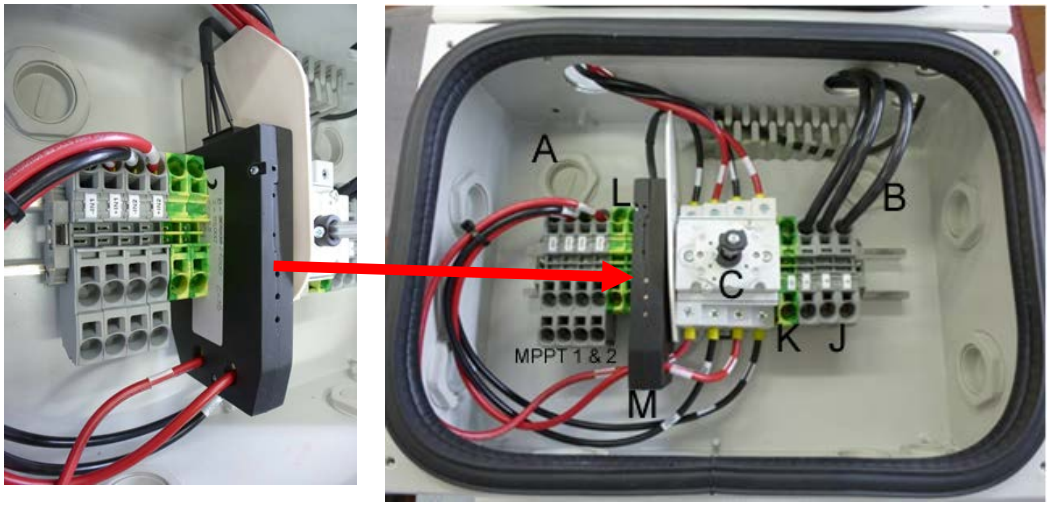


Figure 3-8: Front switch – wiring box details with AFD

Table 3-2: Switchbox Internal Parts Summary

Label	Details	Label	Details
A	DC conduit entry KOs, ¾" and 1" trade size	F	DC power cable opening with plastic threaded plug; trade size ¾"/ 1"
B	AC conduit entry KOs, trade size ¾", 1"	J	AC grid output terminals, Note 1
C	DC Disconnect Switch	K	AC main ground ⏚, Note 2
D	Signal cable opening with plastic threaded plug, ½: trade size	L	Array PE ground, Note 1
E	AC power cable opening with plastic threaded plug; trade size 1"	M	AFD board (**-A models only**), Note 3
MPPT1	DC Array MPPT 1 input, Note 1	MPPT2	DC Array MPPT 2 input, Note 1

Notes:

1. Front switch model array wiring and ground terminals are spring pressure type. Use tool provided to open the terminal and insert wire. These terminals accept 16-6 AWG wire. Front switch model AC output terminals are spring pressure type. Use tool provided to open the terminal and insert wire. These terminals accept 14-4 AWG wire. Bottom switch model array wiring and AC output terminals use a standard terminal block. The wire range accepted is 18-4 AWG wire. There is a copper ground bus bar provided which accepts 14-6 AWG wire.

2. Ground terminals for the front switch model are spring pressure type and accept 16-4 AWG wire. Use tool provided to open the terminal and insert wire. Bottom switch model has two ground connections. One copper bus bar that accepts 14-6 AWG wire .

3. All wiring instructions for –A models are same as those given for -S although AFD board (M) may not be shown

Table 3-3: Bottom switch torque values for terminal bloc and ground lug

Model PVI-4.2(3.6, 3.0)-OUTD-S-US	Wire Size AWG	Temp C	Torque Nm/In-lbs	
AC and GND field wiring terminals	4-8	90	2.26	20
DC field wiring terminals	4-8	90	2.26	20
Grounding Electrode	4-8	90	5.08	45

3.2.1 INVERTER CONNECTION BOARD

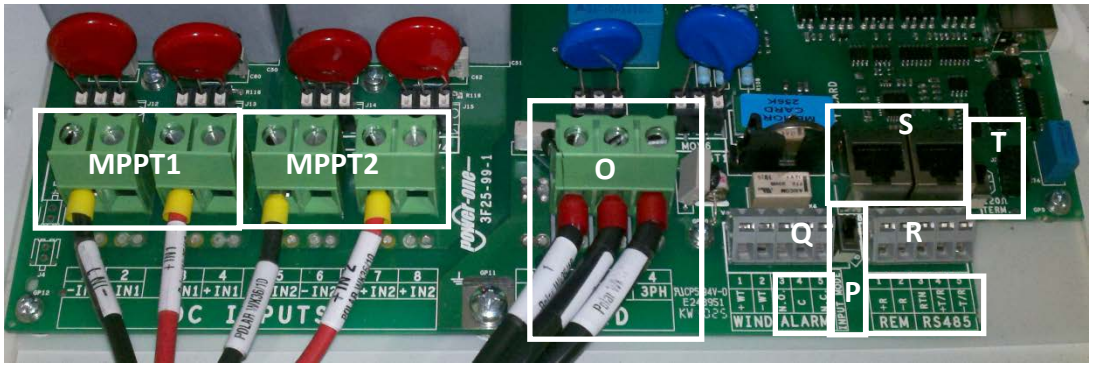


Figure 3-9: Main Inverter Connection Board

Label	Details	Label	Details
MPPT1	DC Array: MPPT 1 input , Note 1	**Q**	External Alarm Out Terminals, Note 4
MPPT2	DC Array: MPPT2 input, Note 1	**R**	RS485 Bus Connection Via Terminals, Note 4
O	AC Grid Output Terminals, Note 2	**S**	RS485 Bus Connection Via RJ45 Connector
P	In Mode Input Selector Switch S1 IND or PAR MPPT Operation	**T**	RS485 Termination Switch S2

Notes:

1. Terminals accept wire range up to #6AWG (Refer to local code for appropriate wire size); torque to 13in-lb.
2. Terminals accept wire range up to #4AWG (Refer to local code for appropriate wire size); torque to 13in-lb.

3.3 ELECTRICAL CONNECTIONS

All PV source and output circuit conductors must have disconnects and over-current protection devices (OCPD) complying with NEC, Section 690, Part III and Section 690.9.

The PV source conductors must be Listed PV wire per NEC 690.35. PV output conductors must consist of sheathed (jacketed) multi-conductor cables or installed in an approved raceway and must be isolated from the enclosure and system grounding, as required by NEC 690.35 and is the responsibility of the installer.

The maximum allowable input short circuit current limit of the photovoltaic array for each MPPT input channel is 22 Adc.

To prevent electrocution hazards, all the connection operations must be carried out with the external AC disconnect switch downstream of the inverter (grid side) open and locked out.

This section describes initial installation procedures for DC and AC wiring connections. This version has an integral DC disconnect switch and associated switchbox.

- Typical system connection for this inverter is shown in Figure 3-10.
- Relevant wiring connections are shown above in section 0.
- Refer to Figure 3-3 and Figure 3-4 to locate the designated entry locations for the conduits from the DC array and to the AC grid. Make sure the appropriate knockouts are used in order to maintain required spacing between wiring groups.

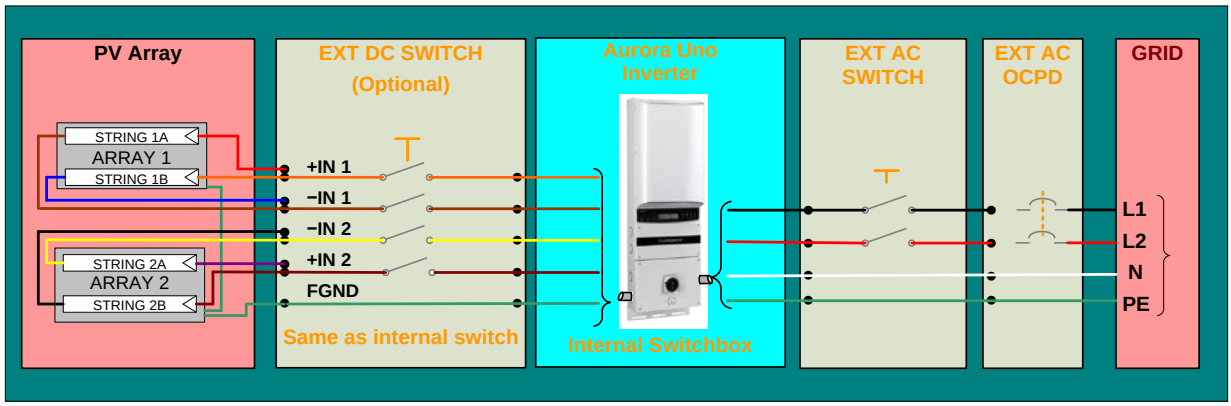


Figure 3-10: Electrical connection diagram

WARNING: Verify that the DC voltage in the Switchbox has the correct polarity and is within the operational range.

The array equipment grounding shall be installed per the requirements of the National Electric Code and it is responsibility of the installer.

3.3.1 DC ARRAY CONNECTIONS

To eliminate the potential for shock hazard during the connection procedure for the PV array wiring, either open-circuit all PV circuits prior to entry to the inverter and/or cover all panels with dark or opaque material in order to eliminate hazardous voltage at the terminals of the array wiring.

Connect array to String 1 and String 2 input positions shown below, running separate wires for POS and NEG for each array.

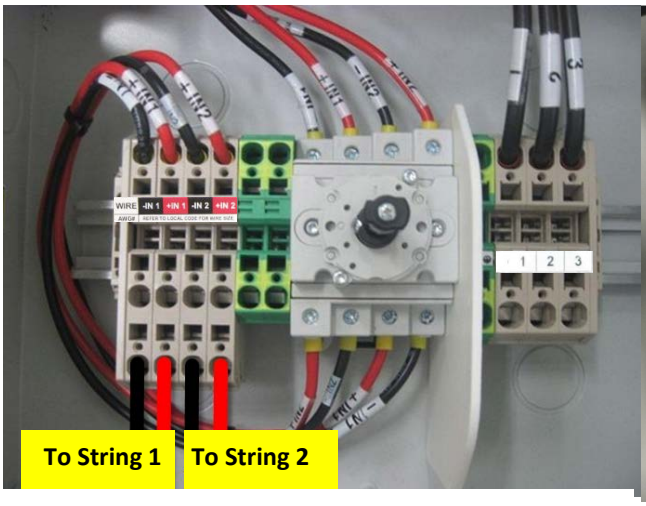


Figure 3-11: Front switch Independent configuration

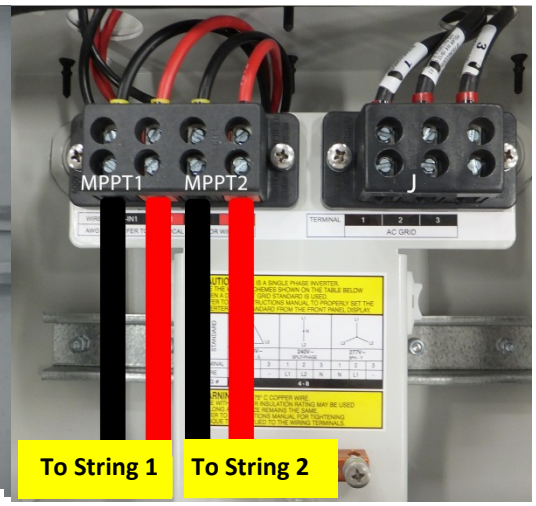


Figure 3-12: Bottom switch Independent configuration

The Aurora inverter can be configured with an independent MPPT (maximum power point tracking) for each DC input channel or with the two input DC channels connected in parallel (operating with one MPPT).

3.3.1.1 *Independent or Parallel Configuration of Dual Inputs*

The AURORA Inverters have dual inputs with independent maximum power point tracking (MPPT) control. When operated in the dual input mode, the inverter can optimize two independent arrays. Each of the inputs is dedicated to a separate array with independent maximum power point tracking (MPPT) control. This means that the two arrays can be installed with different positions and orientation. Each array is controlled by an independent MPPT control circuit.

The two trackers can also be configured in parallel to handle power and/or current levels higher than those a single tracker can handle. The S1 switch located on the inverter connection board (Figure 3-9) is used to select the parallel or independent input mode. Switch S1 is set to independent mode as default.

The following section details how to connect the inverter in parallel mode.

3.3.1.2 *Independent Connection (default)*

The default position of the S1 switch is set in the IND mode (DOWN position).

In this mode up to four strings can be connected (two per input) without need of external combiner fusing.

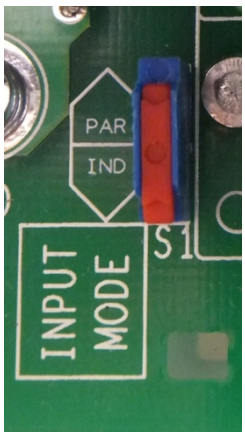


Figure 3-13: S1 Switch in IND position (independent mode)

3.3.1.3 *Parallel Connection*

It is necessary to parallel the two inputs when:

- the current from the photovoltaic array exceeds 22Adc,
- or the array power exceeds the limit for the single channel (see Appendix Table 7-1: Technical Data),
- or when there is a consistent unbalance of power between two arrays.

To operate the inverter in the parallel MPPT mode place S1 switch UP in the PAR position.

Note that only two strings can be directly connected to the inverter in this mode. If more than two strings are required, all strings must be combined in an external fused combiner box, or the IND mode must be used.

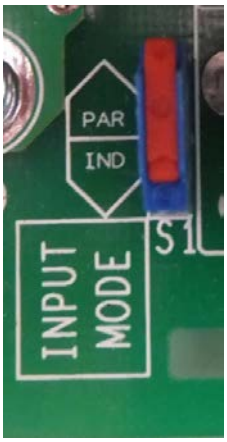


Figure 3-14: S1 Switch in PAR position (parallel mode)

Front switch wiring box - parallel configuration –S versions only

In the switchbox, parallel the two MPPT inputs of terminal [–IN1 and –IN2] and [+IN1 and +IN2] as shown in Figure 3-15 using the two #10 AWG jumper wires provided (1 black and 1 red cable) to connect the input.

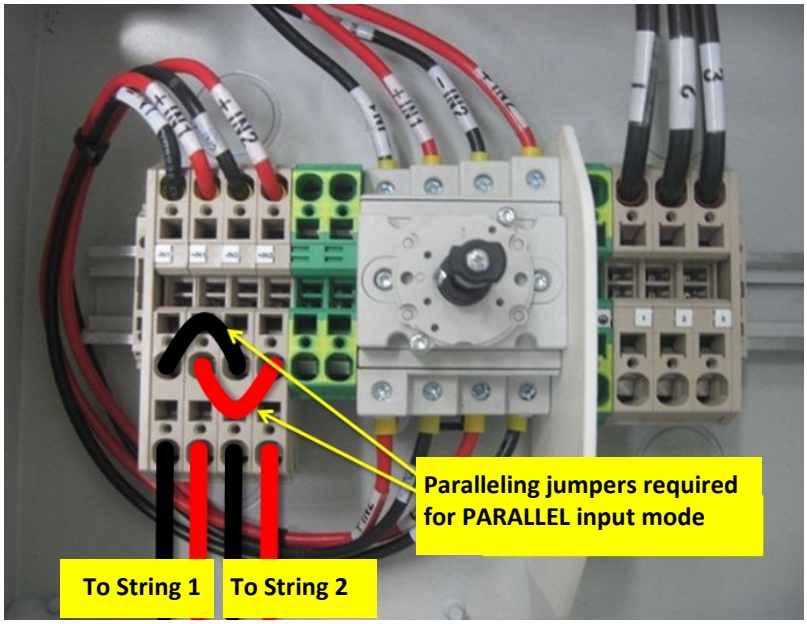


Figure 3-15: Front switch jumpers parallel MPPT input configuration –S versions only

When Arc Fault Detection (AFD) is installed, the paralleling must be done inside the inverter (Figure 3-16).

Bottom switch wiring box - parallel configuration and Front switch –A versions only

In the inverter box, parallel the two MPPT inputs of terminal [–IN1 and –IN2] and [+IN1 and +IN2] as shown in Figure 3-16, using the two #10 AWG jumper wires provided (one black and one red cable) to connect the input.

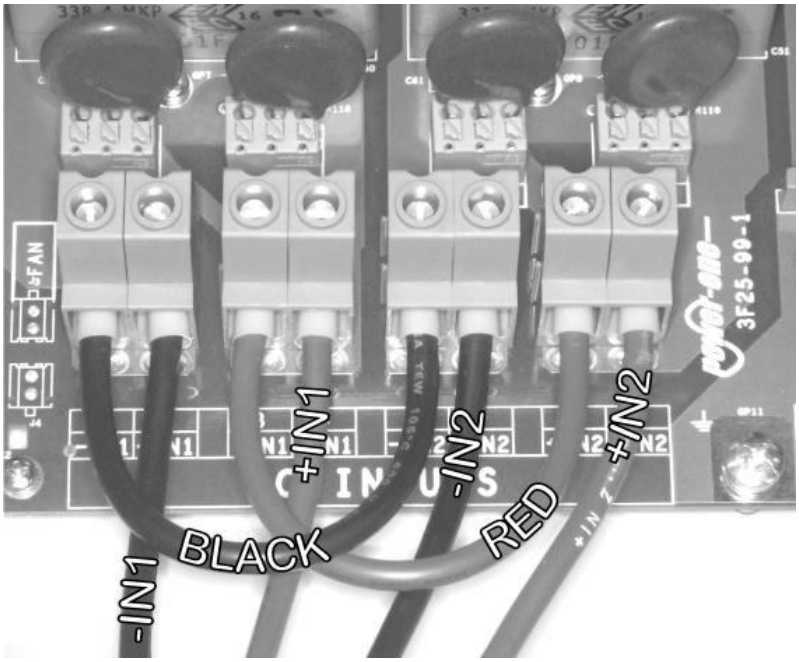


Figure 3-16: Bottom switch jumpers for parallel MPPT Configuration and Front switch –A versions only

3.3.1 AC GRID CONNECTIONS

AC output overcurrent protection is not provided with the Aurora; it is the responsibility of the end user to provide overcurrent protection for the AC output circuit.

AC grid wiring is connected through the inverter switchbox. Run an approved raceway between inverter and external AC disconnect switch. Make conduit entry through openings (**B** or **E**) shown in Figure 3-3 and Figure 3-4.

Connect AC wiring to switch box terminal block (**J**) and the main AC ground cable to switchbox terminal block **(K)**.

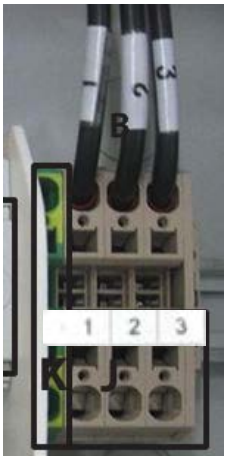
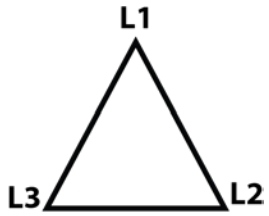
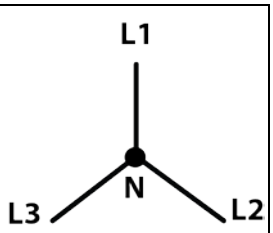


Figure 3-17: Front switch AC Grid terminal

Figure 3-18: Bottom switch AC grid terminal

Table 3-4, which is also on a label within the switch box, shows AC wiring connections according to the AC grid type; connect wiring to the numbered terminals as shown. **Size conductors per NEC Article 310; use only 75°C or 90°C. copper wire only. Terminal block accommodates conductor type shown and wire size range per** Table 3-2 **and** Table 3-3**.**

Table 3-4: AC Grid Standard

GRID STANDARD									
	208V~ 3PH – Δ – 3W			**240V~** SPLIT-PHASE			**277V~** 3PH – Y		
TERMINAL	1	2	3	1	2	3	1	2	3
WIRE	L1*	L2*	-	L1	L2	N	N	L1*	-

(*) IMPORTANT: If several Aurora inverters are installed to a three-phase AC GRID, always distribute the inverters between the phases in order to reduce power imbalance between the phases. Always refer to the local standards.

The default AC grid connection, 240V$_{RMS}$/3W/Split-Phase, requires the Neutral terminal to be connected to the grid neutral conductor for proper operation.

Before connecting the inverter to the grid the grid type must be selected if it differs from the default 240V-SPLIT PHASE setting. See Operations, section 4.2.5.2 - Set Vgrid, for instructions to change the default.

3.3.2 SIGNAL WIRING CONNECTIONS

The AURORA Inverters have remote monitoring and capabilities which are accessed externally using an RS485 communication port. The AURORA Inverter is provisioned with the communication capability as a standard feature, and all that is needed for remote monitoring is monitoring hardware which connects to the RS485 port and collects the available data.

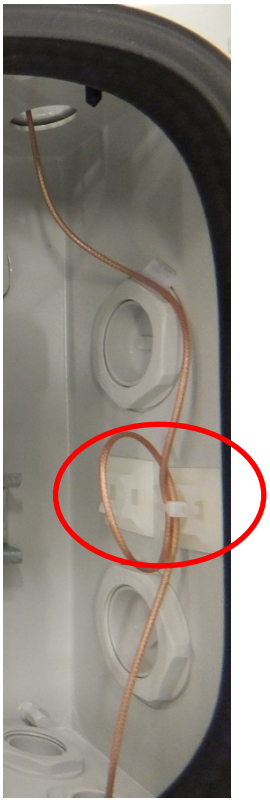
3.3.2.1 *Connection of RS485 and Alarm Contact*

Route the cables through the switchbox and into the inverter keeping close to right wall of the switchbox chassis.

- For versions with a front-facing switch, route the cables through the plastic guides located on the side of the wiring box.

- For versions with a bottom switch, use the plastic clamp to secure to the wall.

Front switch – cable guides



Bottom switch – cable clamp

Refer to Figure 3-19. Locate the terminals for the alarm and monitoring connections within the inverter. The following sections provide detail of the RS-485 wiring connections.

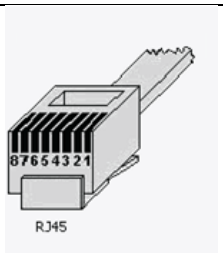
3.3.2.2 *Alarm contact connection*

Three connections are provided to drive an external alarm comprised of a common contact, a normally open contact and a normally closed contact. To cable the alarm contact, use a three-wire or two-wire cable.

3.3.2.3 *Connection of RS485 Serial Port*

Inside the inverter the communication line cabling can be done using the RJ45 connectors or using the terminal block (Figure 3-19). If the terminal blocks are used, the signal RTN, +T/R and –T/R have to be cabled. If the RJ45 plugs are used, the pin-out is reported in Table 3- 1 below.

Table 3- 1: RJ45 Connectors



Pin #	Signal Name	Description	Notes
1,2,6,8	N/U	Not Used	-
3	+TR	+ Data Line	1
4	+R	DO NOT CONNECT	2
5	-TR	- Data Line	1
7	RTN	Signal Return	1

1. Required for RS485 communication.
2. Required for Remote OFF control; **DO NOT CONNECT pin #4 when cabling units with AFD installed.**

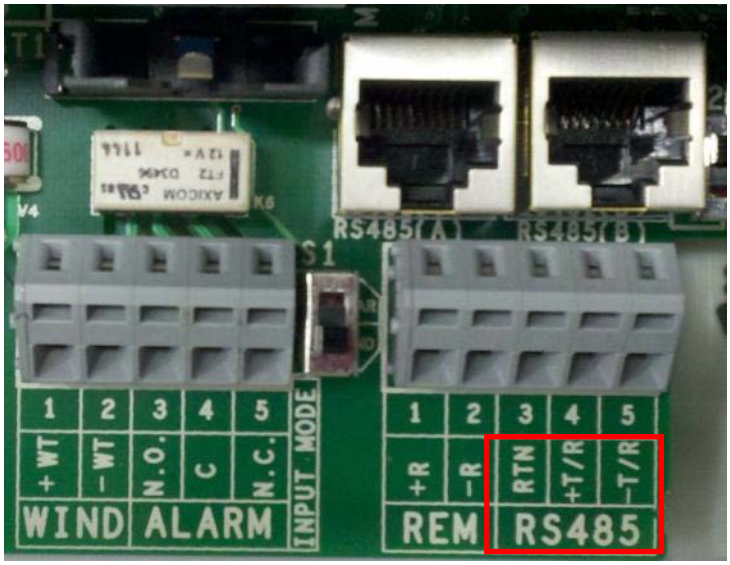
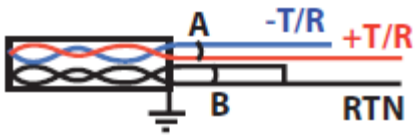


Figure 3-19: Standard RS485 connection

CAUTION HAZARDOUS VOLTAGE – The ±WT (WIND) terminals are not isolated and can have hazardous voltages present. These terminals must not be utilized for any purpose in a PV installation (for use with wind models only).

Use a cable designed for use with RS-485 communications such as Belden 3106A, which is a data cable wire with one twisted pair, one ground conductor, and a shield with drain wire (equivalent). The shield wiring must be continuous as it passes from one inverter to the next on a daisy chain, but must not be tied to ground at these junctions.



Signal	Symbol	Pair	Cable
Positive data	+T/R	A	1
Negative data	-T/R	A	2
Reference	RTN	B	1+2

Figure 3-20: Data cable for use with RS-485 communications

Continuity of the shield in the RS-485 cable is important for low noise on the line; this is particularly so for large plants with multiple inverters. For best results the shield must be tied to ground at only one point on the line, typically at one end or the other.

The shield wiring must be continuous as it passes from one inverter to the next on a daisy chain, but must not be tied to ground at these junctions.

The SH terminal is provided as a floating tie point for this purpose. It allows shields (drain wires) from incoming and out-going daisy chain cables to be secured together but not grounded.

If using standard multi-conductor RS-485 cable, connect the three RS-485 leads (-RTN, +T/R, -T/R) to the terminal block corresponding points (Figure 3-19).

3.3.3 Daisy Chain Multi-Unit Configuration

The RS-485 terminal block or RJ45 connectors are used in a multi-unit daisy-chain.

If a daisy chain connection is required for AFD installed inverters use standard multiconductor RS-485 cable and connect the three RS-485 leads (-RTN, +T/R, -T/R) using only the mating connector in Figure 3-13. Do not connect pin 4 of RJ45 connector in any case with AFD installed inverters.

3.3.3.1 *Connection & Cabling*

Per the RS-485 standard, it is possible to connect up to 31 AURORA Inverters on one RS-485 bus link; however, the feasibility of this arrangement is dependent on the type of cabling used for the link and the workmanship of the bus connections. Also, most data loggers are limited by the manufacturer as to the total number of slave units connectable. Please verify all aspects of the intended communication system and components before attempting to install a monitoring system.

The recommended length of total communication cable line for all inverters in the system is 1,000 meters [1094 yards] or less, and this distance capability depends strongly on the cable type used and installation workmanship.

Depending on the type of computer used, the cable line adaptor can be RS-485-RS232 or RS-485 to USB.
In order to ensure optimum communication on the RS-485 line, Power-One recommends connecting the RS-485 converter to a location between the first unit in the daisy chain or multi-unit system configuration and the computer; not in between two inverters in the series.

Using the appropriate cable, connect all the Aurora Inverter units.RS-485 lines in a series according to the daisy chain method.

On the last inverter in a daisy chain, or on a single inverter, activate the termination resistance of the communication line by moviings switch S2 down into the ON position. All other inverters in the daisy chain will have the switch S2 up in the OFF position (Figure 3-22).

NOTE:

- The **ON** position means the RS485 port is inactive.
- The **OFF** position means the RS485 port is active.

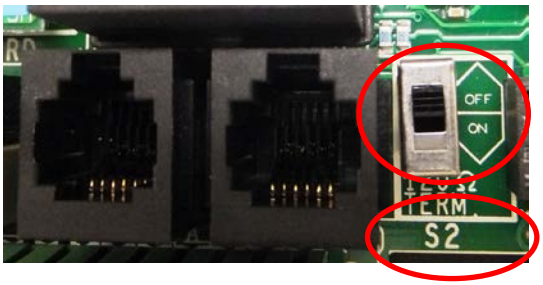


Figure 3-21: Termination Switch S2

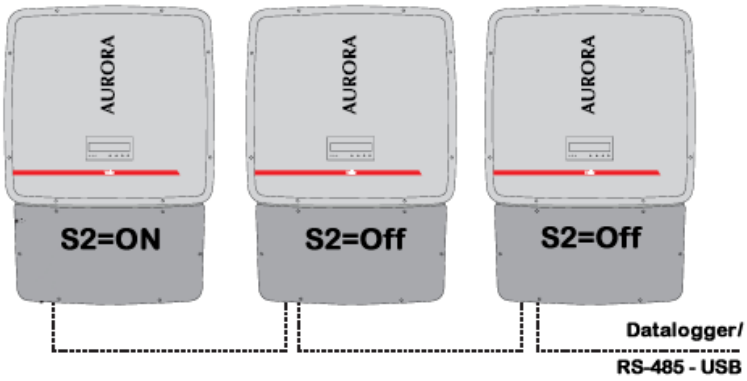


Figure 3-22: Daisy Chain Communication Wiring

3.3.3.2 *Addressing Each Inverter*

When multiple inverters are connected in a daisy chain, it is necessary to assign a different RS-485 address to each unit.

This enables the bus addresses (for the inverter connected to the RS-485 communication bus) to be set to an appropriate value. Address values are assigned manually using any value in the range [2 to 64]. See Part 4, section 4.2.5.2 for instructions to assign addresses using the display menu.

Other third party RS-485 converters available on the market can also be used, but Power-One does not assure correct connection operation since these devices have never been specifically tested. Also, please note that other commercial devices could require external termination impedance, which is not necessary for Aurora brand RS-485 converters.

PART 4 OPERATIONS GUIDE

4.1 MONITORING AND DATA TRANSMISSION

In order to prevent damage to the equipment and injury to the operator IT is essential to have a thorough knowledge of the user interface.
Power-One **cannot be held responsible for damage to the equipment or the operator if caused by incompetence, insufficient qualifications or lack of training.**

4.1.1 USER INTERFACE

The AURORA Inverter provides operational data to the user through the following instruments:

- LED Indicator lights
- Liquid Crystal Display (LCD)
- Digital data transmission via a dedicated RS-485 serial port using ***AURORA Inverter Protocol*** and a PC or a data logger equipped with an RS-485 port to collect data.

  If an RS-485 line is used, it may be convenient to use the AURORA USB/RS-485_232 serial interface converter (model number PVI-USB-RS485_232).

  The optional AURORA PVI-UNIVERSAL data logger is also available, which allows a web-based monitoring platform.
- Data transmission via USB cable. This type of connection is typically used when monitoring a single inverter and for maintenance purposes. To connect the USB cable, remove the waterproof plug at the bottom end of the inverter right wall to access the USB input.

Monitoring System Options

<u>Simple Monitor</u>

- Aurora RS485/USB Line Converter
- User Supplied PC
- Use ***Aurora Communicator*** Software

<u>Web Based Data Logger</u>

- Use ***Aurora Universal*** Data Logger
- Optional I/O (Meters, Irradiance Sensors, etc.) can be connected
- Ethernet (LAN) to Internet and connection to Aurora Web Portal service

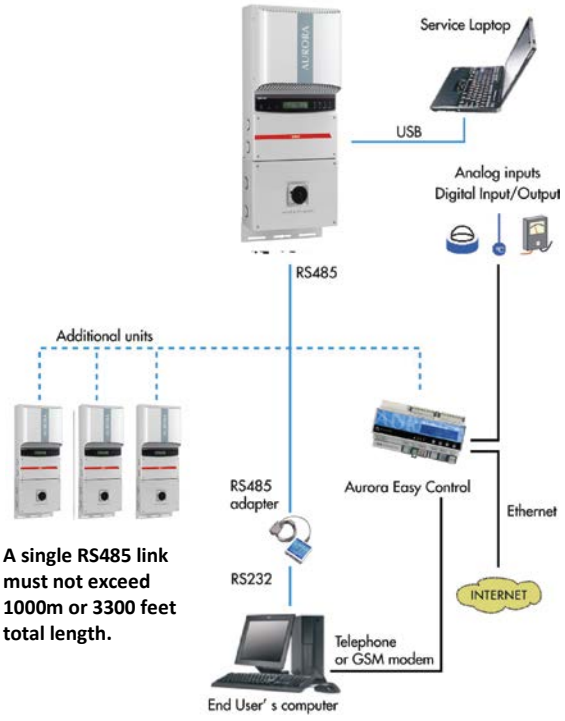


Figure 4-1: Data Transmission Options

4.1.2 DATA TYPES AVAILABLE

AURORA Inverter provides two types of data that can be collected using the display and/or the appropriate interface software.

4.1.2.1 *Real-Time Operational Data*

Real-time operational data can be transmitted on demand through the communication lines and are not stored inside the inverter. The free AURORA Communicator software (included on the installation CD) may be used to transmit data to a PC. Please check the Power-One website at www.power-one.com for the latest updated version.

The following data is available via the RS-485 link:

- Grid voltage
- Grid current
- Grid frequency
- Power transferred to the grid
- Voltage of photovoltaic array 1
- Current of photovoltaic array 1
- Voltage of photovoltaic array 2
- Current of photovoltaic array 2
- Serial Number/Code
- Week of production
- Firmware revision code
- Daily energy
- Leakage current of the system
- Total energy
- Partial energy
- Mean grid voltage
- Insulation resistance
- Leakage current to ground
- Date, time

4.1.2.2 *Data Logged Internally*

Power-One's AURORA Vision stores the following data internally:

- Total and partial counter of grid connection time.
- Total and partial counter of energy transferred to the grid.
- Daily Energy Production (365 values).
- Energy transferred to the grid every 10 seconds for the last 8,640 periods of 10 seconds (which on average cover more than 2 days of logged data).
- Last 100 fault conditions with error code and time stamp.
- Last 100 changes to grid connection parameters with parameter code and new value.

The first two types of data (Total and partial counters) are displayed on the LCD and through the RS-485 interface, while all other data logged internally can be displayed only through the RS-485 interface.

4.1.3 DISPLAY AND KEYPAD

AURORA Inverters are equipped with an LCD, four buttons for menu navigation and three LEDs indicating the device status.

- **POWER** LED (green) indicates the AURORA Inverter is operating normally.
  This light flashes upon start-up, during the grid check routine. If a correct grid voltage is detected and sunlight is strong enough to start-up the unit, the LED stays on steady. If not, the LED keeps flashing until sunlight becomes strong enough to start-up the inverter. In this condition, the display will read **'Waiting Sun….'**

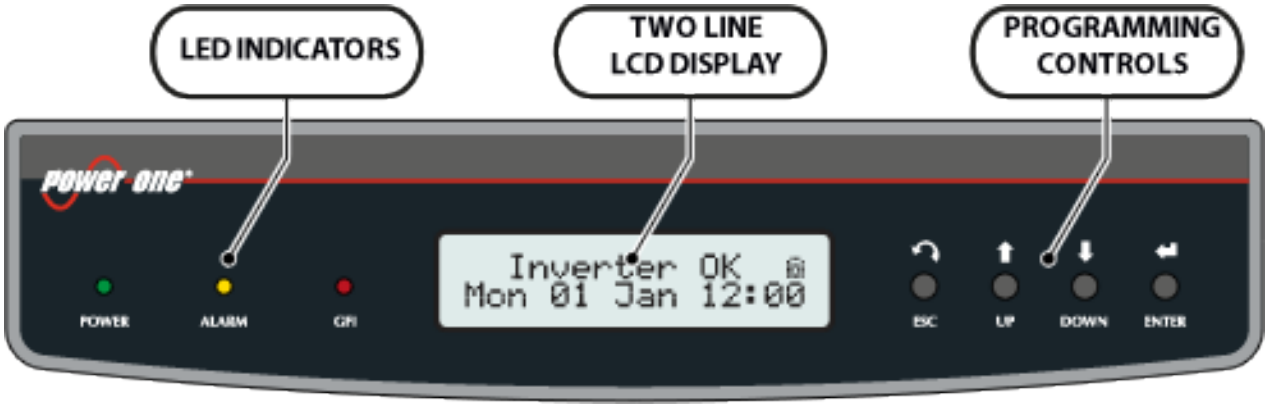


Figure 4-2: LED Indicators and Controls

- **ALARM** LED (yellow) indicates a fault condition has been detected. A description will appear in the two-line display.

- **GFI** LED (red) indicates the inverter has detected a ground fault in the DC side of the PV system. When this kind of fault is detected, the AURORA Inverter disconnects from the grid and the corresponding fault indication appears in the two-line LCD display.

  The AURORA Inverter remains in this condition until the operator presses the **ESC** key to re-start the grid connection sequence. If pressing the **ESC** key doesn't clear the ground fault, check the ground-fault fuse located in the switchbox. If the AURORA Inverter does not reconnect to the grid, contact Power-One Technical Service.

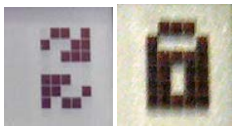
A two-line LCD located in the center of the front panel provides the following:

- Inverter operating status and statistics;
- Service messages for the operator;
- Alarm and fault indicators.

During operation, the display cycles through available data points, updating every five seconds. Screens may be scrolled manually by pressing the **UP** and **DOWN** Programming Control keys. Pressing the ESC key gives access to three main menus: ***Statistics - Settings - Info.*** To return to the preceding menu, press the **ESC** key

The *Statistics*, *Settings* and *Info* menus can be accessed with just the array connected. Some parameters (e.g., current, voltage, power, partial energy, lifetime energy etc.) are available only after grid connection.

Activation of cyclical scrolling will be indicated by two arrows in the top left corner of the two-line display.



Scrolling can be blocked by pressing the **ENTER** key. A padlock symbol will appear.

In their various combinations, the LEDs can indicate conditions that are different from the single one. The following table shows the possible combinations of LED-signalling indications related to the operational status of AURORA Inverter.

LED BEHAVIOR		
☒ LED off ■ ■ ■ LED on ◪ ◪ ◪ LED flashing ☐ Any condition		
LED STATUS	**OPERATIONAL STATE**	**DESCRIPTION**
1: green: ☒ 2: yellow: ☒ 3: red: ☒	Inverter off; AURORA self-disconnects during night	Input voltage and/or power are not sufficient to switch on the inverter.
1: green: ◪ 2: yellow: ☒ 3: red: ☒	STAND-BY: Inverter initialization	Transition state during which the inverter is waiting for sufficient sunlight to start. The inverter checks the parameters necessary for connection to the grid, such as input voltage, grid voltage, etc.
1: green: ◪ 2: yellow: ■ 3: red: ☒	STAND-BY WITH WARNING: inverter initialization in presence of a fault or anomaly. Grid is disconnected.	The inverter is waiting for sufficient sunlight to start exporting energy to the grid and checks the parameters necessary for connection to the grid. However it has also detected a condition which could limit its functionality. A warning message (Wxxx code) is on the LCD.
1: green: ■ 2: yellow: ☒ 3: red: ☒	The inverter is connected to and feeding energy to the grid.	Normal operation. The inverter automatically searches for and tracks the maximum power point (MPPT) from the PV array.
1: green: ■ 2: yellow: ■ 3: red: ☒	RUN with WARNING: The inverter is connecting and feeding power to the grid in the presence of an anomaly.	The inverter is connected to the grid and an anomaly, which may be internal or external to the inverter, has been detected. A warning message (Wxxx) is on the LCD.
1: green ☒ 2: yellow ■ 3: red ☒	W warning code E error code	Inverter detects an anomaly (Wxxx) or a fault (Exxx) in the system, which may be internal or external, and displays a message.
1: green: ☐ 2: yellow: ☐ 3: red: ■	INVERTER ALARM	A malfunction of the inverter prevents export of power to the grid. An error message (Exxx) is displayed on the LCD.
1: green ■ 2: yellow ◪ 3: red ☒	Internal Fan fault	The inverter does not disconnect and stays operational; however, critical environmental conditions may create over-temperature conditions with possible power limitations.
1: green: ☒ 2: yellow: ☒ 3: red: ◪	GRID ALARM: There is a problem with the electrical grid.	Indicates the grid voltage for connection is not present. The inverter shows “Missing Grid” message on display.

4.2 COMMISSIONING

Do not place any items on the AURORA Inverter during operation.

Do not touch the heat sink when the inverter is operating, as some parts may be hot and cause burns.

The procedure for commissioning AURORA Inverter is as follows:

1) Set the inverter's DC disconnect switch to ON.

2) Set the AC disconnect switch to the inverter to ON.

NOTE: There is no specific order for closing the two switches.

3) Once both disconnects are closed, the inverter starts the grid connection sequence. This routine is indicated by the flashing green LED labeled POWER on the display.

This routine may take from 30 seconds up to several minutes, depending on grid condition. Three messages are displayed in sequence on the LCD during this routine:

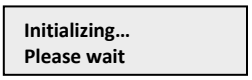
- "Measuring Riso..." connection in progress with progress signal (Riso = insulating resistance).
- Grid voltage value and status compared to specified values (within/outside range).
- Grid frequency value and status compared to specified values (within/outside range).

4) When the connection sequence is completed the AURORA Inverter starts operating. Proper operation is indicated by a warning sound and the steady green LED lights. This means the sunlight is sufficient to feed the grid.

5) If the grid check routine does not give a positive result, the unit will repeat the procedure until all grid voltage, frequency parameters, and grid configuration are found (or changed) to be within the specified range. During this process, the green LED will keep flashing.

4.2.1 CONNECTION OF THE SYSTEM TO THE GRID

The following two screens are displayed at inverter start-up:



When waiting for sunlight ('Waiting Sun'), the POWER LED flashes GREEN.

While the system checks for grid connection to be established ('Missing Grid'), the ALARM LED turns steady YELLOW, while the POWER LED flashes GREEN.

As soon as the 'Missing Grid' and 'Waiting Sun' conditions are met successfully, the inverter is connected and displays the following.

For –A versions ONLY, the display shows the AFD board self-test running and results:

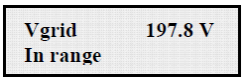
If the self-test results are OK, the inverter will continue to Next connections.

If a potential problem on the AFD board is detected, the self-test will result in error. Refer toTable 5-1 ***in Troubleshooing to clear the error and possible solutions.***

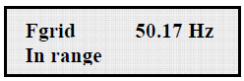
All versions will display the following screens during connection:

This display shows the time (seconds) remaining to complete the output voltage and frequency values check.

This display shows the instant output voltage value and whether it is within/outside range status.



This displays the instant output frequency value and whether it is within/outside range status.

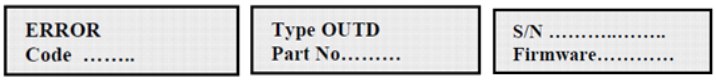


If the measured instant values of voltage and frequency are outside the allowed range, the above three screens are scrolled alternately: **Next connections** → **Vgrid** →- **Fgrid**

4.2.2 ERROR MESSAGES

After the connection is established, the inverter runs a test cycle. If the wrong data is found, the cycle is interrupted and an error code is displayed. Refer to Table 5-1in Troubleshooting for error codes and their meanings.

Until the error is rectified, the following screens are alternately displayed:



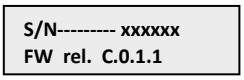
Once the error is cleared, the inverter resets all functions in progress and re-starts the connection.

4.2.3 FIRST PHASE- ELECTRIC PARAMETER CHECK

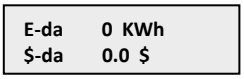
If the measurements taken in section 4.2.1 are found to be correct, the system will proceed to the next checks. The twelve screens outlined below are scrolled alternately on the display.

1) Inverter type and part number.

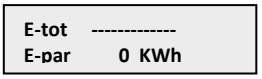
2) This display shows the inverter serial number and firmware revision level.



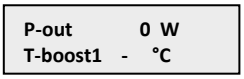
3) E-da: Daily energy output.
$-da: Daily energy savings. The value is expressed in the set currency.



4) E-tot: Total energy output (since first installation).
E-par : Partial energy output during the period selected by user.

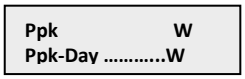


5) P-out: Measures instant output power.
The second line of the display shows the higher of the two temperatures:

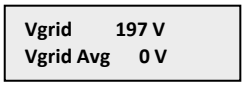


- T-boost1: Booster channel 1 switching device temperature.
- T-boost2: Booster channel 2 switching device temperature.

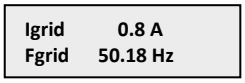
6) Ppk: Maximum peak power achieved since the 'partial' function was activated.
Ppk-Day: Indicates the maximum peak power achieved during the day. The counter will reset when unit is powered OFF.



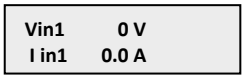
7) Vgrid: Measures instant grid voltage.
Vgrid Avg: Average grid voltage during the last 10 minutes of inverter operation.



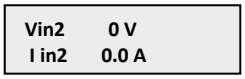
8) Igrid: Measures instant grid current.
Fgrid: Measures instant grid frequency.



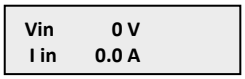
9) Vin1: Instant input voltage value measured at channel 1 input.
Iin1: Instant input current value measured at channel 1 input.



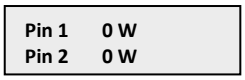
10) Vin2: Instant input voltage value measured at channel 2 input.
Iin2: Instant input current value measured at channel 2 input.



If the inverter configuration is set for single input (Parallel) mode, this screen appears instead of the two screens previously described in 9A and 10A.

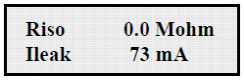


11) Pin1: Measures instant input power of channel 1.
Pin2: Measures instant input power of channel 2.



If the inverter configuration is set for single input (Parallel) mode, this screen appears instead of the screen described in 11.

12) Riso: Measured insulation resistance. Unlike the parameters discussed above, this is not an instant value but a one-of-a-kind measurement taken upon inverter start-up.
Ileak: Value of the leakage current passing through the grounding fuse and displayed only when the connected positive or negative terminal is being grounded



If all items described above test OK, the inverter shows a corresponding message in the display top line along with the date and time.

Clock malfunctioning or other non- function-related faults (meaning faults that do not affect the inverter's ability to generate energy) are shown in the second line of the display instead of the date and time. The following error messages could be displayed:

- CLOCK FAILURE: Indicates clock malfunction; contact Technical Support.
- BATTERY LOW
- ADJ. TIME: Appears the first time the unit is powered up or after the battery has been replaced.
- FAN FAILURE: Does not affect the inverter's proper operation; replace the fan at the first convenient opportunity.
- MEMORY FAILURE: Data logging malfunction. Contact Technical Support.

4.2.4 NORMAL START- UP PROCEDURE

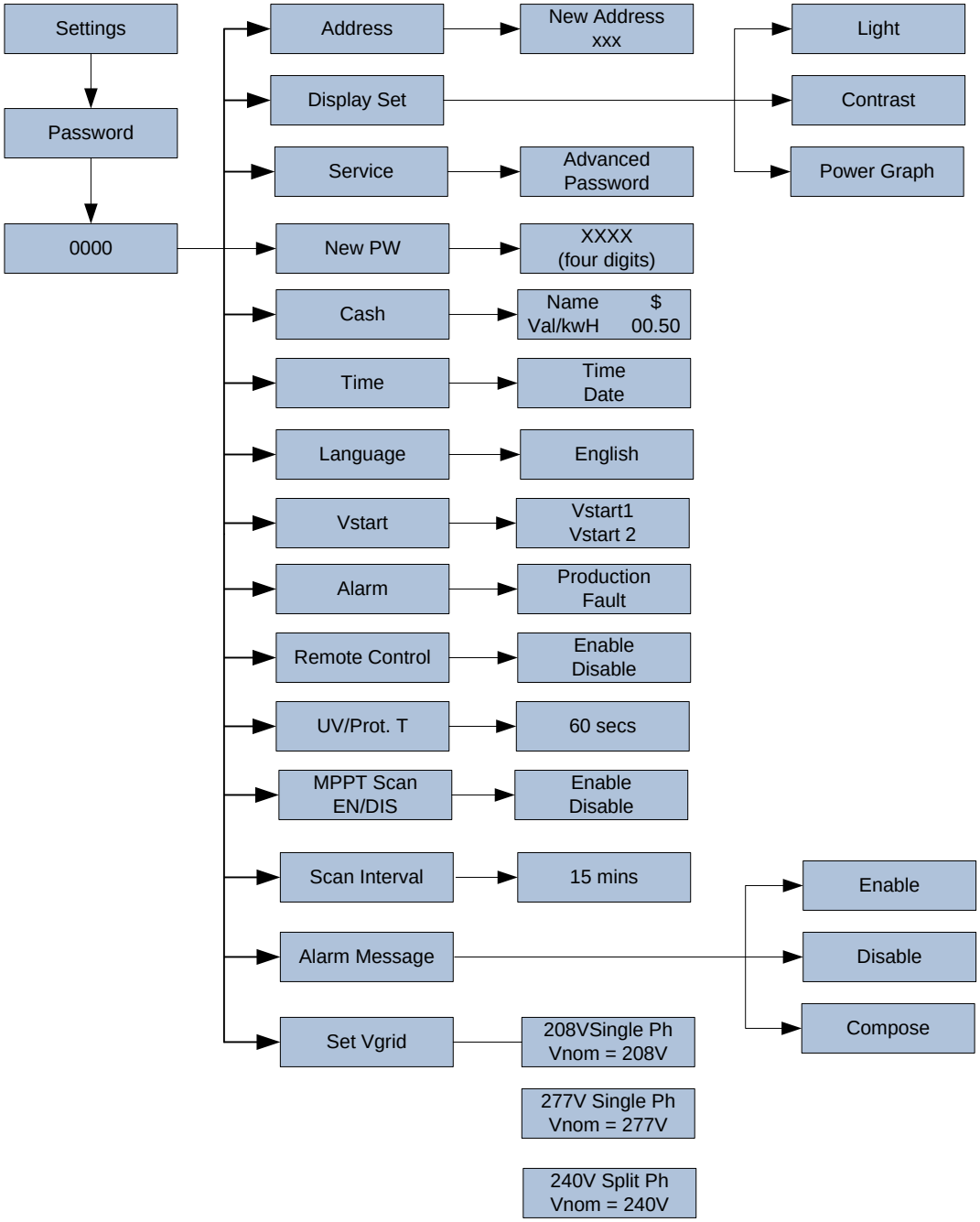
Normally, the Aurora inverter operates automatically and needs no particular supervision. When sunlight is not enough to generate power for the grid (for instance, at night), the Aurora disconnects automatically and goes into standby mode. The operating cycle is resumed automatically when sunlight becomes strong enough. This is indicated by the LEDs on the front panel display. Depending on the DC input voltage present, the inverter behaves as follows:

- When the inverter is switched ON, it will start as soon as the input voltage value exceeds the set Vin start value.
- The inverter will display the message 'Waiting Sun' until the input voltage exceeds the set Vin start value.
- When the Vin start value is exceeded, the inverter will connect to the grid if it is identified or it will display the message '*Vac absent*' if the grid is not connected.
- The inverter will remain connected to the grid if the input voltage is between 70% of the Vin start set and 480 Vdc. If the input voltage value is outside this range, the inverter disconnects itself from the grid.

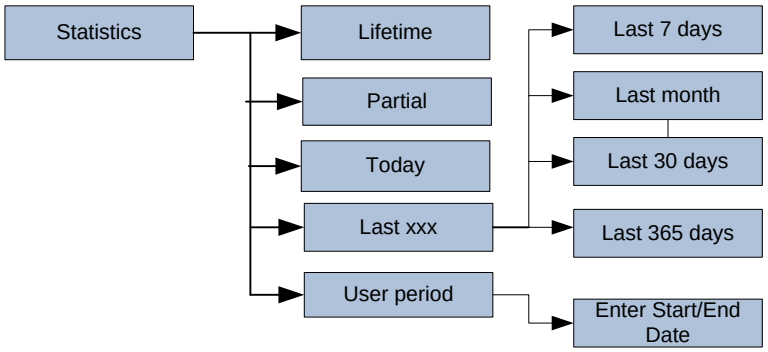
4.2.5 MAIN MENUS

The three main menus enable monitoring of the inverter's operations and are outlined below. To access the menus from the initial screen, press the **ESC** button. Use the **UP** and **DOWN** keys to scroll through the three menu and press **ENTER** to make a selection.

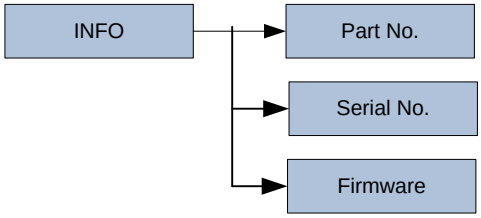
The Settings menu allows access to confiuration and modification of the basic inverter settings. See section 4.2.7 for instructions to view and adjust the parameters.



The Statistics menu is a view only display of internally logged inverter data. See section 4.2.5.1 for a description of each parameter in the submenu.

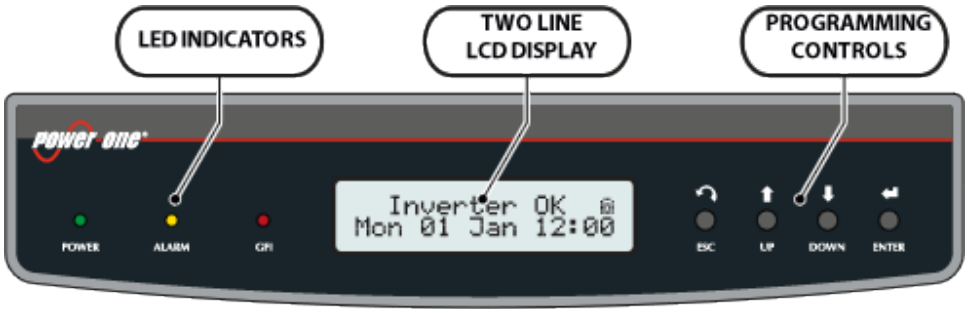


The INFO menu provides information about the inverter. A complete description of the submenus can be found in section 4.2.5.3.



Display Key Operation using Programming Controls

	Press **ENTER** to open a selection or confirm an entry.
	Press the **UP** and **DOWN** keys to move through menu items or increase/descrease numerical settings.
	Press the **ESC** key to access the three main menus, go back to the previous menu, or go back to the previous digit to be edited.



4.2.5.1 *Statistics Menu*

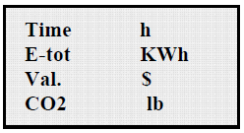
Press ENTER to select the **STATISTICS** menu and display the submenu.

An arrow on the left side of the display highlights the current selection.

Only two lines can be viewed on the display; use the UP and DOWN control keys to scroll through all selections. Press ENTER to open the submenu corresponding to the arrow.

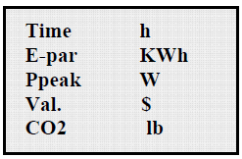
Lifetime

- Time: Lifetime operation time
- E-tot: Total energy produced
- Val. : Economic gain
- CO_2: CO_2 saving compared to fossil fuels



Partial

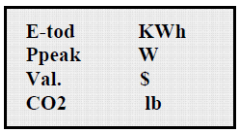
- Time: Total operation time since the counter was last reset. *
- E-par: Total energy produced since the counter was last reset. *
- PPeak: Maximum peak power measured since the 'partial' counter was activated
- Val. : Economic gain since the counter was last reset.*
- CO_2: CO_2 saving compared to fossil fuels since counter was last reset. *



** To reset all counters in this submenu, Press and Hold the ENTER key until a warning sound is repeated 3 times.*

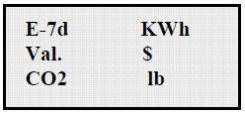
Today

- E-tod: Total energy produced during the day.
- Ppeak: Peak power value achieved during the day.
- Val. : Economic gain during the day.
- CO_2: CO_2 saving for the day compared to fossil fuels.



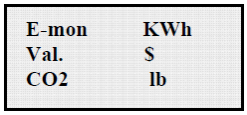
Last 7 Days

- E-7d: Total energy output over the last 7 days.
- Val. : Economic gain over the last 7 days.
- CO_2: CO_2 saving over the last 7 days compared to fossil fuels.



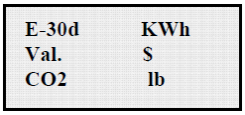
Last Month

- E-mon: Total energy output during the month.
- Val.: Money earned during the month
- CO2: CO2 saving compared to fossil fuels during the month.



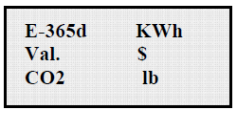
Last 30 Days

- E-30d: Total energy output over the last 30 days.
- Val. : Economic gain over the last 30 days.
- CO2: CO2 saving over the last 30 days compared to fossil fuels.



Last 365 Days

- E-365: Total energy output over the last 365 days.
- Val. : Economic gain over the last 365 days.
- CO2: CO2 saving over the last 365 days compared to fossil fuels.



User Period

To create a user defined period of time, press ENTER from the 'User period' screen to access the submenu below.

Use the display keys to set the start and end date of the period as follows:

- Use ENTER to move from one field to the next (from left to right).
- Use ESC to go back to the previous field (from right to left).
- Press ESC repeatedly to go back to the previous menus.
- To set the day:
  - Press DOWN to scroll numbers backwards (from 31 to 1).
  - Press UP to scroll numbers forwards (from 1 to 31).
- To set the month:
  - Press DOWN to scroll months from December to January.
  - Press UP to scroll months from January to December.

If the dates entered are inconsistent, the display alerts the user to the problem.

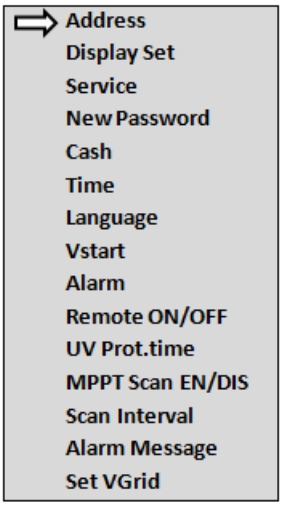
4.2.5.2 *Settings Menu*

Select ***SETTINGS*** from the Main Menu display. The first screen requires a password to continue:

The default password is 0000 and can be changed using the keys on the display.

- Use ENTER to move from one digit location to the next (from left to right).
- Use ESC to go back to the previous figure (from right to left).
- Press DOWN to scroll numbers backwards (from 9 to 0).
- Press UP to scroll numbers forwards (from 0 to 9).
- Press ESC repeatedly to go back to the previous menus.

After entering the required password, press **ENTER** to access to the ***Settings Menu***:

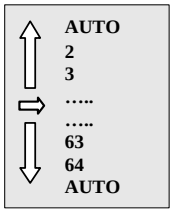


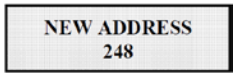
The front panel display has only two lines and the display keys must be used to scroll through the menu items and/or open the corresponding submenus.

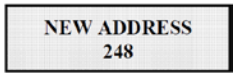
An arrow on left side of the display highlights the current selection. Once the chosen item is selected, press enter to access the desired submenu. The following section provides descriptions of each of the available submenus.

Address

Selecting **Address** enables the bus addresses (for the inverter connected to the RS485 communication bus) to be set to an appropriate value







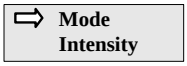
Address values are assigned using any value in the range [2 to 64]. Press the **UP** and **DOWN** keys to scroll through numbers. Press **ENTER** when desired number is displayed.

NOTE: If wiring multiple units using a daisy chain configuration, do not select AUTO configuration.

Display Set

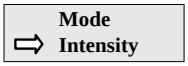
Selecting this function displays the submenu enabling the user to set display feature parameters:

1) ***Light*** - select this menu choice to display light settings:
Select ***MODE*** to set the display backlighting.



ON: Light always ON.
OFF: Light always OFF.
AUTO: Light turns ON every time a key is pressed and stays on for 30 seconds before fading OFF.

Select ***INTENSITY*** and enter to adjust the backlighting intensity from 1 to 9.



2) **Contrast*:*** Select this menu choice and enter to adjust display lighting contrast

Available display light tones go from 0 to 9. Press UP and DOWN keys to scroll the numbers and then press ENTER to confirm the selection.

3) **Buzzer:** Select this menu choice and enter to set key tone setting, choices are:

- **ON**: The key tone is ON.
- **OFF**: The key tone is OFF.

Service

This is a controlled access area of the operating system used by the factory to set certain control functions. Access is via an Advanced Password, which is a dedicated security code based on the unit serial number and access controlled by Power-One.

Installers may need to access this menu for certain adjustments during the installation process. Power-One will provide Advanced Password access to authorized installers to allow specific actions upon completion of required documentation.

New Password

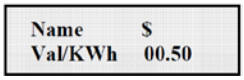
Selecting this function allows changing the default password (0000) to a personal code. To set a personal code, use the display keys as follows:

- Use ENTER to move from one digit to the next (from left to right).
- Use ESC to go back to the previous digit (from right to left).
- Press ESC repeatedly to go back to the previous menus.
- Press DOWN to scroll numbers backwards (from 9 to 0).
- Press UP to scroll numbers forwards (from 0 to 9).

Cash

Selecting this function enables the user to set the measurement units for earnings based on energy output.

Name: Set desired currency, using the keys in the usual manner. The default currency is US Dollar.



Val/KWh: This indicates the cost of 1 kWh expressed in the currency set. The default setting is Euro 0.50.

Time

Selecting this function allows adjustment of the system time and date settings.

Language

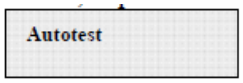
Selecting this function allows setting of the language desired for system prompts. Choices are Italian or English (default).

Vstart

Start-up voltage can be set according to the available photovoltaic system. Voltage range can be 120V to 350V. Default setting for Aurora is 200V. This parameter can be changed by means of the display keys.

Autotest

This is the Aurora inverter's internal test for checking correct operation of the protection and the grid interface device, as provided for by UL 1741 regulation.



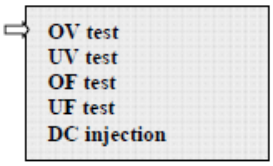
Press **ENTER** to access the following information:

OV = Max. voltage

UV = Min. voltage

OF = Max. Frequency

UF = Min. Frequency



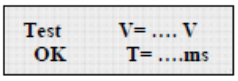
DC injection = Output current direct component.
This component shall not be >0.5% with respect to inverter maximum rated current or the unit will switch off.

The display has 2 lines; use the keys at the side of the display to scroll through items or open the corresponding submenus. An arrow on left side of the display highlights your current selection. When the chosen item is selected, press **ENTER** to open the submenu.

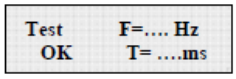
As soon as a test item is selected, the display shows

During the test the display gives test progress indication. If the test passes the display shows one of the three screens below, depending on which test item was selected.

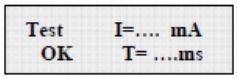
V= measured voltage
T= time necessary to take the measurement



F= measured frequency
T= time necessary to take the measurement



I=measured current
T=time necessary to take the measurement

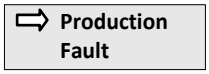


If the test fails, the same information as above is returned with the message **Test Fail** in place of Test OK.

Alarm

Selecting this function accesses the inverter's alarm function, which is used for external controls or, for example, to activate a visual and/or audible alarm. The function has two different modes of operation.

Select the desired mode using the **UP/DOWN** arrow keys and press **ENTER** to open the relevant submenu:



The function controls a set of dry relay contacts, which can be wired by the user as either normally open (N.O.) or normally closed (N.C.); contacts are rated at 250V/1A. The terminals for this function are accessed via the front panel and shown below in Figure 4-3. The two operational modes are described below:

1) **PRODUCTION**: In this mode, the relay is activated only when the inverter is connected to the grid.

   For example, if the N.O. (Normally Open) contact is chosen, the contact will remain open (closed) as long as the inverter is not connected to the grid. Once grid connection occurs and the inverter begins to export power, the relay switches its status and closes (opens). Upon disconnection from the grid, the relay contact returns to its rest position, i.e. open (closed).

2) **FAULT**: In this mode, the alarm relay triggers when the system logs a fault condition, based on the error codes (E-code) described in Section 5.3.

   For example, if the N.O. (Normally Open) contact is chosen, the contact will remain open (closed) as long as no E-code fault is logged (E-code faults disconnect the inverter from the grid). When any E-code is logged, the relay will change state and stay latched until the next successful grid reconnection, at which time it is reset.

   NOTE: the alarm function does not switch when warning codes (W-code) are logged.

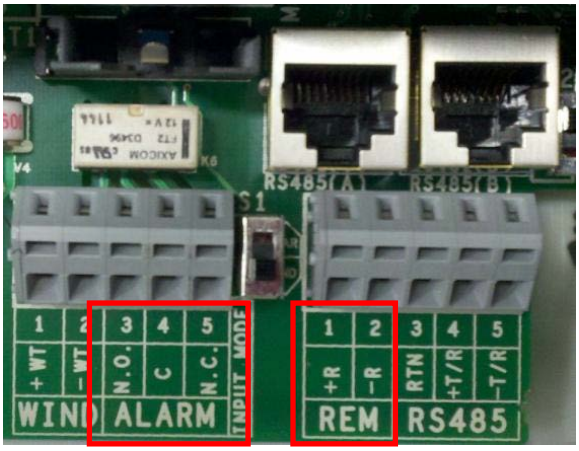


Figure 4-3: Alarm and Remote Contacts Terminal Block

Remote Control

This function is not available for –A models with AFD; terminal +R is used for AFD and not accessible by the end user.

Selecting this function accesses the remote ON/OFF function used to disable the inverter operation by an external switch or an external controller. Set as follows:

ENABLE - Activates the ON/OFF function, requiring an external contact closure to activate the inverter.

Remote ON/OFF Enable

DISABLE: Disables the ON/OFF function, so that inverter operation will operate normally, depending only on grid access and external solar radiation, (default).

Remote ON/OFF Disable

Hardware access to the ON/OFF function is via terminals +R and -R, shown in Figure 4-3. When the function is active,

- Turn ON the inverter terminals by shorting terminals +R and –R.
- Turn OFF the inverter by removing the short between terminals +R and –R.

With the function enabled, the ON/OFF input status is indicated on the inverter display.

When set to OFF, the display will cycle through the two screens.

Remote OFF	Waiting Rem.ON… to restart

UV Protection Time (PROT. TIME)

Selecting this function allows setting of the inverter connection time after the input voltage drops below the under voltage limit, set at 90V.

For example: If UV Prot.time is set at 60 seconds, and Vin voltage drops below 90V, the inverter stays connected to the grid (at 0 power) for up to 60 seconds afterwards.

The default value is 60 seconds, but can be set over the range of [1 s to 3,600 s].

MPPT Scan EN/DIS

This function is used to automatically detect input power max multiples and Enable or Disable MPPT scan as necessary.

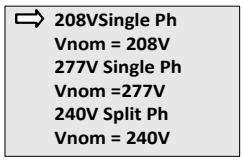
Scan Interval

This function is used to set time interval for system max.multiple scan. The default setting is 15 minutes.

Alarm message

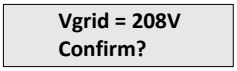
Set Vgrid

Selecting this menu opens a sub-menu which allows access for setting the grid type of the inverter connection:



To choose a single phase 208V grid connection, use the **DOWN** arrow key to move to the ***208V Single Ph*** line and press the **ENTER.**

A second display screen will open; press the **ENTER** key to confirm or **ESC** to go back.



Similarly, to choose one of the other preset grid voltage/type combinations, move the arrow to the associated row and repeat the steps above.

4.2.5.3 *Info Menu*

Selecting the Information menu display the following AURORA Inverter data:

- Part No. (part number)
- Serial No. – Wk – Yr (serial number, week, year)
- Fw rel (firmware revision level)

4.3 USING THE AURORA® MANAGER-TL SOFTWARE

This Aurora Manager Software is included on the CD shipped with each inverter and is typically loaded on a laptop PC for portability to the installation site. If this software is not included in the CD, please call Power-One Technical Support 1-877-261-1374.

The installation of this software is optional as most of this functionality can be done through the inverter display. If it is desired to view the basic monitoring and setting options from a computer screen, follow the installation instructions:

- Remove the disk from its cover. Insert the disk into the computer to install the program. The installation will create an icon on the computer desktop.
- Connect the adapter from inverter to the computer. Depending on the configuration determine the type of converter needed (RS485-RS232 or RS485-USB) in section 3.3.3.1 above.

For more a more comprehensive monitoring solution, please see Power-One's AURORA Vision product line at www.power-one.com

4.3.1 SERIAL CONNECTION WITH USB PORT

Serial connection through use of the inverter's USB port allows connection of a single inverter to a personal computer equipped with a USB 2.0 interface and dedicated software supplied by Power-One. The PC-inverter connection cable is a standard USB 2.0 cable, 5 meters long, with terminals of the A and B type.

Remove the waterproof plug located on Aurora's side to make the USB connection.

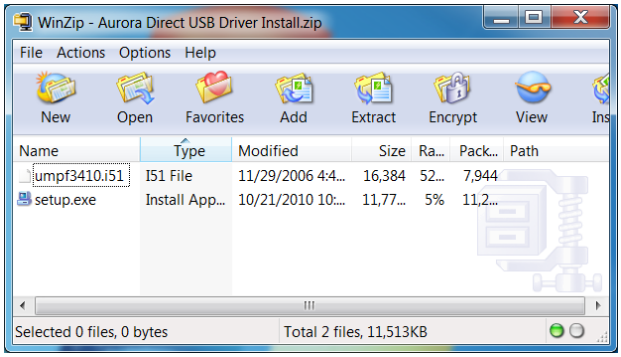
4.3.1.1 *Installation Guide for a Direct Connection from Aurora to Computer via USB Windows XP and 7 (32 & 64 bit)*

A driver installed on a computer or laptop will be necessary to communicate with the Aurora Inverter using a USB connection. Download the driver, *USB Driver Files,* from the installation CD included with this inverter or from the Power-One website and follow the process described below.

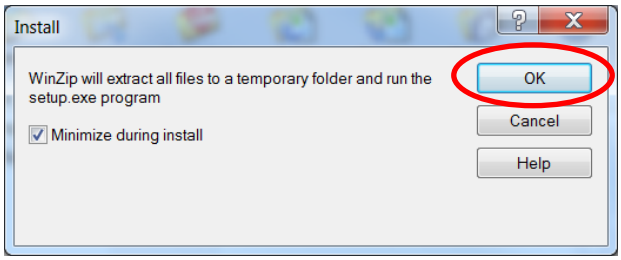
- The first **step** extracts the files into the computer *(C:\Program Files\Texas Instruments Inc).*
- The second **step** installs the actual TUSB3410 driver to the particular Operating System (XP 32 bit, XP 64 bit, Vista 32bit, Vista 64bit, Win7 32bit, Win7 64bit). Below are steps to complete the process.
- The final step connects the inverter to a pc or laptop for communication.

STEP 1:

After downloading the .zip file, unzip the "*USB Driver Files*" and click on **setup.exe**.



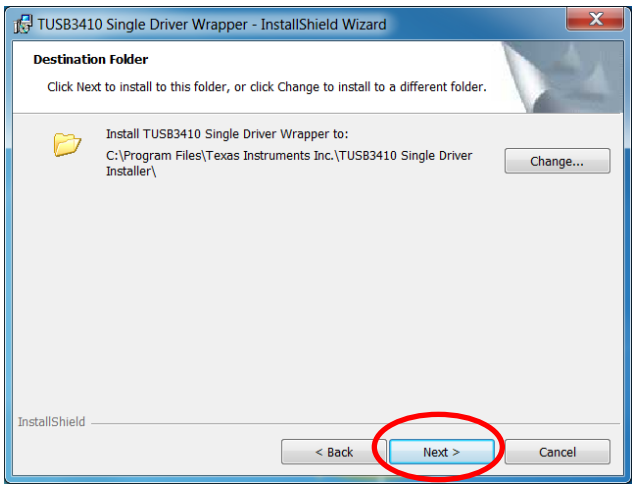
Click on **OK**. This setup will extract all the necessary files to your computer at *C:\Program Files\Texas Instruments Inc.*



Choose **Accept** from the license agreement screen.

Click **Next** to begin installation.

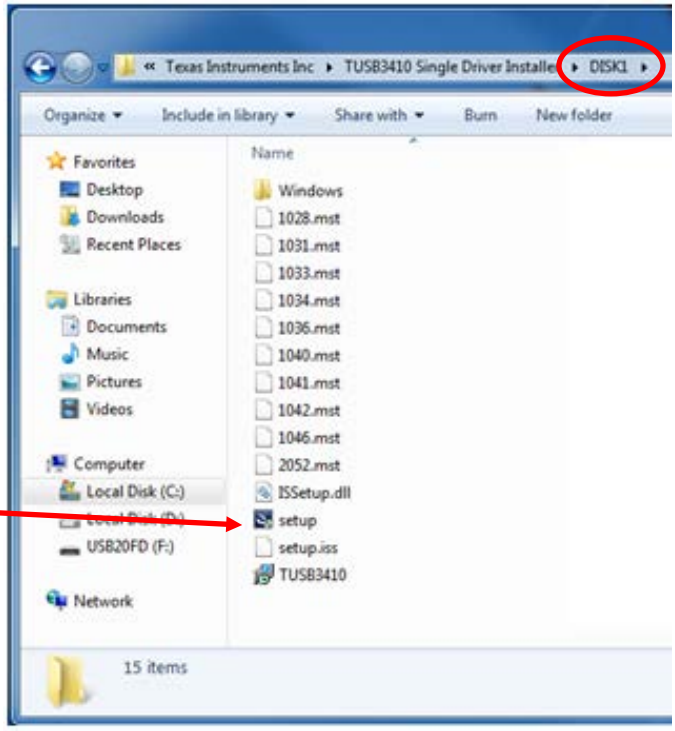
Continue the TUSB3410 Single Driver Wrapper installation by clicking on **Next, Install** and **Finish** to complete.



STEP 2:

After completing the initial setup, navigate to *Computer -> Local Disk (C:) -> Program Files -> Texas Instruments Inc -> TUSB3410 Single Driver Installer -> DISK1*.

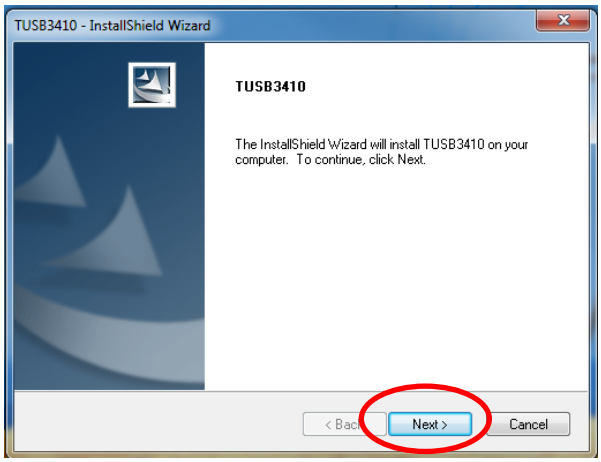
You should see these files in the *DISK1* folder.



Click on the **setup** icon to install the TUSB3410 VCP driver.

This setup will install the driver on your computer.

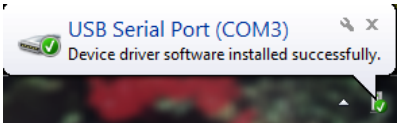
Click **Next** and **Finish** completing the TUSB3410 VCP driver installation.



STEP 3:

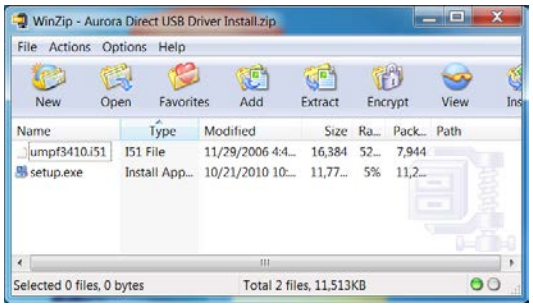
After completing the installation wizard, plug the USB cable into the computer with the inverter powered **ON** and wait for it to recognize the USB port.

When installed successfully, you will see a pop-up on the bottom right corner of the computer desktop.



Power **OFF** the inverter.

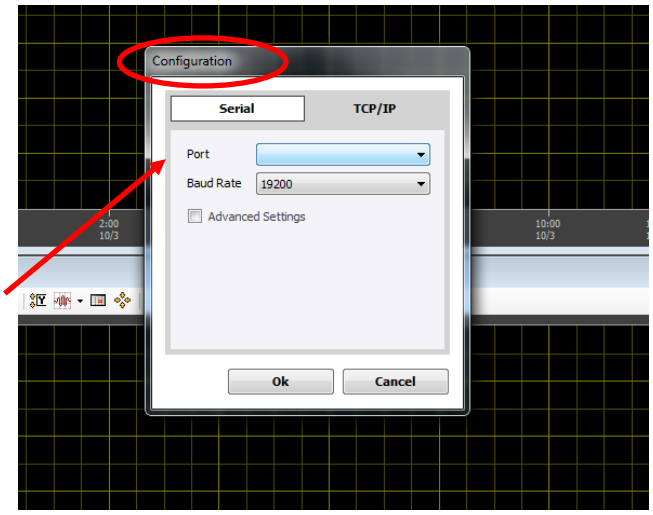
Copy the ***umpf3410.i51*** file from the open zip file on the computer.



Navigate to *Computer -> Local Disk (C:) -> Windows -> System32 -> Drivers* and **paste** the file, ***umpf3410.i51*** from the zip file into this *Drivers* folder.

Power the inverter back **ON**.
Launch either Aurora Installer or Aurora Communicator(CVI) or Aurora Manager software installed previously on the computer and go to *Configuration -> Communication Setup (ctrl+S)*.

From the Configuration window, use the drop-down arrow to select the port the USB is connected to and click **OK**.



The Aurora Inverter is now ready communicate via the USB connection.

4.4 ADJUSTMENTS OF DISCONNECTION PARAMETERS

Changes to these parameters must be made to meet the requirements of the local utility. Entry of improper values could cause the inverter to shut down.

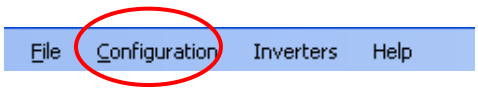
If it is necessary to adjust the frequency and disconnect times to meet local utility requirements, modifications are made using the Aurora Manager-TL software. Instructions to download and install the software on a PC can be found on the CD included with this inverter; if an internet connection is available, check the product page at www.power-one.com/renewable-energy and download the most recent version.

Prior to connecting to the grid, with the inverter's DC disconnect switch set to ON, a computer (with software installed) should be connected to the inverter via an RS485-USB adaptor (not included). The USB driver files and instructions for installation can be found on the CD or Power-One website. PC-inverter connection cable requires is standard USB 2.0 cable, terminals type A and B.

The computer loaded with the software must be interfaced to the inverter RS-485 port, utilizing an adapter such as the Aurora ***PVI-USB-RS485_232*** adaptor. This device has a port for the RS-485 and a standard USB port for connection to the computer. See section 3.3.2 above for connection via USB.

Once the software is loaded and the computer is interfaced to the inverter, double-click the desktop icon (loaded with software) to open the program and follow the steps below to make the field adjustments.

STEP 1- Configure the Communication
Click on the Configuration Tab on the Command Bar, as shown below to open the configuration panel.



On the *Configuration* panel shown below, select the appropriate COM port assigned to the RS 485 adapter. If this value is unknown, follow the procedure described in the Power One USB-RS485/RS 232 user manual. The other parameters should be left to the default values.

Serial Port: COM Port used to communicate with the inverters.
Set as described in USB-RS485/RS232 user manual.

Baud Rate: Speed of the communication line (leave the default value: *19200 bit/s*)
Stop Bits: Stop bit of RS 485 communication.
Leave the default value: *One (1*)
Parity: Parity bit for error recovery.
Leave the default value: *None*
DTR/RTS Enable: flag to enable DTR or RTS synchronization.
Leave the flags *unchecked* (*disabled*).

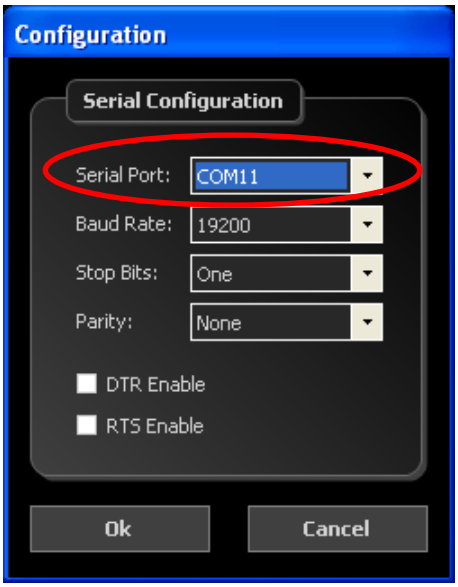


Figure 4-4: Configuration Panel

STEP 2- Scan the Inverter Bus to acquire the Inverters
The *Select Mode* panel allows scanning of the communication bus to acquire the inverters. It is possible to choose between *Single Inverter* and *All Inverters.*

Single Inverter: insert the inverter address and then press **Start.**

All Inverter: by pressing **Scan**, the software will search for all the inverters up to the maximum address configured.

NOTE: If it is not possible to find the inverters, check the cabling on the RS 485 Bus and the inverter address from the inverter display.

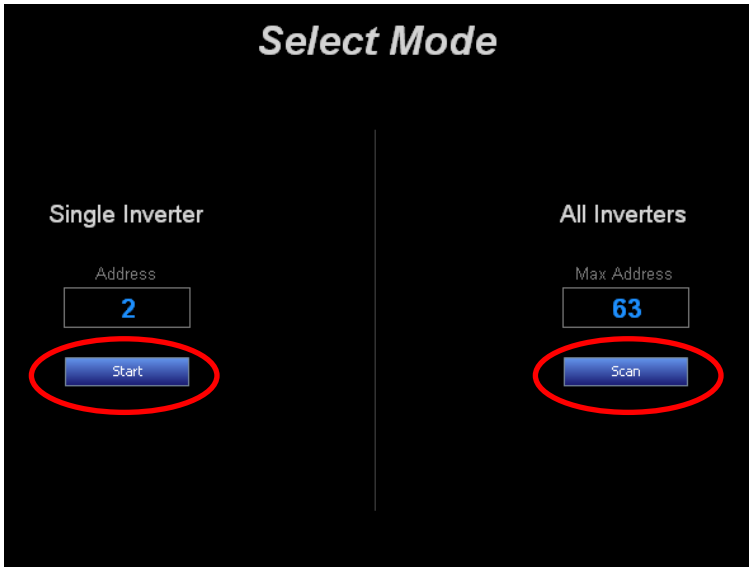


Figure 4-5: Select Mode Panel

STEP 3- Set the Grid parameters
Aurora Manager TL immediately recognizes the inverter Country and Grid Standard and will display the Voltage and Frequency Parameters according to the Grid requirements ().

Press the **READ** button to acquire the actual values. The inverter factory settings cause automatic disconnection from the grid in 160ms when line frequency is outside the range of 59.3 Hz < f < 60.5 Hz. Press the **WRITE** button to change values of desired parameters to those required by the local utility. The symbols on this screen are defined in Table 4- 1 below.

NOTE: When the frequency and disconnect time values have been changed, turn OFF and ON the DC power in order to preserve the new data.

If the inverter's frequency and disconnect(clearing time) values are field adjusted, apply the label (included in this shipment) to the external, side panel of inverter to indicate the changes.

THIS INVERTER HAS BEEN PROGRAMMED TO AUTOMATICALLY DISCONNECT FROM THE UTILITY DISTRIBUTION SYSTEM WHEN THE FREQUENCY AT THE POINT OF INTERCONNECTION REACHES THE FOLLOWING CONDITIONS:

FREQUENCY CONDITION	DISCONNECT TIME INTERVAL
f > 60.5 Hz	within 0.16 seconds
f = 57 Hz	within 300 seconds
f < 57 Hz	within 0.16 seconds

This screen-shot is the fixed setting defaults per IEEE1547, which states for line frequency, **f**:

- If **f** is in the range [59.3Hz ≤ f ≤ 60.5], the inverter operates normally
- If **f** falls below 59.3Hz the inverter must disconnect within 160ms

There is only one set point associated with the Under Frequency in this scenario:

- **f< set point** => the frequency value below which the inverter disconnects within 160ms; value used is 59.3Hz
- **Timeout f<** => this timeout is set to 160ms

The voltage values shown are based on the 240V default.

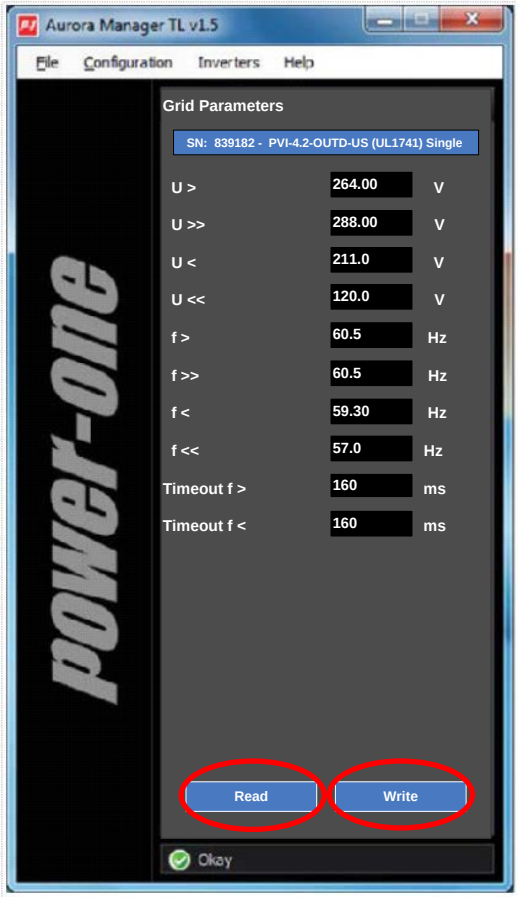


Figure 4-6: Grid Parameters Panel

Table 4- 1: Voltage and Frequency Disconnect Parameters and associated *-TL Manager* Symbols

-TL Manager Symbol	Factory Default Setting [Range]	Parameter Definition and Action
U>	110%xV_{NOM} [***Fixed***]	Indicates the value of the intermediate **Over Voltage set point** **Set by control system to 110% of V_{NOM} DO NOT CHANGE**
U>>	120%xV_{NOM} [***Fixed***]	Indicates the absolute maximum value of the **Over Voltage set point** **Set by control system to 120% of V_{NOM} DO NOT CHANGE**
U<	88%xV_{NOM} [***Fixed***]	Indicates the value of the intermediate **Under Voltage set point** **Set by control system to 88% of V_{NOM} DO NOT CHANGE**
U<<	50%xV_{NOM} [***Fixed***]	Indicates the absolute minimum value of the **Under Voltage set point** **Set by control system to 50% of V_{NOM} DO NOT CHANGE**
f>	60.5 Hz [***Fixed***]	Indicates the value of the timed **Over Frequency setpoint**. This parameter is not consistant with UL1741/IEEE1547 certifications and is not applicable to the -TL string inverters. **DO NOT CHANGE DEFAULT SETTING**
f>>	60.5Hz [***Fixed***]	Indicates the value of **absolute maximum Over Frequency setpoint**. For a UL1741/ IEEE1547 certified inverter this value is fixed at 60.5Hz. **DO NOT CHANGE**
f<	59.3 Hz [57Hz-59.3Hz]	Indicates the value of the **adjustable Under Frequency setpoint**. For line frequency below this value, a disconnect timer is set to count down the ride through time**[Timeout f<]** If the timer reaches full count, the inverter will be disconnected from the grid. If the measured frequency rises above this value, the disconnect timer is reset. The default setting indicates the disconnect timer will initiate its count down at 59.3Hz
f<<	57 Hz [***Fixed***]	Indicates the value of **absolute minimum allowable Under Frequency setpoint** For a UL1741/ IEEE1547 certified inverter the default value is 59.3Hz, This parameter will cause the inverter to disconnect from the grid within 160ms if the line frequency falls below below its set-point value. **DO NOT CHANGE DEFAULT SETTING**
Timeout f>	160ms [***Fixed***]	Indicates the initial value of the countdown timer associated with **Over Frequency** setpoint **f>** This parameter is not consistant with UL1741/IEEE1547 certifications and is not applicable to the -TL string inverters. **DO NOT CHANGE DEFAULT SETTING**
Timeout f<	300000ms [160ms -300000ms]	Indicates the initial value of the count down timer associated with Under Frequency set-point **f<** The value of the timer begins to decrease when line frequency falls below setpoint **f<**, and resets when the line frequency rises above the value of set point **f<** The inverter will operate for up to 300000ms (5min) for an under-frequency below the **[f<]** set-point as long as the frequency does not fall below the **[f<<]** setpoint
Note that only two highlighted parameters above need to be adjusted to obtain settings for all known adjustable Under Frequency applications		

PART 5 TROUBLESHOOTING GUIDE

5.1 GENERAL CONDITIONS

AURORA UNO Inverters comply with the standards set for grid-tied operation, safety, and electromagnetic compatibility.

Before the product is dispatched various tests are carried out successfully to ensure: functioning, protection devices, performance and durability.

Such tests, together with the Power-One quality assurance system, support optimal operation of the AURORA Inverter.

In case of any possible malfunction of the inverter, solve problems as follows:

1. Work under safe conditions. Check that the connections between AURORA, photovoltaic field and power distribution network have been made correctly as stated in Part 1 Introduction & Safety and Part 3 Wall Mount & Wire Configuration.
2. Carefully observe which LED is flashing and read the signal appearing on the display; then try to identify the type of fault found by following the instructions below.

5.2 ARC FAULT DETECTION SELF-TEST ERRORS (-A MODELS ONLY)

For –A models only, an autotest circuit is included in the module design of Power-One's DC ARC FAULT DETECTOR and INTERRUPTOR (AFDI) solution. The AFDI performs a self-test when the system is started, (ie every morning when sunlight is sufficient for grid connection). The inverter display shows the results of the self-test :

If the self-test results are OK, the inverter will continue to AC grid connection.

Test ARC Sensor OK

If a potential problem on the AFD board is detected, the self-test will result in error. Refer to Table 5-1 ***to clear the error and possible solutions.***

AF Self Test E053

During normal operation,(while the inverter in connected to the grid), the input current is continually measured and analyzed.

If a DC arc fault is detected, the inverter is disconnected from AC grid and the following error will be shown on the inverter display:

ARC FAULT E050

Press and hold the ESC key for three seconds to clear the error which will start the self-test. If self-test results are OK, the inverter will re-connect to the AC grid. If the DC arc fault is still present, the self test will result in error E053. Refer toTable 5-1 ***to clear the error and possible solutions.***

When the AFD protection trips continously an electrical arcing has taken place. In this case Power-One recommends a complete and accurate check of DC connections.

The AF self test can be manually started anytime using the following procedure:

1. Turn off the inverter (switching off both DC and AC switches) and,
2. Turn on both the DC and AC switches waiting for display communication of self-test result.

5.3 DISPLAY MESSAGES AND ERROR CODES

The system status is identified through message or error signals displayed on the LCD display. The following table briefly describes the two types of signals which may be displayed.

Messages identify the current status of the Aurora inverter. Messages do not relate to a fault. When a **(W)** with a number after it appears in the display, it indicates a **Warning Code** and is usually cleared through an orderly shutdown/re-set or a self corrective action performed by the inverter. See the **(W)** codes in the following table.

Alarms or **(E)** codes identify a possible equipment failure, fault or incorrect inverter setting or configuration. However, some of the **(E)** codes may require you to contact Power-One Technical Support to assist in correcting a fault. Any and all attempts to correct or clear a fault must be performed by qualified personnel. Typically, the **(E)** code can be cleared once the cause or fault is removed. Some of the **(E**) codes, **(Int. Error)** as indicated in the table below, may indicate a fatal error and require you to contact Power-One technical support for diagnostics and / or a product replacement.

Table 5-1: Display Messages and Error Codes

Display Message	*Causes*	*Solution*
Ground Fault Red LED	The alarm is generated when a ground leakage current is detected in the DC section of the system. The alarm is accompanied by the lighting up of the red LED on the front of the inverter.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground. If the measured value is less than 1 mega ohm, the photovoltaic generator must be checked by a technician/ installer to identify and eliminate the problem. If the measured value is greater than 1 mega ohm and the error warning continues to be present, contact Power-One Service.
E001 ***Input OC*** Input Overcurrent	The alarm appears when the inverter input current exceeds the set overcurrent threshold.	Check whether the composition of the PV generator allows an input current that exceeds the maximum threshold allowed by the inverter and that the configuration of the (independent or parallel) inputs is carried out correctly. If the configuration of the PV generator and the setting of the input channels are suitable, contact Power-One Service.
E002 ***Input OV*** Input Overvoltage	This alarm is indicated when the inverter input voltage (coming from the PV generator) exceeds the operating threshold. The alarm is triggered before reaching the absolute threshold beyond which the inverter will be damaged. When the inverter input voltage exceeds the Over Voltage threshold, the inverter will not start because of the generation of the alarm.	Measure the input voltage in the inverter with a voltmeter. If it is higher than the maximum voltage of the operating interval, the alarm is real. Check the configuration of the PV generator. If it is lower than the maximum voltage of the operating interval, the alarm is caused by an internal malfunctioning; contact Power-One Service

Display Message	Causes	Solution
E003 ***No Parameters*** Internal Parameters Error	The main microcontroller is unable to correctly initialize the two DSPs (booster stage and inverter stage). This is usually due to communication problems on the internal bus of the inverter.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E004 ***Bulk OV*** Bulk Overvoltage	Error inside the inverter. The alarm is raised when the voltage at the ends of the bulk capacitors exceeds the Over Voltage threshold.	The alarm can be caused by causes external to the inverter: an excessive inverter input voltage can be detected as a bulk overvoltage condition. In this case, it is advisable to check the inverter input voltage and, if this value is near the input OV threshold, re- examine the configuration of the photovoltaic generator. The alarm can be caused by causes internal to the inverter; contact Power-One Service.
E005 ***Comm.Error*** Internal Communication Error	The alarm occurs when there are communication problems between the control devices inside the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E006 ***Output OC*** Output Overcurrent	The alarm appears when the inverter output current exceeds the output overcurrent threshold of the inverter.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E007 ***IGBT Sat*** IGBT Saturation	The alarm appears when one of the active devices of the inverter is in saturation state.	Once the error appears, the inverter attempts to resume normal operation. If the error occurs sporadically, it may be caused by a sharp transition of the grid voltage or the input voltage but is not attributable to inverter malfunctioning. If the error is associated with an internal fault, it will continue to appear; contact Power-One Service.
E009 ***Internal error***	Error inside the inverter	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E010 ***Bulk Low*** Low Bulk Voltage	The alarm can be triggered by causes external to the inverter: a low inverter input voltage (just above the activation voltage) that is not accompanied by sufficient availability of power from the photovoltaic generator (typical condition of periods of insufficient irradiation).	If the error warning appears sporadically, it can be attributed to causes external to the inverter (insufficient irradiation, and therefore little power available from the PV generator). If the problem appears systematically even in conditions of high solar radiation and with input voltage significantly higher than the activation voltage, contact Power-One Service.
E011 ***Ramp Fail*** Bulk ramp timeout	Error inside the inverter regarding the time for starting steady state operation of the DC-DC circuit part (Booster).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.

Display Message	Causes	Solution
E012 ***DcDc Fail*** Booster module error revealed by Inverter	Error inside the inverter regarding the operation of the DC-DC circuit part (Booster).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E013 ***Wrong Mode*** Wrong Input Mode (parallel instead of independent)	The alarm is generated only when the inverter is configured with parallel inputs. In this particular configuration, the inverter carries out the input voltage check of each of the two channels, and the alarm is raised if the two voltages differ by more than 20Vdc.	Make sure the setting of the "IN MODE" switch has been intentionally positioned on "PAR" and that the jumpers have been inserted between the two input channels. If the configuration of the inverter is correct, check that the input strings have the usual number of panels in series, of the usual make and with the same inclination/orientation. If both the configuration of the inverter and the characteristics of the PV generator comply with the specifications, contact Power-One Service.
E014 ***Over Temp.*** Over- temperature	External temperature above 60°C. This parameter also depends on the power that the inverter must supply since the measurement of the temperatures is carried out internally and is affected by the heat dissipated by the components of the inverter.	Wait for the temperatures to which the inverter is exposed to return within operating range and for the inverter to cool down If the problem persists (once the ambient temperature has returned within the range), contact Power-One Service. Remember to wait for the time necessary to allow the inverter to cool down.
E015 ***Bulk Cap Fail***	Error inside the inverter regarding a problem in the bulk capacitors.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E016 ***Inverter Fail*** Inverter module error revealed by Booster	The alarm is generated when a problem is detected in the inverter circuit part (DC/AC).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E017 ***Start Timeout*** Inverter module start- up timeout	Error inside the inverter regarding the time for starting steady state operation of the DC-AC circuit part (Inverter).	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E018 ***Ground Fault*** Leakage current fail	The alarm is generated when, during normal operation of the inverter, a ground leakage current is detected in the DC section of the system. The alarm is accompanied by the lighting up of the red LED on the front of the inverter. The inverter may even also generate the E018 alarm message for AC leakage currents associated with the capacitive nature of the photovoltaic generator compared to ground.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground. If the measured value is less than 1 mega ohm, the PV generator must be checked by a technician/installer to identify and eliminate the problem. If the measured value is greater than 1 mega ohm and the error warning continues to be present, contact Power-One Service.

Display Message	Causes	Solution
E019 ***Self-Test Error 3*** Leakage current sensor self- test fail	Before connecting to the grid, the inverter carries out an autotest that tests the leakage current sensor. The test is carried out by "forcing" a current of known value in the leakage current sensor: the microprocessor compares the read value with the known value. The error is generated if the comparison between the read value and the known value during the test is not within the allowed tolerance.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service. By its nature, the alarm appears only before connection to the grid.
E020 ***Self-Test Error 1*** Booster relay self-test fail	Before connecting to the grid, the inverter carries out some internal tests. One of these tests regards the correct operation of the booster relay. The test is carried out by "forcing" the switching of the relay and checking its functionality. The error is generated if a problem is found with the operation of the relay.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service. By its nature, the alarm appears only before connection to the grid.
E021 ***Self-Test Error 2*** Inverter relay self-test fail	Before connecting to the grid, the inverter carries out a test that regards the operation of the inverter relay. The test is carried out by "forcing" the switching of the relay and checking its functionality. The error is generated if a problem is found with the operation of the relay.	This is an error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service. By its nature, the alarm appears only before connection to the grid.
E022 ***Self-Test Error 4*** Relay self- test timeout	Time taken to execute the autotest carried out on the relays of the DC_AC circuit part (inverter) is too long. This may indicate a problem associated with the aforesaid relays.	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E023 ***DC inj error*** Dc-Injection out of range	The error is generated if the direct component of the current supplied to the grid exceeds the threshold of 0.5% of the rated operating current. In any case, the inverter does not stop because of the E023 error, but tries to connect to the grid again. Sporadic repetition of the error is a sign of large grid distortions or sudden changes in irradiation, whereas systematic repetition of the error warning will be a sign of an inverter fault.	If the grid voltage is strongly distorted, report this anomaly to the grid company for the resolution of the problem If there is an inverter fault, contact Power-One Service.

Display Message	Causes	Solution
E024 ***Internal erro***r	Error inside the inverter	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E025 ***Riso Low(not shown on the display***) Low insulation resistance	Before connecting to the grid, the inverter measures the insulation resistance of the PV generator compared to ground. If the insulation resistance measured by the inverter is less than 1 MOhm, the inverter does not connect to the grid and shows the “Riso Low” error. The causes may be: - Damaged PV panel(s). - Junction box(es) of the panels not properly sealed, so allowing water and /or damp seepage ; - Problems in the connections between panels (not perfectly connected); - Poor quality cable junctions; - Presence of unsuitable (trigger voltage lower than the characteristics of the PV generator strings) or damaged overvoltage surge arresters outside the inverter in the DC section. - Presence of damp inside the field panel, if there is one.	If possible, measure the insulation resistance using a megohmmeter positioned between the photovoltaic field (positive terminal short-circuited to the negative pole) and ground (as described in the relevant section: "checking the ground insulation of the PV generator"). If the measured value is less than 1 mega ohm, the photovoltaic generator must be checked by a technician/installer to identify and eliminate the problem If the measured value is greater than 1 mega ohm and the error warning continues to be present, contact Power-One Service. (Damp increases leakage and can therefore be the cause of a reduction in insulation resistance).
E02 ***Vref Error*** Bad internal reference voltage	Wrong measurement of the reference voltage inside the equipment.	Internal error that cannot be checked externally. If the problem persists (even after switching the inverter off and then on again), contact Power-One Service.
E027 ***Error Meas V*** VGrid Measures Fault	Error in the internal measurement of the grid voltage (imposed by regulations) to have a measurement redundancy (2 measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact Power-One Service.
E028 ***Error Meas F*** FGrid Measures Fault	Error in the internal measurement of the grid frequency (imposed by regulations) to have a measurement redundancy (2 measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact Power-One Service.

Display Message	Causes	Solution
E029 ***Error Meas Z*** ZGrid Measures Fault	Error in the internal measurement of the insulation resistance of the PV generator compared to ground (imposed by regulations) to have a measurement redundancy (2 measurements on the same parameter carried out by two different circuits).	Error inside the inverter that cannot be checked externally. The error occurs if the internal measurement is carried out before connection to the grid) If the problem is persistent (even after switching the inverter off and then on again), contact Power-One Service.
E030 ***Error Meas Ileak*** ILeak Measures Fault	Error in the internal measurement (carried out when the inverter is connected to the grid) of the leakage current of the DC side (PV generator) compared to ground (imposed by regulations) to have a measurement redundancy (2 measurements on the same parameter carried out by two different circuits).	This is an error inside the inverter that cannot be checked externally. If the problem is persistent (even after switching the inverter off and then on again), contact Power-One Service.
E031 ***Error Read V*** Wrong V Measure	Measurement of the internal voltage at the ends of the output relay out of range. There is too great a difference in voltage between the input and the output of the output relay.	This is an error inside the inverter that cannot be checked externally. If the problem appears repeatedly, contact Power-One Service.
E032 ***Error Read I*** Wrong I Measure	Measurement of the output voltage unbalance (carried out between the three phases) out of range (only in three-phase models).	This is an error inside the inverter that cannot be checked externally. If the problem appears repeatedly; contact Power-One Service.
E033 ***UTH*** Under Temperature	Temperature outside the inverter below -25°C	Wait for the temperatures to which the inverter is exposed to return within operating range. If the problem persists, contact Power-One Service. Remember to wait for the time necessary to allow the inverter to warm up.
E034 ***Interlock fail*** IGBT not ready	Error inside the inverter	Error inside the inverter that cannot be checked externally. If the problem persists (after switching the inverter off and then on again), contact Power-One Service.
E035 ***Remote Off***(not shown on the display) Waiting remote ON	The inverter has been switched off remotely (remote OFF) and remains in waiting state for the signal that will switch it on again (remote ON).	Switch on the inverter remotely. If the unit does not switch on, disable the remote on/off function and switch the equipment off completely and then switch it on again. If the problem persists (after re-enabling the Remote ON/ OFF function from the display), contact Power-One Service.

Display Message	Causes	Solution
E036 ***Vout Avg error*** Average Vout out of range	The average grid voltage value (every 10 minutes) does not fall within the allowed ranges. The grid voltage at the point connected to the inverter is too high. This may be caused by grid impedance that is too high. Towards the end of the timeout, the inverter limits the power to check whether the grid voltage stabilizes within the normal parameters. If this does not happen, the inverter disconnects from the grid.	Check the grid voltage at the inverter connection point. If the grid voltage diverges from the range because of grid conditions, ask the grid company to adjust the grid voltage. If the grid company authorizes a change to the inverter parameters, arrange the new limits with Power-One Service.
E037 ***Riso Low*** Low insulation resistance (amorphous mode only)	This error can appear only if the "Amorphous" mode is enabled. This function is enabled only in inverters equipped with grounding kit and is used to monitor the voltage at the ends of the grounding resistor. The error appears when the voltage at the ends of the resistor connected between ground and pole of the photovoltaic generator exceeds 30V for more than 30 minutes or 120V for more than one second.	Check for the presence and correct contacting of the two terminals of the grounding resistor installed inside the inverter. If possible, measure the insulation resistance using a megohmmeter positioned between the PV field (positive terminal short-circuited to the negative pole) and ground (as described in the operation chapter). If the measured value is less than 1 mega ohm, the photovoltaic generator must be checked by a technician/ installer to identify and eliminate the problem. If the measured value is greater than 1 mega ohm and the error warning continues to be present, contact Power-One Service.
Mid Bulk OV	NA	NA
E050 ***Arc Fault*** (-A version ONLY) DC Arc detected	An electrical arc has been detected on DC cables. This error latches the inverter in a disconnected state.	Check DC cables and connections to identify the source of possible arcing. Press ESC like indicated in the display in order to unlatch the inverter.
E053 ***AF Self-Test*** (-A version ONLY) Arc fault detector (AFD) sensor Self-test failed	Self-Test performed by AFD board failed. The board will try another self-test after user turns inverter off and on.	Press ESC as indicated in the display in order to unlatch the inverter. If the problem persists (after switching the inverter off and on), contact Power-One Service.
W001 ***Sun Low*** (Low input voltage during switch-on of the inverters)	Insufficient irradiation. Wrong configuration of the PV generator or a configuration "at the limit" as regards the minimum input voltage of the inverter.	Check the inverter input voltage. If it does not exceed the Vstart, check that there is sufficient irradiation and that the composition of the system is correct. If it exceeds the Vstart, contact Power-One Service.
W002 ***Input UV*** (Low input voltage during switch-off)	Insufficient irradiation Wrong configuration of the photovoltaic generator or a configuration "at the limit" as regards the minimum input voltage of the inverter.	Check the inverter input voltage. If it does not exceed the Vstart, check that there is sufficient irradiation and that the composition of the system is correct. If it exceeds the Vstart, contact Power-One Service.

Display Message	Causes	Solution
W003 ***Grid Fail*** Grid Fail (grid voltage parameters outside the limits)	This error warning appears during normal operation of the inverter when the grid parameters fall outside the limits set by the grid company. No grid voltage (after the warning, the inverter goes on "No Vac") Unstable grid voltage (downwards and upwards) Unstable grid frequency.	Check the grid voltage on the inverter. If absent, check for the absence of grid voltage on the supply. If the voltage tends to rise (when the inverter is connected), it means there are high line or grid impedances. Check the grid voltage on the supply as well; if it is high, it means there is high grid impedance. In this case, ask the grid company to adjust the grid voltage. If the grid company authorizes a change to the inverter parameters, arrange the new limits with the Power-One Service. If the voltage at the supply point is much lower than that measured on the inverter, the line must be adjusted (inverter- counter). If the grid voltage and frequency fall within the limits (even when the inverter is connected to the grid), contact Power-One Service.
W009 ***Table fail***	NA	NA
W010 ***Fan Fail*** (Alarm not shown on the display; there is only a flashing yellow LED)	This error appears when there is malfunctioning of the fan(s) inside the inverter. In this condition, the yellow LED on the front panel flashes.	Error inside the inverter that cannot be resolved with external operations. If the alarm is persistently repeated, contact Power-One Service.
W011 ***Bulk UV***	Reading of the internal voltage on the bulk capacitors carried out when the inverter is connected to the grid.	
W012 ***Battery low*** Low internal clock battery voltage	Internal battery for maintenance of the date/time settings is discharged or damaged.	Replace the battery with the inverter completely switched off (disconnect AC side and DC side) and be sure to observe the correct polarity.
W013 ***Clk fail*** Internal clock failure	The alarm appears when the time shown on the display differs by more than 1 minute from the internal time of the microprocessors and indicates clock circuit malfunctioning.	This is an error inside the inverter that cannot be resolved with external operations. If the alarm is persistently repeated, contact Power-One Service.
W017 ***Jbox fail*** Fuse-control board fail (DC string fail)	Fuse(s) on the fuse boards is/are damaged.	Using a multimeter, check the condition of the fuses (situated on the fuse boards). Replace any open fuses and check that the input current on the string(s) does not exceed the rating of the fuses (if string parallels have been made outside the inverter). If there are no damaged string fuses and the inverter continues to display the alarm message, check whether the settings to be made through the Aurora Manager software are correct (presence or absence of one or more input strings).

Display Message	Causes	Solution
W018 SPD DC protection open	Overvoltage surge arresters situated on the DC side are damaged.	Look at the inspection window present on each surge arrester (DC side). If it is red, the surge arrester is damaged and the cartridge must be replaced. If the alarm status continues to be present even though all the surge arresters have a green inspection window, contact Power-One Service.
W019 SPD AC protection open	Overvoltage surge arresters situated on the AC side are damaged.	Look at the inspection window present on each surge arrester (AC side). If it is red, the surge arrester is damaged and the cartridge must be replaced. If the alarm status continues to be present even though all the surge arresters have a green inspection window, contact Power-One Service.

5.4 THE POWER ONE SERVICE CALL

INFORMATION ON AURORA UNO INVERTER

A. AURORA model?
B. Serial number?
C. Week of production?
D. Which LED is flashing?
E. Steady or flashing light?
F. What signals are shown on the display?

NOTE: Information items A, B, and C above are available directly from the INFO menu of the LCD display.

Additional helpful information when troubleshooting with the Power-One Technical Service Engineers:
Provide a brief description of the fault.

- Information on the Photovoltaic Field
- Brand and model of photovoltaic panels
- Identify the System structure:
  - Maximum array voltage and current values
  - Number of strings in the array
  - Number of panels for each string
  - Can the fault be reproduced? If so, how?
  - Is the fault cyclical in nature? If so, how often?
  - Was the fault apparent at the time of installation?
  - If so, has it got worse?
  - Describe the atmospheric conditions at the time the fault appears/appeared.

Power-One Technical Support
Phone: 1-877-261-1374

PART 6 MAINTENANCE GUIDE

6.1 GENERAL CONDITIONS

The AURORA UNO Inverter has no user-serviceable parts. Maintenance and service procedures must comply with the manufacturer's documentation. Call Power-One Technical Support at 1-877-261-1374 for a list of qualified service contractors.

Checking and maintenance operations must be carried out by specialized staff assigned to carry out this work. DO NOT allow the equipment to be used if problems of any kind are found, and restore the normal conditions correctly or make sure this is done.

Maintenance operations must be carried out with the equipment disconnected from the grid, unless otherwise indicated.

For cleaning, DO NOT use rags made of filamentary material or corrosive products that may corrode parts of the equipment or generate electrostatic charges.
Avoid temporary repairs. All repairs should be carried out using only genuine spare parts.
The maintenance technician is under an obligation to promptly report any anomalies.

Always use the personal protective equipment provided by the employer and comply with the safety conditions in Part 1 of this manual.

6.2 POWER-DOWN PROCEDURES

THE FOLLOWING OPERATIONS MUST ALWAYS BE PERFORMED before accessing the power input of the Switch Box in order to avoid injury to personnel and/or damage to equipment.

To avoid the risk of electric shock from energy stored in capacitors, wait at least ten minutes after disconnecting both AC and DC sides before opening the front panel.

Once the inverter is wired and connected to the grid use the following procedures to disconnect for maintenance:

Disconnect from the AC Grid by one of the following methods:

- Turn-OFF the external AC switch
- Turn-OFF the Over Current Protection Device (circuit breaker)

Disconnect the inverter from the PV array by turning OFF the external DC disconnect switch.

NOTE: When possible, turn off the AC switch first, however, there is no specific order for turning off the two switches.

Cover all the photovoltaic panels using appropriate cover or perform the grid CONNECTION and/or DISCONNECTION operation during night hours. Ensure that no photovoltaic panel can provide energy during this operation.

Remove the inverter cover (section 3.2.2). Using a voltmeter, check voltage levels at the DC input terminals and the AC output cables to ensure no hazardous voltages are present.

6.3 ROUTINE MAINTENANCE

Routine maintenance is recommended to maintain efficient operation of the PV installation.

Table 6-1: Recommended Periodic Maintenance

Annual visual inspection	• Check that all labels and safety symbols are visible; • Check that the envrionmental conditions have not changed drastically (exposure to weather condition); • Check that the inverter or PV panels have not been shaded or isolated by foreign bodies.
Annual operations	• Check the tightness of the cable opening plugs; • Check the fitting of the connectors and front covers (loose fittings can allow water seepage into the cabinet which may result in short circuits due to humidity).
Annual cleaning	• Clean the equipment; verigy that no obstructions are present on the fins of the heat sink. If possible, use an extractor or suitable pipe cleaners.

6.4 CR2032 LITHIUM BATTERY REPLACEMENT

WARNING: The replacement of the battery should be performed only by trained personnel.

The replacement of the internal battery must be carried out when the display shows the error W012 “Battery Low” or the settings of current date/time are frequently reset.

The battery is visible after removing the AURORA PV Inverter's front panel. Refer to Part 3, section 3.2.2 for the procedure to remove the front panel. Extract the battery from it’s housing with a 30° tilt.

Insert the replacement battery into the housing at a 30° angle. When pushed in the battery should seat into the correct position within the holder. Reinstall and tighten the cover screws with at least 1.5Nm (13.2 in-lbs) torque.

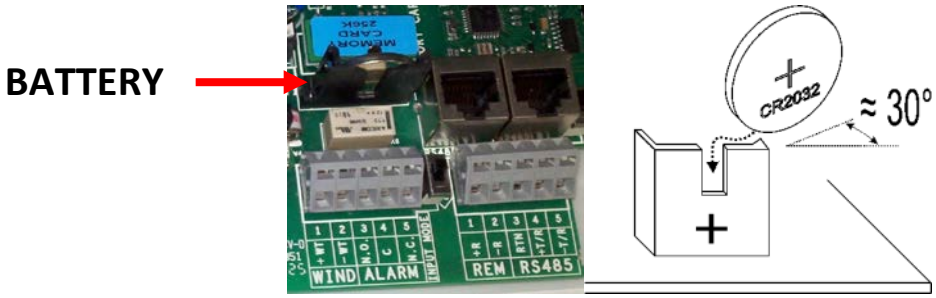


Figure 6- 1: Internal battery replacement

6.5 STORAGE AND DISMANTLING

6.5.1 STORAGE OF THE EQUIPMENT OR PROLONGED STOP

If the equipment is not used immediately or is stored for long periods, check that it is correctly packed and contact ***Power-One*** for storage instructions. The equipment must be stored in well-ventilated indoor areas that do not have characteristics that might damage the components of the equipment.

Restarting after a long or prolonged stop requires a check and, in some cases, the removal of oxidation and dust that will also have settled inside the equipment if not suitable protected.

6.5.2 DISMANTLING, DECOMMISSIONING AND DISPOSAL

Power-One CANNOT be held responsible for disposal of the equipment: displays, cables, batteries, accumulators, etc., and therefore the customer must dispose of these substances, which are potentially harmful to the environment, in accordance with the regulations in force in the country of installation.
If the equipment is dismantled, to dispose of the products it consists of, you must stick to the regulations in force in the country of destination and in any case avoid causing any kind of pollution.

Dispose of the various types of materials that the parts of the equipment consist of in dumps that are suitable for the purpose.

Table 6- 1: Component Disposal

COMPONENT	MATERIAL OF CONSTRUCTION
Frame, brackets, supports	Arc-welded steel FE37
Casing or covers	ABS, Plastic
Paint	RAL
Gaskets and seals	Rubber / Teflon / Viton
Electrical cables	Copper / Rubber
Cable trays	Polyethylene / Nylon
Backup battery	Nickel / Lead / Lithium

PART 7 APPENDIX

7.1 DATA SHEETS

Table 7-1: Technical Data

TECHNICAL DATA	VALUES	PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Nominal Output Power	W	5000			6000		
Maximum Output Power	W	5000			6000		
Rated Grid AC Voltage	V	208	240	277	208	240	277
Input Side (DC)							
Number of Independent MPPT Channels		2			2		
Maximum Usable Power for Each Channel	W	4000			4000		
Absolute Maximum Voltage (Vmax)	V	600			600		
Start- Up Voltage (Vstart)	V	200 (adj. 120-350)			200 (adj. 120-350)		
Full Power MPPT Voltage Range	V	200-530			200-530		
Operating MPPT Voltage Range	V	0.7xVstart-580			0.7xVstart-580		
Maximum Current (Idcmax) for both MPPT in Parallel	A	36			36		
Maximum Usable Current per Channel	A	18			18		
Maximum Short Circuit Current Limit per Channel	A	22			22		
Number of Wire Landing Terminals Per Channel		2 Pairs			2 Pairs		
Array Wiring Termination		Terminal block, Pressure Clamp, AWG8-AWG4					
Output Side (AC)							
Grid Connection Type		1Ø/2W	Split-Ø/3W	1Ø/2W	1Ø/2W	Split-Ø/3W	1Ø/2W
AdjustableVoltage Range (Vmin-Vmax)	V	183-228	211-264	244-304	183-228	211-264	244-304
Grid Frequency	Hz	60			60		
Adjustable Grid Frequency Range	Hz	57-60.5			57-60.5		
Maximum Current (Iacmax)	A_{RMS}	27	23	20	30	28	24
Power Factor		> 0.995			> 0.995		
Total Harmonic Distortion At Rated Power	%	< 2			< 2		
Contributory Fault Current**	A_{pk}/A_{RMS}	36.25/25.63	36.5/25.81	31.75/22.45	36.25/25.63	36.5/25.81	31.75/22.45
Grid Wiring Termination Type		Terminal block, Pressure Clamp, AWG8 - AWG4					
Protection Devices							
Input							
Reverse Polarity Protection		Yes			Yes		
Over-Voltage Protection Type		Varistor, 2 for each channel			Varistor, 2 for each channel		
PV Array Ground Fault Detection		Pre start-up Riso and dynamic GFDI (Requires Floating Arrays)			Pre start-up Riso and dynamic GFDI (Requires Floating Arrays)		
Output							
Anti-Islanding Protection		Meets UL 1741/IEEE1547 requirements			Meets UL 1741/IEEE1547 requirements		
Over-Voltage Protection Type		Varistor, 2 (L_1 - L_2 / L_1 - G)			Varistor, 2 (L_1 - L_2 / L_1 - G)		
Maximum AC OCPD Rating	A	35	30	25	40	35	30
Efficiency							
Maximum Efficiency	%	97.1			97.1		
CEC Efficiency	%	96	96.5	96.5	96	96.5	96.5
Operating Performance							
Stand-by Consumption	W_{RMS}	< 8			< 8		
Night time consumption	W_{RMS}	< 0.6			< 0.6		
Communication							
User-Interface		16 characters x 2 lines LCD display					
Remote Monitoring (1xRS485 incl.)		AURORA-UNIVERSAL (opt.)					
Wired Local Monitoring (1xRS485 incl.)		PVI-USB-RS485_232 (opt.), PVI-DESKTOP (opt.)					
Wireless Local Monitoring		PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.)					
Environmental							
Ambient Air Operating Temperature Range	°F (°C)	-13 to +140 (-25 to +60)			-13 to +140 (-25 to +60) with derating above 122 (50)		
Ambient Air Storage Temperature Range	°F (°C)	-40 to 176 (-40 to +80)			-40 to 176 (-40 to +80)		
Relative Humidity	% RH	0-100 condensing			0-100 condensing		
Acoustic Noise Emission Level	db (A) @1m	< 50			< 50		
Maximum Operating Altitude without Derating	ft(m)	6560 (2000)			6560 (2000)		
Mechanical Specifications							
Enclosure rating		NEMA 4X			NEMA 4X		
Cooling		Natural Convection			Natural Convection		
Dimensions (H x W x D)	in (mm)	41.4 x 12.8 x 8.6 (1052 x 325 x 218)					
Weight	lb (kg)	< 59.5 (27.0)			< 59.5 (27.0)		
Shipping Weight	lb (kg)	< 78 (35.4)			< 78 (35.4)		
Mounting System		Wall bracket			Wall bracket		
Conduit Connections		Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4", 3 places side, front, rear)			Trade Size Kos: (2ea x 1/2") and (2ea x 1-1/4", 3 places side, front, rear)		
DC Switch Rating (Per Contact)	A/V	25 / 600			25 / 600		
Safety							
Isolation Level		Transformerless (Floating Array)			Transformerless (Floating Array)		
Safety and EMC Standard		UL 1741, CSA - C22.2 N. 107.1-01			UL 1741, CSA - C22.2 N. 107.1-01		
Safety Approval		$_cCSA_{us}$			$_cCSA_{us}$		
Warranty							
Standard Warranty	years	10			10		
Extended Warranty	years	15 & 20			15 & 20		
Available Models							
Standard - With DC Switch - Floating Array		PVI-5000-OUTD-US			PVI-6000-OUTD-US		
Standard - With DC Switch - Floating Array and Arc Fault Detection (AFD)		PVI-5000-OUTD-US-A			PVI-6000-OUTD-US-A		

*** All data is subject to change without notice** ****Inverter can apply that much current – Breaker will open**

7.1.1 VOLTAGE AND FREQUENCY LIMITS

The UL1741 requires the following voltage and frequency limits for utility interaction:

Table 7- 1: Voltage and Frequency Simulated Utility Source Limits

Condition	Simulated utility source		Maximum time (sec) at 60 Hz before cessation of current to the simulated utility
	Voltage (V)	Frequency (Hz)	
A	V< 50% V_{nom} (**)	Rated (Default/Fixed)	0.16 sec (Fixed)
B	50%V_{nom}≤ V< 88% V_{nom}	Rated	2 sec (Fixed)
C	110%V_{nom}≤ V< 120% V_{nom} (*)	Rated	1 sec (Fixed)
D	V≥120% V_{nom} (*)	Rated (Default, Fixed)	0.16 sec (Fixed)
E	Rated	f > 60.5 (Default)	0.16 sec (Default)
F	Rated	f < 59.3 (Default) (Adj. Set Points 59.7 Hz to 57 Hz)	0.16 sec (Default) (Adj. Set Points 0.16s to 300s)
G	Rated	f < 57.0 (Default, Fixed)	0.16 sec (Fixed)
H	Rated	f > 60.5 (Fixed)	0.16 sec (Fixed)

(*) Note: For model at 277V High Voltage is fixed at 110% Vnom and Very High Voltage is fixed at 111% Vnom.
(**)Note: for model at 208V Very Low Voltage is fixed at 55% Vnom. Minimum adjustable Low Voltage level is 55% Vnom.

7.1.2 EFFICIENCY CURVES

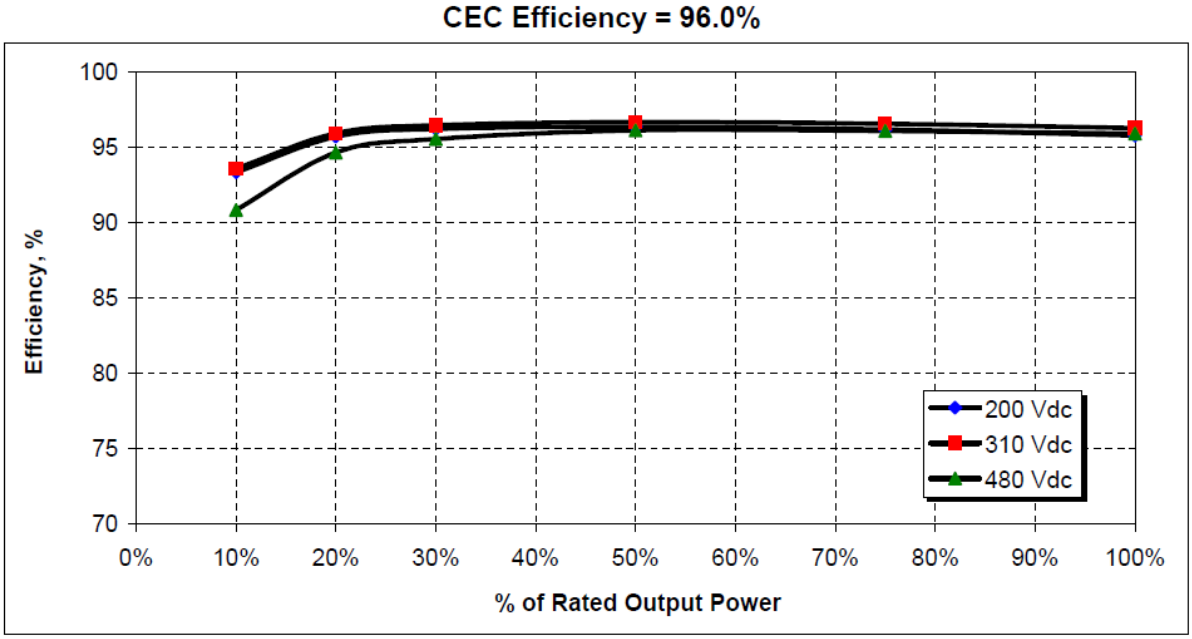


Figure 7-1: Efficiency Curve PVI-6000-OUTD-TL-US

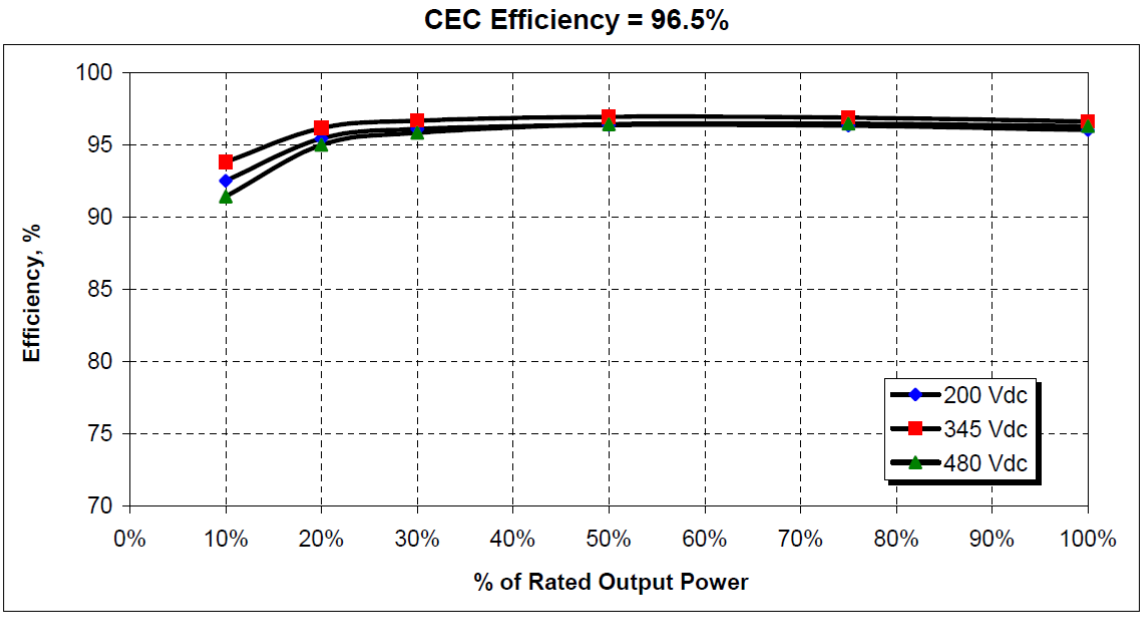


Figure 7-2: Efficiency Curve- PVI-5000-OUTD-US (240V)

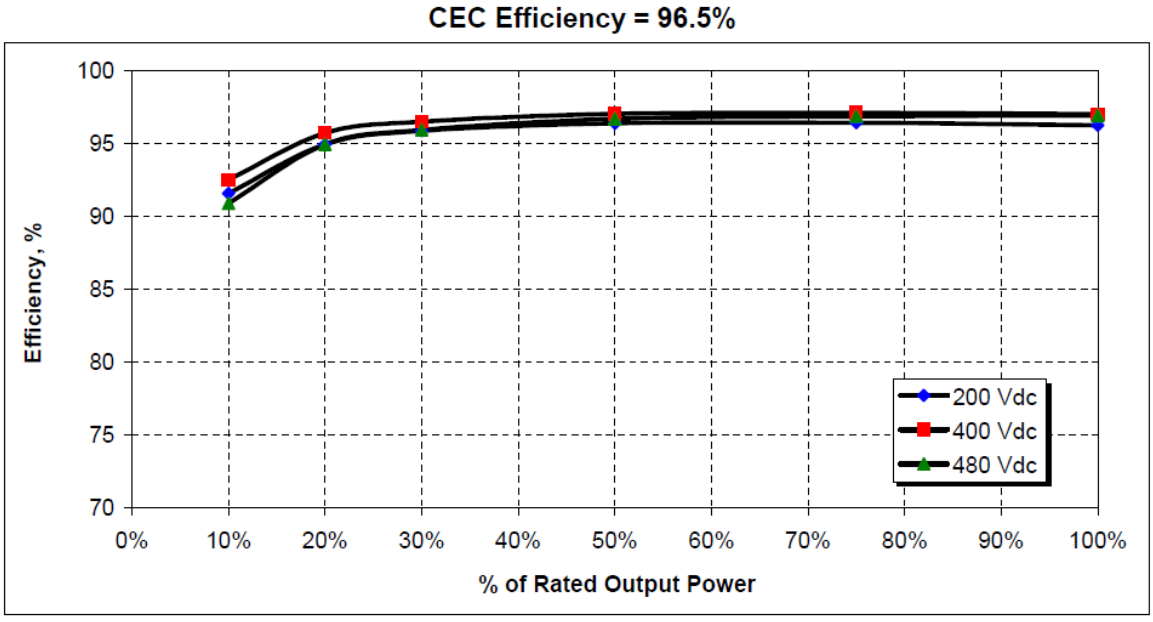


Figure 7-3: Efficiency Curve- PVI-5000-OUTD-US (277V)

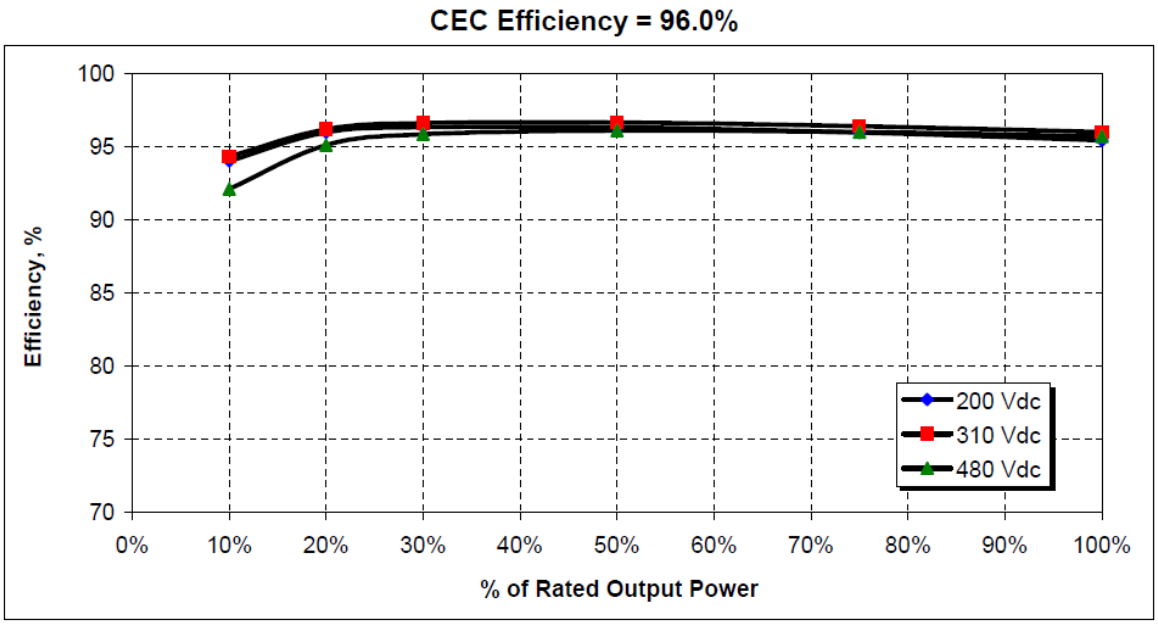


Figure 7-4: Efficiency Curve- PVI-6000-OUTD-US (208V)

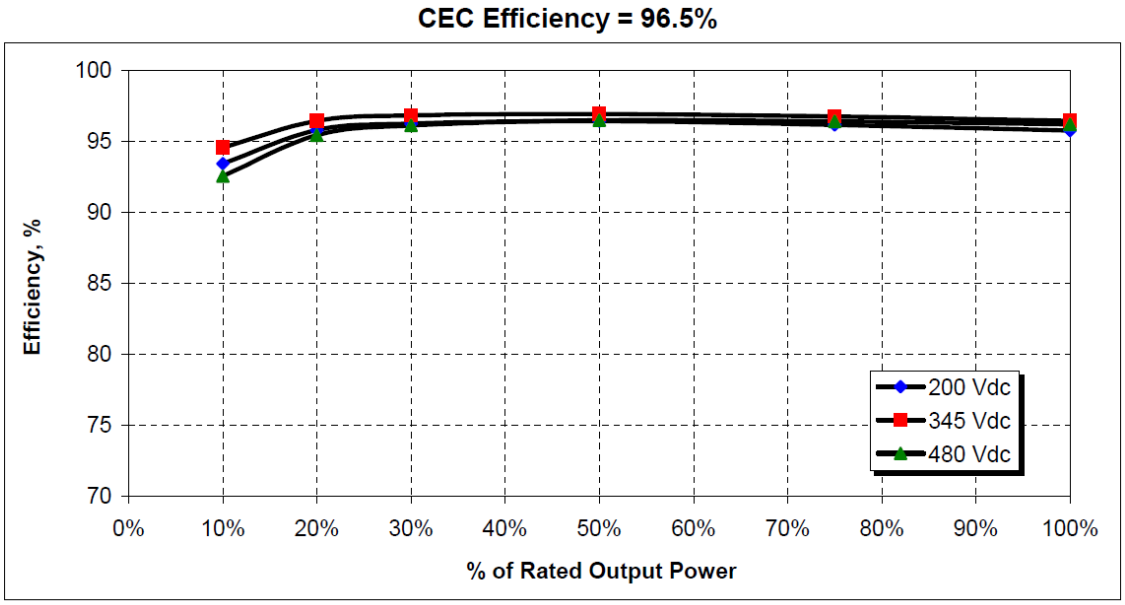


Figure 7-5: Efficiency Curve- PVI-6000-OUTD-US (240V)

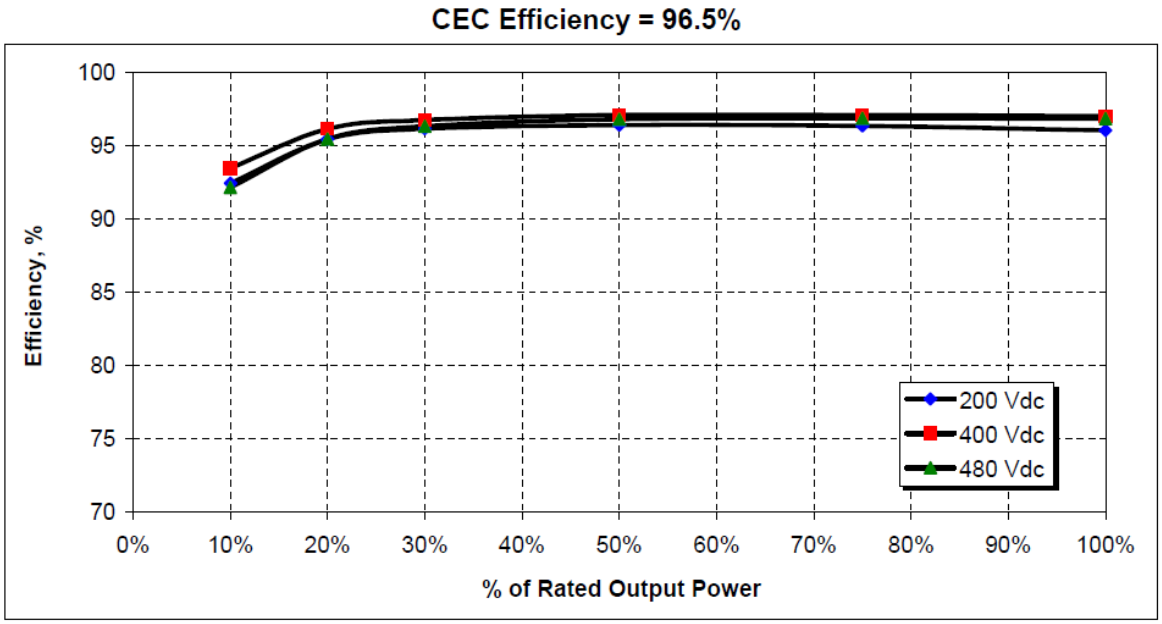


Figure 7-6: Efficiency Curve- PVI-6000-OUTD-US (277V)

7.1.3 POWER DERATING

In order to ensure inverter operation under safe conditions both from the temperature and electrical point of view, the unit automatically decreases power input to the grid. Power derating can occur in two cases:

Power reduction due to environmental conditions
Power reduction and temperature at which it occurs depend on many operating parameters other than ambient temperature, such as input voltage, grid voltage, and power available from the photovoltaic panels. The Aurora inverter can thus decrease power output during certain periods of the day according to these parameters.

In any case, the inverter ensures top power up to 40°C ambient temperature, when it is not directly exposed to the sun.

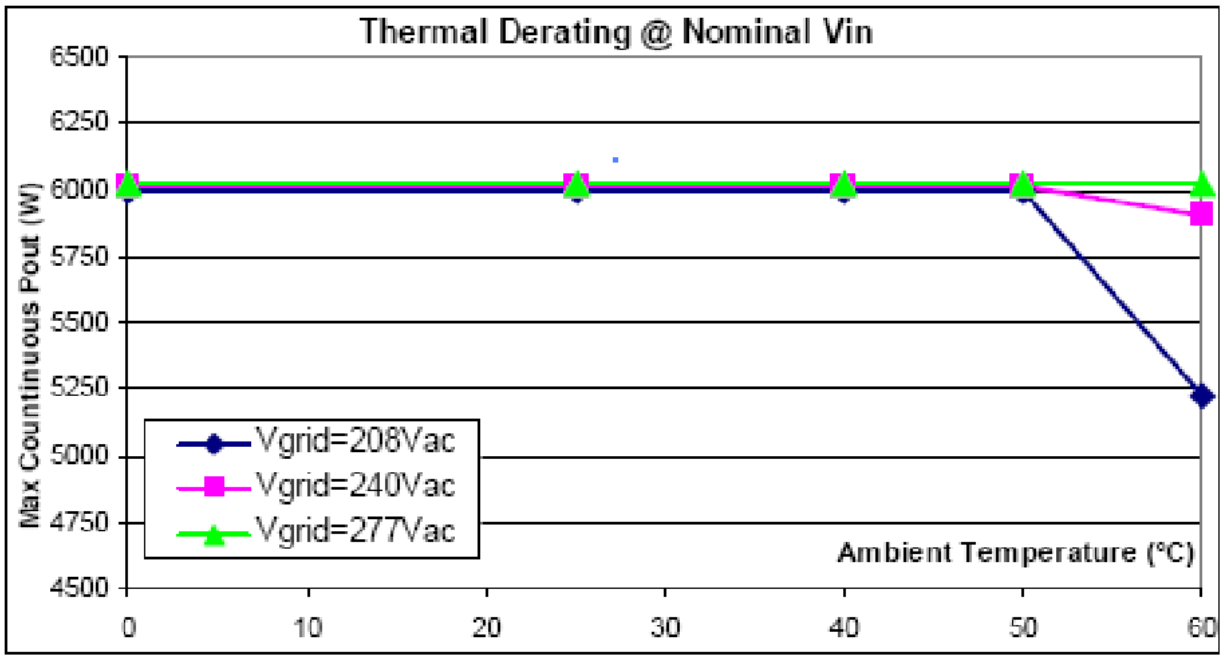


Figure 7-7: Aurora operating ambient temperature at full power (without derating) -25°C…+50°C for PVI-6000-OUTD-US

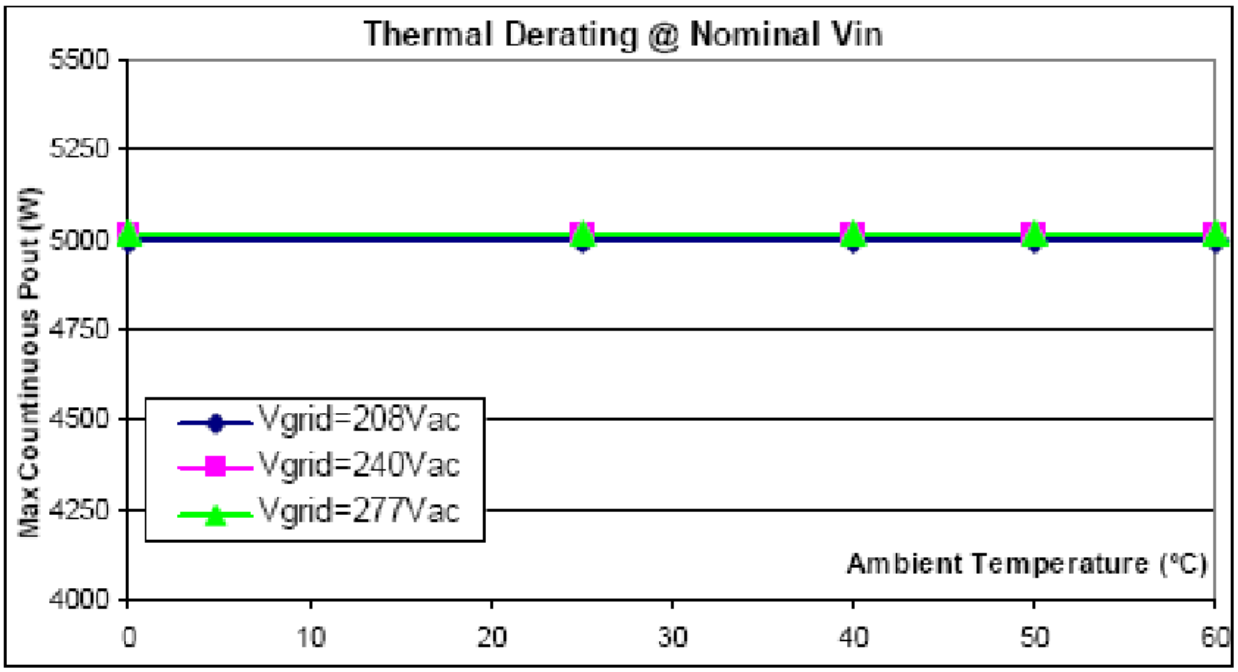


Figure 7-8: Aurora operating ambient temperature at full power (without derating) -25°C +60°C for PVI-5000-OUTD-US

Power reduction due to input voltage

The graph BELOW shows automatic power output derating when input or output voltage is too high or too low.

Necessary conditions for power derating due to environmental conditions and to input voltage can occur at the same time, but in this instance power derating will always consider the lowest value detected.

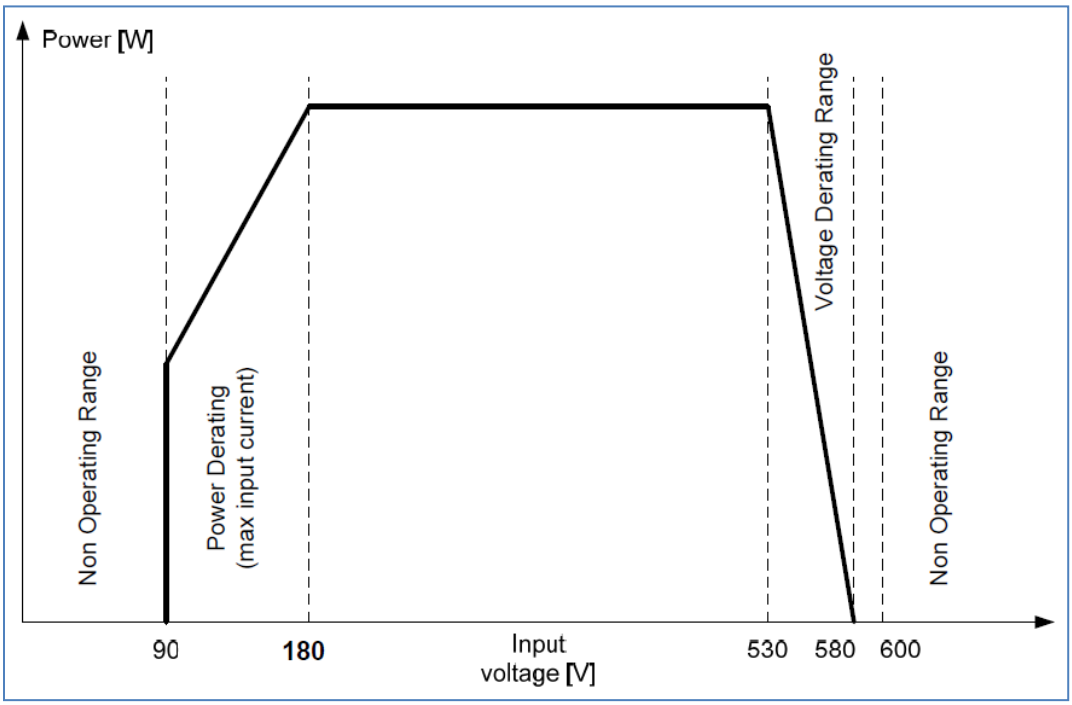


Figure 7-9: Output Power –Two DC Sections Operating

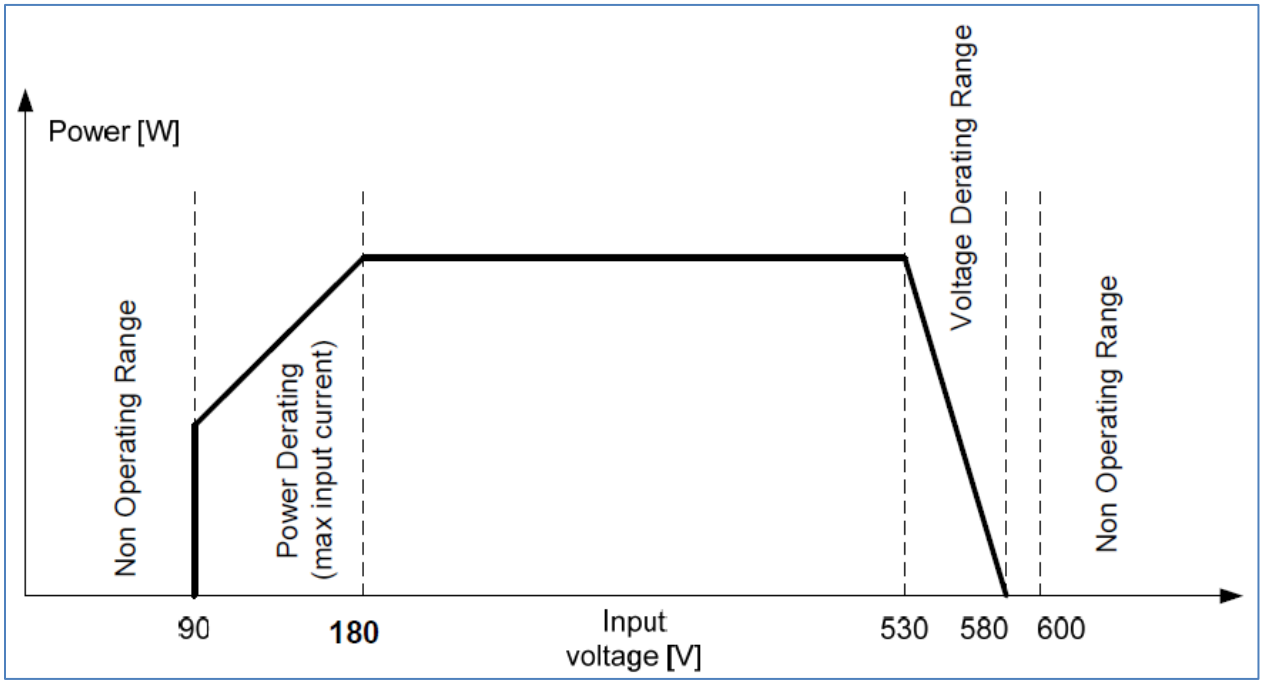


Figure 7-10: Output Power – One DC Section Operating

7.2 SYSTEM DESCRIPTION

AURORA UNO grid-tied inverters provide the capability to supply the utility grid with energy obtained from PV panels. To use the DC generated by a Photovoltaic field efficiently, it must be transformed into alternating current (AC) via a conversion process known as DC-AC inversion.

This process is the basis of all grid-tied inverters and is achieved very efficiently by the AURORA Inverter without the use of rotating elements. When the inverter output is connected in parallel to the utility power grid, the alternating current output from the inverter flows directly into the distribution circuit, and is connected in turn to the public distribution utility grid.

The photovoltaic energy system can thus feed all the connected user electrical loads:

- If the energy supply from the photovoltaic system is lower than the user's load requirement, the quantity of energy necessary to guarantee normal functioning of the connected appliances is taken from the public distribution network.
- If the energy supply from the photovoltaic system is greater than the user's load requirement (i.e. an excess of energy is produced) it is sent directly into the public network, thus becoming available to other users.

Depending on prevailing codes and regulations of the installation area, the energy produced can be sold to the utility or credited against future consumption, thereby producing energy savings.

7.2.1 ELEMENTS OF A PHOTOVOLTAIC SYSTEM: 'STRINGS' AND 'ARRAYS'

In order to significantly reduce installation costs of the photovoltaic system, especially related to the wiring problem on the inverter DC side and the subsequent distribution on the AC side, the STRING technology was developed. The terminology is as follows:

1. A photovoltaic panel is composed of a great number of photovoltaic cells fixed onto a single supporting base.
2. A STRING consists of a certain number of panels connected in series.
3. An ARRAY is one or more strings connected in parallel.

Large photovoltaic systems can be composed of several arrays, connected to one or more AURORA Inverters. By maximizing the number of panels in each string, the cost and complexity of the connection systems of the plant can be reduced.

7.2.2 INVERTER INPUT - THE PHOTOVOLTAIC ARRAY

The input of a photovoltaic (PV) inverter is intended to be connected to a PV array. The input circuitry includes Maximum Power Point Tracking (MPPT) circuitry, which maximizes the output of the PV array under all allowable environmental conditions.

All AURORA UNO models are provisioned with two independent inputs, each equipped with its own MPPT circuit that enables the AURORA UNO Inverter to be connected to two independent arrays that are maximized for output power individually. See Block Diagram in Figure 7-11 below.

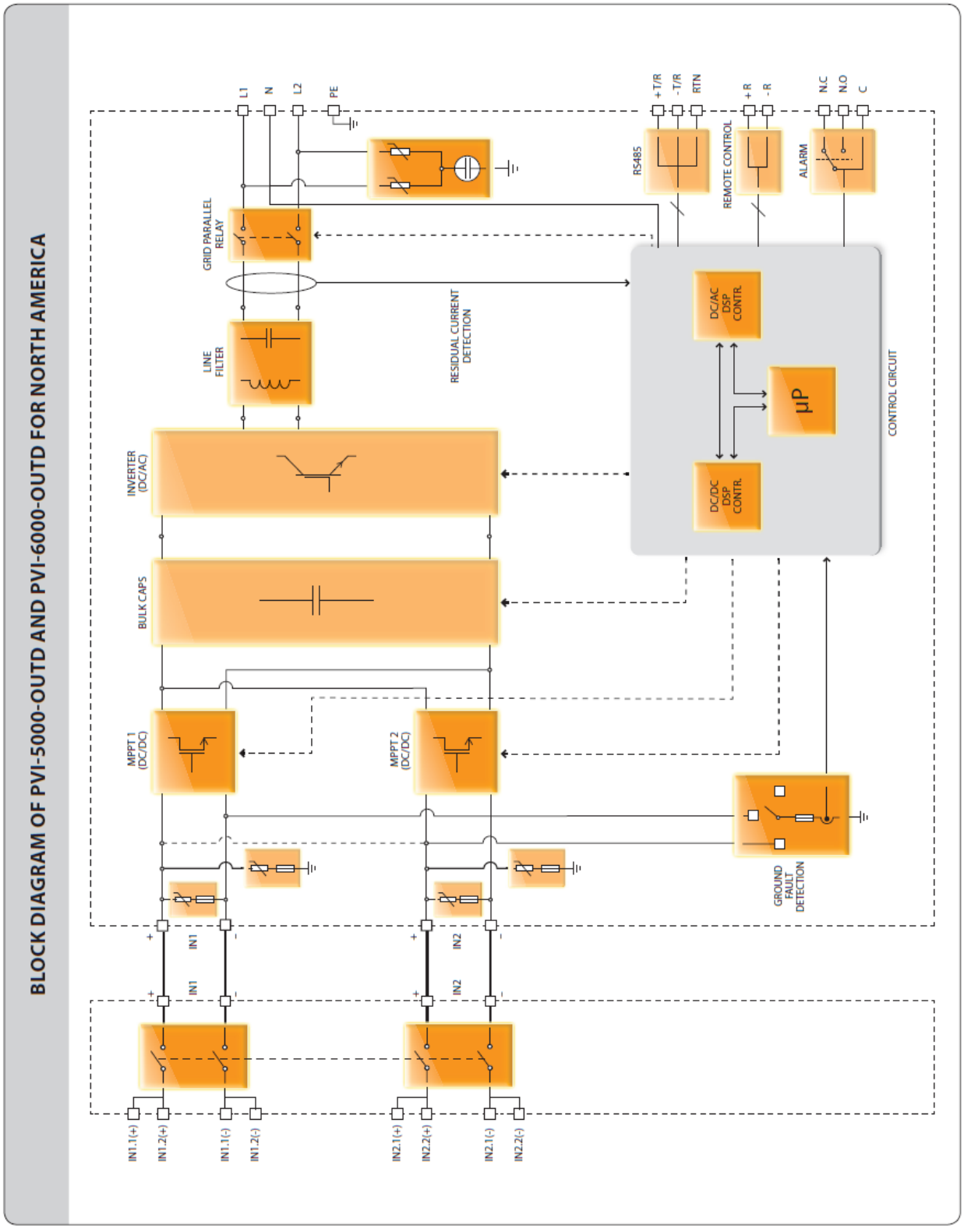


Figure 7-11: Block Diagram

The MPPT circuitry has a specific operating range and the arrays must be designed to operate within this range. In order to properly operate the AURORA Inverter, proper array sizing must be completed and the results translated to a connectable system.

Array sizing is based on many variables and must be done for every array, as specifications are dependent on the type and quantity of PV panel used, and environmental factors such as expected high and low ambient temperatures to which the array will be subjected, as well as the orientation of the array panels to the sun.

In addition to properly sizing the array to match the inverter to which it is connected, the sizing of the interconnecting wiring is critical to ensure safe operation and high reliability. In North America, the wire sizing for the array and the grid interconnection are regulated and controlled by electric and building codes.

Generally in the US, the National Electric Code (NEC) is used, but some areas use variations to this code. In Canada, the national code is the Electrical Safety Code (ESC); however, there are also local variations to this code (e.g., in Ontario the Ontario Electrical Safety Code (OESC) is the regulating document). The sizing and specification of a PV array requires trained individuals.

Decisions on how to structure a photovoltaic array depend on a number of factors and considerations, such as the type of panels, the available space, the future location of the system, long-term energy production targets, etc. Power-One offers a configuration program (AURORA Stringtool) that can aid the designer in setting correct dimensioning of a photovoltaic array to match characteristics of AURORA Inverters is available on the Power-One website (http://stringtool.power-one.com/).

To avoid equipment damage, the string voltage must not exceed 520 Vdc for any reason.

The effect of the negative thermal coefficient on the PV module's open circuit voltage causes Over Current (OC) Voltage to occur in conditions of minimum ambient temperature. It is the responsibility of the installer to check the PV generator's configuration before connecting any PV array.

The AURORA Inverter has a maximum allowable input short circuit current limit of the PV string of 22 Adc for each MPPT input channel.

The default value of the input voltage required to start the inverter (Vstart) is 200 Vdc; however, this can be set from the control panel over the range between 120 Vdc and 350 Vdc. This voltage level is required for the AURORA Inverter to start its grid connection sequence.

Once connected, the inverter will transfer the maximum available power for any Vdc input voltage value in a range between 70% of the value set by Vstart and 580 Vdc to the grid.

7.2.3 NOTES ON DIMENSIONING OF THE SYSTEM

Decisions about how to structure a photovoltaic system depend on a certain number of factors and considerations to meet the type of panels, the availability of space, the future location of the system, energy production goals over the long term, etc.

A configuration program that can help to correctly size the photovoltaic system is available on the Power-One website at www.power-one.com.

7.2.4 TECHNICAL DESCRIPTION OF AURORA INVERTER

The main segments of the design are the independent input DC-DC converters (termed 'boosters', one for each MPPT channel) and the main output inverter. Both of the DC-DC converters and the output inverter operate at a high switching frequency to enable a compact design and low weight.

These versions of Power-One's AURORA Inverters utilize "high-frequency switching" transformers, to provide a high-level of galvanic isolation between inverter input (array) and output (grid). This circuitry provides galvanic isolation from the secondary (AC side), while maintaining very high performance in terms of energy yield and export.

An AURORA with two independent input DC-DC converters; each converter is typically dedicated to a separate array and has independent Maximum Power Point Tracking (MPPT) circuitry and control. This means that the two arrays can be installed with different positions, facing different directions and with different string lengths; each array is controlled by an MPPT control circuit.

The Aurora's high efficiency and extra large heat dissipation system enables operation at maximum power over a broad range of ambient temperatures. Two independent *Digital Signal Processors* (DSP) and one central microprocessor control the inverter; and therefore, two independent computers control the grid connection in full compliance with safety standards and regulations.

The AURORA Inverter operating system (program) communicates with all of the sub-systems within the inverter performing necessary data processing, calculations to guarantee optimal performance levels of the system and high-power harvesting in all installation and load conditions, while maintaining full compliance with prevailing safety directives, laws and regulations.

7.2.5 PROTECTIVE DEVICES WITHIN THE AURORA INVERTER

7.2.5.1 *Inverter Output - the Grid Connection*

The inverter converts energy harvested from the PV array into a form that can be transported to the connected AC grid, and by doing so, enables the energy to be used to power grid-loads.
Connections of an inverter to the grid is a very controlled process not only in the actual electrical connection, but the regulatory processes required to gain approval from the controlling utility and other regulatory bodies. AURORA UNO Inverters meet the requirements of all interconnection standards.

7.2.5.2 *Data Transmission and Check*

The AURORA Inverters have a sophisticated communication capability that enables monitoring of single or multiple inverters over a single communication link. Remote monitoring is implemented over an RS-485-based serial interface using a version of the AURORA Protocol. There is an optional web-based data logging system (AURORA Universal) also available for remote monitoring via the Internet via LAN, or GSM digital modem. The PVI-Desktop is another monitoring option that enables (with the use of the PVI-Radio-module installed in each inverter) the ability to monitor wirelessly operation of up to six inverters within a 1000-foot radius. The PVI desktop is not a web-based monitoring system and is intended for local ('in-house") monitoring applications.

7.2.5.3 *Anti-Islanding*

When the local utility AC grid fails due to a line fault or otherwise interrupted (e.g., equipment maintenance) the AURORA UNO Inverter must be physically disconnected in a fail-safe manner to protect any personnel working on the network. The AURORA system accomplishes this in full compliance with all prevailing standards and regulations. To avoid any possible operation without the presence of an active grid connection, the AURORA

design includes an automatic disconnection protection system called 'Anti-Islanding'. All AURORA models are equipped with an anti-islanding protection system certified to both US and Canadian standards (UL Std N.1741 and CSA-C22.2 N.107.1-01)

7.2.5.4 *Grounding/Differential Protection Fault*

AURORA UNO Inverter has a sophisticated ground protection circuit that continually monitors the ground connection for significant changes in fault current. when a ground fault current sufficient to cause safety hazards is detected, this circuit shuts down the inverter and illuminates a red LED on the front panel indicating a ground fault condition. The AURORA Inverter is equipped with a terminal for the system ground conductors.

Normally grounded conductors may be ungrounded and energized when a ground-fault is indicated resulting in risk of electric shock. Test before touching.

Work on the AURORA UNO Inverter must be carried out by qualified personnel.

NOTE: The protective devices for ground fault detection and control comply with CSA-C22.2 N.107.1-01 and UL Std N.1741.

7.2.5.5 *Additional Protective Devices*

AURORA UNO Inverter is equipped with additional protections to guarantee the safe operation under any circumstances. Such protections include:

- Constant monitoring of grid voltage to ensure that voltage and frequency remain within the specified operational limits (in accordance with UL 1741 standard);
- Automatic power limitation (derating) controlled by internal temperature monitoring to avoid overheating (heat sink temperature ≥158°F).

7.2.5.6 *Arc Fault Detector (AFD)*

This safety function allows the inverter to recognize electrical arcing on DC cables. Once the arcing has been detected the inverter will fall into secure state. The inverter will remain in this disconnected state even after turn it off and on again. It's possible to unlatch the unit pressing 'ESC' button on the display after a complete check of DC cables.

7.2.6 FCC REMARKS

The equipment specified in this manual complies with Part 15 of the FCC rules. Operation is subject to following two conditions:

- This equipment may not cause harmful interference.
- This equipment must accept any interference received, including interference that may cause undesired operation.

7.3 INDEX OF FIGURES AND TABLES

Revision Number	*Author*	*Date*	*Description of Modification*
1.0	*Italy*	*11/19/07*	*New release*
1.1	*Italy*	*12/15/08*	*US added*
2.0	*Italy*	*3/17/09*	*Certificate of Compliance added*
2.1	*Italy*	*6/26/00*	*Modified allowed cable section*
BCG.00565 NA 1.0, Rev AA	*Tech docs*	*4/5/12*	*8 ½ X 11 size for NA*
BCG.00682 NA 2.0 Rev AA	*Tech Docs*	*6/08/2013*	*Combined manual for front-facing and bottom DC switch.Incorporated addendums BCG.00025; BCA.00016; BCG.00607; BCG.00648. Added part number and description of AFD*

SUNPOWER™

E20/327 SOLAR PANEL

20% EFFICIENCY

SunPower E20 panels are the highest efficiency panels on the market today, providing more power in the same amount of space

MAXIMUM SYSTEM OUTPUT

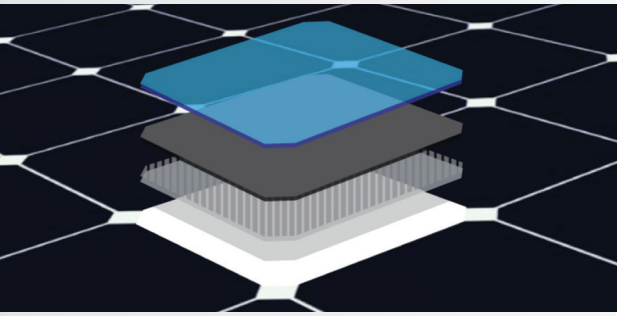
Comprehensive inverter compatibility ensures that customers can pair the highest-efficiency panels with the highest-efficiency inverters, maximizing system output

REDUCED INSTALLATION COST

More power per panel means fewer panels per install. This saves both time and money.

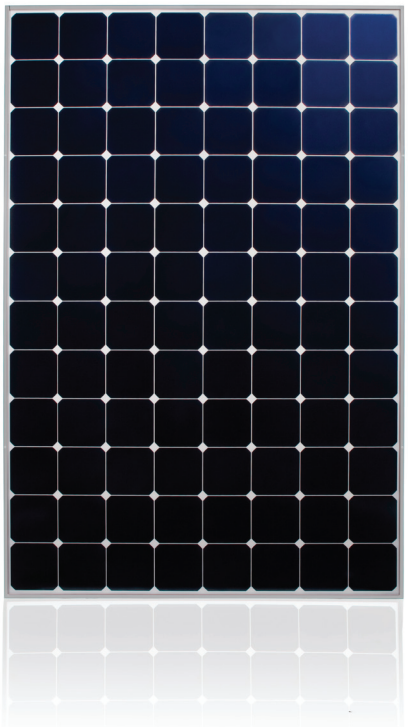
RELIABLE AND ROBUST DESIGN

SunPower's unique Maxeon™ cell technology and advanced module design ensure industry-leading reliability



MAXEON™ CELL TECHNOLOGY

Patented all-back-contact solar cell, providing the industry's highest efficiency and reliability

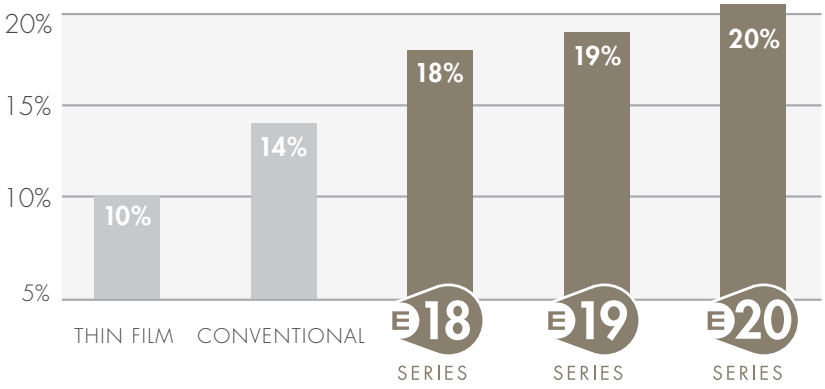


E20 SERIES

THE WORLD'S STANDARD FOR SOLAR™

SunPower™ E20 Solar Panels provide today's highest efficiency and performance. Powered by SunPower Maxeon™ cell technology, the E20 series provides panel conversion efficiencies of up to 20.1%. The E20's low voltage temperature coefficient, anti-reflective glass and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

SUNPOWER'S HIGH EFFICIENCY ADVANTAGE



sunpowercorp.com

SUNPOWER E20/327 SOLAR PANEL

MODEL: SPR-327NE-WHT-D

ELECTRICAL DATA

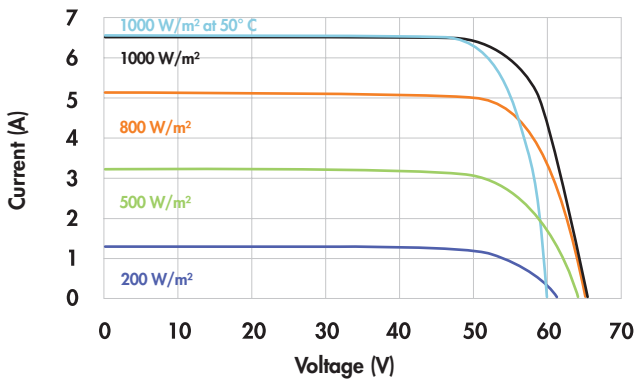
Measured at Standard Test Conditions (STC): irradiance of 1000W/m², AM 1.5, and cell temperature 25° C

Peak Power (+5/-3%)	P_{max}	327 W
Cell Efficiency	η	22.5 %
Panel Efficiency	η	20.1 %
Rated Voltage	V_{mpp}	54.7 V
Rated Current	I_{mpp}	5.98 A
Open-Circuit Voltage	V_{oc}	64.9 V
Short-Circuit Current	I_{sc}	6.46 A
Maximum System Voltage	UL	600 V
	IEC	1000 V
Temperature Coefficients	Power (P)	– 0.38 %/K
	Voltage (V_{oc})	–176.6 mV/K
	Current (I_{sc})	3.5 mA/K
NOCT		45° C +/– 2° C
Series Fuse Rating		20 A
Grounding		Positive grounding not required

MECHANICAL DATA

Solar Cells	96 SunPower Maxeon™ cells
Front Glass	High-transmission tempered glass with anti-reflective (AR) coating
Junction Box	IP-65 rated with 3 bypass diodes Dimensions: 32 x 155 x 128 mm
Output Cables	1000 mm cables / MC4 compatible connectors
Frame	Anodized aluminum alloy type 6063 (silver); stacking pins
Weight	41.0 lbs (18.6 kg)

I-V CURVE



Current/voltage characteristics with dependence on irradiance and module temperature.

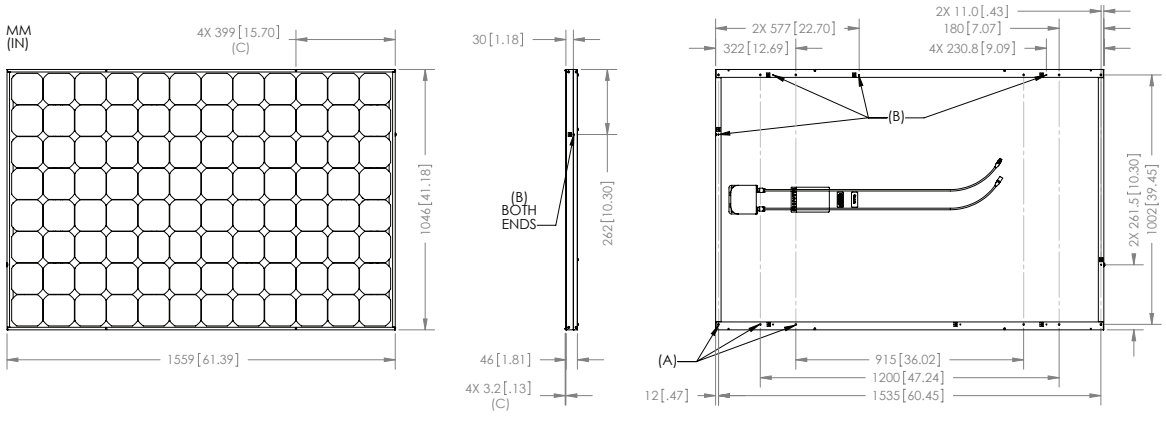
TESTED OPERATING CONDITIONS

Temperature	– 40° F to +185° F (– 40° C to + 85° C)
Max load	113 psf 550 kg/m² (5400 Pa), front (e.g. snow) w/specified mounting configurations 50 psf 245 kg/m² (2400 Pa) front and back (e.g. wind)
Impact Resistance	Hail: (25 mm) at 51 mph (23 m/s)

WARRANTIES AND CERTIFICATIONS

Warranties	25-year limited power warranty
	10-year limited product warranty
Certifications	Tested to UL 1703. Class C Fire Rating IEC 61215 Ed. 2, IEC 61730 (SCII)

DIMENSIONS



(A) - MOUNTING HOLES
12X Ø6.6 [.26]

(B) - GROUNDING HOLES
10X Ø4.2 [.17]

(C) - STACKING PINS
4X Ø6.1 X 3.2 [Ø.24 X .13]

Please read safety and installation instructions before using this product, visit sunpowercorp.com for more details.

sunpowercorp.com
Document #001-65350 Rev D / LTR_EN
CS 12_370

SECTION 265000

LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Interior luminaires and accessories.
2. Ballasts.
3. Fluorescent lamp emergency power supply.
4. Lamps.
5. Luminaire accessories.

B. Related Documents and Sections
1. Section 26 05 00 - Common Work Results for Electrical.
2. Section 26 05 34 - Outlet and Junction Boxes for Electrical Systems.
3. Section 26 05 35 - Raceway for Electrical Systems.

1.2 REFERENCES

A. ANSI C78.379-2006 - Electric Lamps - Classification of the Beam Patterns of Reflector Lamps.

B. ANSI C82.1-2004 - Line Frequency Fluorescent Lamp Ballast.

1.3 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data
1. Provide manufacturer dimensions, ratings, and performance data. Identify fixtures by luminaire schedule number. Show all required features and options; include data relative to lenses for security fixtures.
2. Submit lighting level performance data where indicated as required or where an approval of a listed fixture is requested. Provide all assumptions. Indicate whether calculated or measured.

C. Shop Drawings
1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

D. Quality Assurance/Control Submittals
1. Manufacturers' Instructions
   a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
   b. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Closeout Submittals

1. Operation and Maintenance Data
    a. Submit under provisions of Division 01.
    b. Include replacement parts list.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements
    1. Conform to requirements of CEC.
    2. Conform to requirements of CBC.
    3. Furnish products listed and classified by UL, or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.5 WARRANTY

A. Provide 3 year warranty on the lighting system.

1.6 MAINTENANCE

A. Extra Materials
    1. Lamps: Provide 10 for each interior lamp type, 5 for each exterior lamp type.
    2. Ballast: Provide 5 of each ballast type.

PART 2 PRODUCTS

2.1 LUMINAIRES - GENERAL

A. Furnish products as specified in schedule.
    1. GENERAL: Lighting fixtures as hereinafter specified are identified by type as noted on drawings. Fixture specifications are based on construction and performance. Manufacturer's catalogue numbers are of general nature and indicate level of quality required, but do not necessarily reflect complete options as specified. Approval shall be based on description and specification of fixture as well as catalogue number indicated. See specifications for fixture, lens, lamp and ballast requirements. Verify ballast voltage requirements with circuitry indicated on drawings.

B. Install ballasts and specified accessories at factory.

C. Pendant mounted fluorescent fixtures in continuous rows shall be supported by conduit. Provide reflector alignment clips on all industrial fluorescent fixtures mounted in continuous rows.

2.2 BALLASTS

A. Fluorescent Ballast - Non-Dimming:
    1. Manufacturers:
        a. General Electric
        b. Advance
        c. Philips
    2. Description: ANSI C82.1, high power factor type electronic (Octron) ballast, ETL approved, UL labeled P.
    3. Total Harmonic Distortion will be less than 10%.

4. Protected with two internal automatic resetting thermal switch devices for coil and capacitor.
5. Sound Level: 'A' for 430-MA or less lamps 'B' for 800-ma lamps and 'C' for 1,500-MA lamps. Stamp rating on ballast.
6. Provide low temperature ballasts where installed in non-conditioned spaces. Ballasts shall operate to 0 degrees F.
7. Provide rapid start ballasts for lamps 25 watts and greater.
8. Provide ballast suitable for lamps specified.
9. Voltage: Match luminaire voltage.
10. Source Quality Control: Certify ballast design and construction by Certified Ballast Manufacturers, Inc.
11. Comply with California Title 24 energy requirements.
12. Electronic (Octron) ballasts shall be provided within those lighting fixtures that utilize Octron lamps as follows:
    a. 2 Lamp fixture: 2 lamp ballast.

2.3 LAMPS

A. Fluorescent Lamps:
1. Manufacturers:
    a. General Electric Company.
    b. Sylvania.
    c. Philips.
2. All lamps shall be 4100K unless otherwise indicated.
3. All F32 lamps shall be the latest generation of T8 energy saving type such as Sylvania Octron unless otherwise indicated.

B. Provide lamp type compatible with luminaire.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
1. Examine substrate and supporting grids for luminaires.
2. Examine each luminaire to determine suitability for lamps specified.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturers' instructions.

B. Mount lighting fixtures at heights indicated.

C. Install accessories furnished with each luminaire.

D. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

E. Bond products and metal accessories to branch circuit equipment grounding conductor.

F. Install specified lamps in each luminaire.

G. Maintain fire rating of ceiling where luminaire are installed.

3.3 FIELD QUALITY CONTROL

A. Site Tests
   1. Test under provision of Division 01.
      a. Operate each luminaire after installation and connection.

B. Inspection
   1. Inspect for proper connection and operation.

3.4 ADJUSTING

A. Adjust Work under provisions of Division 01.

B. Aim and adjust luminaires as indicated on Drawings as directed.

C. Adjust exit sign directional arrows as indicated.

D. Relamp luminaires that have failed lamps at Substantial Completion.

3.5 CLEANING

A. Clean Work under provisions of Division 01.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure.

D. Clean photometric control surfaces as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.6 DEMONSTRATION

A. Provide systems demonstration under provisions of Division 01.

B. Provide minimum of two hours demonstration of luminaire operation.

END OF SECTION

6" HORIZONTAL TRT FLUORESCENT 1-LAMP

LF6

SERIES

LAMPS

1/26-42TRT[1]	
1/26TRT	
1/32TRT	
1/42TRT	

REFLECTOR

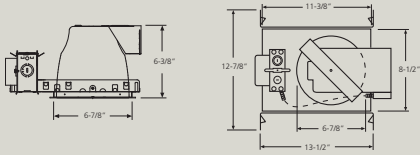
F6O1A	Clear Diffuse Open
F6O1AZ	Clear Specular Open
F6W4A	Clear Diffuse Wallwash
F6W4AZ	Clear Specular Wallwash
F6LS4	White Splay, Flat Clear Glass Fresnel Lens
F6LS73	White Splay, Flat T73 Tempered Prismatic Lens

VOLTAGE

MVOLT[2]
347

OPTIONS

GEB1O	Generic electronic ballast, THD (total harmonic distortion) <10%.
ADEZ	Advance Mark 10™ electronic dimming ballast, 120V or 277V. Minimum dimming level 5%.
DMHL	Lutron Compact SE™ electronic dimming ballast, 120V or 277V. Minimum dimming level 5%.
GMF	Single slow-blow fuse.
EL	Emergency battery pack with integral test switch. Consult factory for availability.
ELR	Emergency battery pack with remote test switch.
WLP	35K lamp (shipped separately).
TRW	White flange.

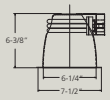


NOTES:
1 Not available with DMHL or WLP.
2 MVOLT – Electronic multi-volt ballast capable of operating any line voltage from 120-277V, 50 or 60Hz.

REFLECTORS: All reflectors are damp location listed. Lensed reflectors are wet location listed. Lamp types and maximum wattages are listed for each reflector. For complete reflector offering, refer to product specification sheets.

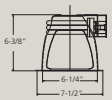
F6O1A
OPEN

1/42TRT



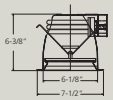
F6W4A
OPEN WALLWASH WITH KICKER

1/42TRT

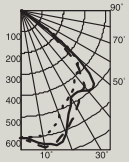


F6L
GLASS LENS

1/42TRT



F6O1A, (1) Philips PL-C 32W/27SH lamp, sc(across) = 1.2, sc(along) = 1.3, 3600 rated lumens, Test no. LTL12515



	cp.	Lumens
0°	598	
5°	612	59
15°	639	178
25°	533	247
35°	471	296
45°	444	330
55°	137	135
65°	11	12
75°	3	3
85°	1	1
90°	0	

Zone	Lumens	%lamp
0°-30°	487.7	20.2
0°-40°	780.1	32.5
0°-60°	1245.0	51.9
0°-90°	1261.5	52.6
90°-180°	0.0	0.0
0°-180°	1261.5	*52.6
*Total Efficiency		

pf pc pw	80% 50%	80% 30%	20% 50%	20% 30%	30% 50%	30% 30%
0	.63	.63	.61	.61	.58	.58
1	.57	.55	.56	.54	.54	.53
2	.52	.49	.51	.48	.49	.47
3	.47	.43	.46	.43	.44	.42
4	.42	.38	.42	.38	.40	.37
5	.38	.34	.38	.34	.37	.33
6	.35	.31	.34	.31	.34	.30
7	.32	.28	.32	.28	.31	.27
8	.29	.25	.29	.25	.28	.25
9	.27	.23	.27	.23	.26	.23
10	.25	.21	.25	.21	.24	.21

Mount height	Initial fc at beam center
104.1°	
8.0	19.8
10.0	10.6
12.0	6.6
14.0	4.5
16.0	3.3

50% Beam angle 62.9° Beam diameter	fc at beam edge	10% Beam angle Beam diameter	fc at beam edge
6.7	9.9	14.1	2.0
9.2	5.3	19.2	1.1
11.6	3.3	24.3	0.7
14.1	2.3	29.5	0.5
16.5	1.6	34.6	0.3

LITHONIA LIGHTING

6" HORIZONTAL DTT FLUORESCENT 2-LAMP

LF6

SERIES

LAMPS

2/18DTT
2/26DTT

REFLECTOR

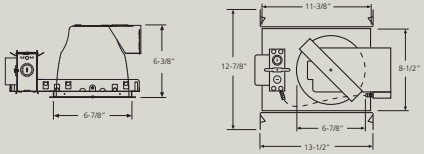
F6O2	White Open
F6O2A	Clear Diffuse Open
F6O2AZ	Clear Specular Open
F6O2G	Gold Specular Open
F6B3	Black Baffle
F6B3W	White Baffle
F6W1AZ	Clear Specular Wallwash
F6W1GZ	Gold Specular Wallwash
F6LB4	Black Baffle, Flat Fresnel Lens
F6LFB73	Black Baffle, Flat T73 Tempered Prismatic Lens

VOLTAGE

MVOLT[1]
120
277
347

OPTIONS

GEB1O	Generic electronic ballast, THD (total harmonic distortion) <10%.
ADEZ	Advance Mark 10™ electronic dimming ballast, 120V or 277V. Minimum dimming level 5%.
DMHL	Lutron Compact SE™ electronic dimming ballast, 120V or 277V. Minimum dimming level 5%.
LRC	Provides compatibility with Lithonia Reloc System.
EL	Emergency battery pack with integral test switch. Consult factory for availability.[2]
ELR	Emergency battery pack with remote test switch.[2]
GMF	Single slow-blow fuse.
WLP	35K lamp (shipped separately).
TRW	White flange.

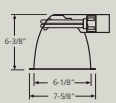


NOTES:
1 MVOLT – Electronic multi-volt ballast capable of operating any line voltage from 120-277V, 50 or 60Hz.
2 Not available with a magnetic ballast.

REFLECTORS: All reflectors are damp location listed. Lensed reflectors are wet location listed. Lamp types and maximum wattages are listed for each reflector. For complete reflector offering, refer to product specification sheets.

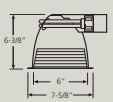
F6O2
OPEN

2/26DTT



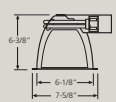
F6B3
PREMIUM METAL BAFFLE W/ DIFFUSE UPPER REFLECTOR

2/26DTT



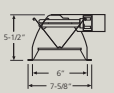
F6W1
OPEN WALLWASH WITH KICKER

2/26DTT

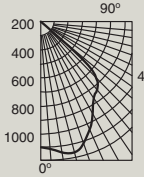


F6L
GLASS LENS

2/26DTT



F6O2AZ, (2) Philips PL-C 26W/27SH lamp, sc=1.2, 3600 rated lumens, Test no. 2193120701



	cp.	Lumens
0°	887	
5°	903	87
15°	960	269
25°	841	384
35°	666	420
45°	569	424
55°	144	158
65°	7	8
75°	1	1
85°	0	0
90°	0	

Zone	Lumens	%lamp
0°-30°	740.3	20.6
0°-40°	1160.8	32.2
0°-60°	1742.1	48.4
0°-90°	1751.4	48.6
90°-180°	0	0.0
0°-180°	1751.4	*48.6
*Total Efficiency		

pf pc pw	80% 50%	80% 30%	20% 50%	20% 30%	30% 50%	30% 30%
0	.58	.58	.57	.57	.54	.54
1	.53	.52	.52	.51	.50	.49
2	.48	.46	.47	.45	.46	.44
3	.44	.41	.43	.40	.42	.39
4	.40	.36	.39	.36	.38	.35
5	.36	.33	.36	.32	.35	.32
6	.33	.29	.33	.29	.32	.29
7	.30	.27	.30	.27	.29	.26
8	.28	.24	.28	.24	.27	.24
9	.26	.22	.26	.22	.25	.22
10	.24	.21	.24	.20	.23	.20

Mount height	Initial fc at beam center
102.6°	
8.0	29.3
10.0	15.8
12.0	9.8
14.0	6.7
16.0	4.9

50% Beam angle 62.4° Beam diameter	fc at beam edge	10% Beam angle Beam diameter	fc at beam edge
6.7	14.7	13.7	2.9
9.1	7.9	18.7	1.6
11.5	4.9	23.7	1.0
13.9	3.4	28.7	0.7
16.4	2.4	33.7	0.5

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — Low-profile static luminaire provides general illumination for recessed applications; Ideal for restricted plenum spaces.

Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.

ATTRIBUTES — Designed exclusively for use with T8 lamps, electronic ballasts and sockets.

CONSTRUCTION — Smooth hemmed sides and smooth, inward formed end flanges for safe handling. Lighter weight fixture allows for safe, easy installation.

Standard steel door frame has superior structural integrity with premium extruded appearance and precision flush mitered corners. Steel door allows easy lens replacement without frame disassembly (for lenses up to .156" think). Powder painted, steel latches provide easy, secure door closure.

Superior mechanical light seal requires no foam gasketing. Integral T-bar clips secure fixture to T-bar system. Housing formed from cold-rolled steel. Acrylic shielding material 100% UV stabilized. No asbestos is used in this product.

FINISH — Five-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

ELECTRICAL — Standard ballast is electronic, thermally protected, resetting, Class P, HPF, non-PCB, UL Listed, CSA certified ballast, universal voltage and sound rated A.

Luminaire is suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures.

LISTING — Standard: UL. Optional: Canada — CSA or cUL; Mexico — NOM.

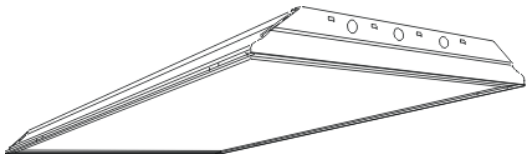
WARRANTY — Guaranteed for one year against mechanical defects in manufacture.

US patents: 6,210,025; 6,231,213; 2,288,471.

Note: Specifications subject to change without notice.

General Purpose T8 Troffer

GT8 2'x4'



2, 3 or 4 Lamps

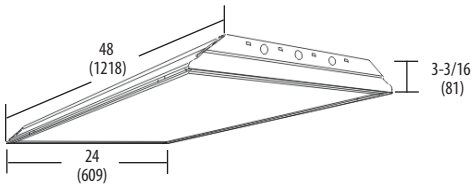
Specifications

Length: 48 (1218)

Width: 24 (609)

Depth: 3-3/16 (81)

Weight: 22 lbs (9.9 kg)



All dimensions are inches (millimeters).

ORDERING INFORMATION For shortest lead times, configure products using **bolded options**.

Example: 2GT8 2 32 A12 MVOLT GEB10IS

2GT8							
Series	**Trim type**	**Number of lamps**	**Lamp type**	**Door frame**	**Diffuser type**	**Voltage**	**Options[2]**
2GT8 2" wide	**(blank)** Grid F Overlapping flanged	**2** **3** **4** Not included	**32** 32W T8 (48")	**(blank)** Flush steel, white FN Flush aluminum, natural FM Flush aluminum, matte black **FW** Flush aluminum, white RN Regressed aluminum, natural RM Regressed aluminum, matte black **RW** Regressed aluminum, white	**A12** #12 pattern acrylic **A12125** #12 pattern acrylic, .125" thick **A19** #19 pattern acrylic, .156" thick A15 #15 pattern acrylic, .2" thick PC1S 1/2" x 1/2" x 1/2" plastic cube louver, silver PC2S 1-1/2" x 1-1/2" x 1" plastic cube louver, silver w/ flange[1] PC3S 3/4" x 3/4" x 1/2" plastic cube louver, silver	**120** 277 347 MVOLT Others available	**1/4** One 4-lamp ballast **1/3** One 3-lamp ballast **GEB10IS** Electronic ballast, <10% THD, instant start GEB10RS Electronic ballast, <10% THD, rapid start **EL** Emergency battery pack (nominal 300 lumens) **EL14** Emergency battery pack (nominal 1400 lumens) GLR Internal fast-blow fuse GMF Internal slow-blow fuse LST Tandem-wired fixture pairs (shared ballasts) **PWS1836** 6' prewire, 3/8" dia., 18-gauge, 1 circuit LP_ Lamped, specify lamp type and color **LP735** Lamped, 700-series, 3500K **LP741** Lamped, 700-series, 4100K JP Palletized and stretch-wrapped without individual cartons; grid trim only **CSA** CSA Certified **NOM** NOM Certified

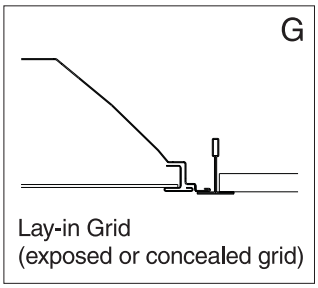
NOTES:

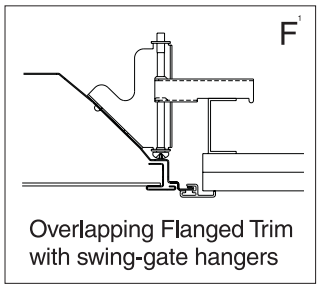
1 Available with flush door frames only.

2 MVOLT standard for 120-277V applications, 50-60 hz operation. Some options require voltage specified.

MOUNTING DATA

Continuous row mounting of flanged units requires CRE and CRM trim options (see Options).

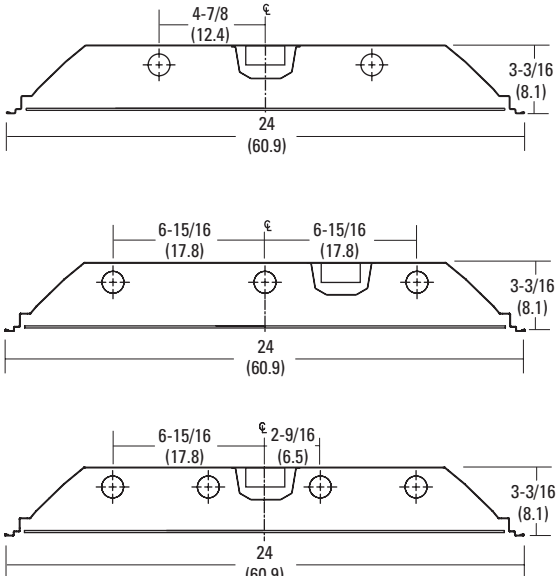




NOTE:

1 Recommended rough-in dimensions for F-trim fixtures 24"x48" (Tolerance is +1/4"-0"). Swing-gate range 1-3/16" to 3-15/16". Swing-gate span 23-3/8" to 26-11/16". Fixture swing-gate points require additional 1-1/16" over nominal fixture height.

DIMENSIONS



PHOTOMETRICS

Calculated using the zonal cavity method in accordance with IESNA LM41 procedure. Floor reflectances are 20%.
Lamp configurations shown are typical. Full photometric data on these and other configurations available upon request.

2GT8 2 32 A12

Report LTL 7424
Lumens per lamp - 2850 – Lum. eff. - 81.7%
S/MH (along) 1.2 (across) 1.4

Coefficient of Utilization

Ceiling	80%			70%			50%		
Wall	70%	50%	30%	70%	50%	30%	50%	30%	10%
0	97	97	97	95	95	95	91	91	91
1	89	86	82	87	84	81	80	78	76
2	82	75	70	80	74	69	71	67	63
3	75	67	60	73	65	59	63	58	54
4	69	59	52	67	58	52	56	51	46
5	63	53	46	62	52	46	51	45	40
6	59	48	41	47	47	40	46	40	35
7	54	44	37	53	43	36	42	36	31
8	51	40	33	49	39	33	38	32	28
9	47	37	30	46	36	30	35	29	25
10	44	34	27	43	33	27	32	27	23

Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixture
0-30	1372	24.1	29.4
0-40	2277	39.9	48.9
0-60	3907	68.5	83.9
0-90	4658	81.7	100.0
90-180	0	0	0
0-180	4658	81.7	100.0

2GT8 3 32 A12 1/3

Report LTL 7421
Lumens per lamp - 2850 – Lum. eff. - 80.1%
S/MH (along) 1.2 (across) 1.4

Coefficient of Utilization

Ceiling	80%			70%			50%		
Wall	70%	50%	30%	70%	50%	30%	50%	30%	10%
0	95	95	95	93	93	93	89	89	89
1	88	84	81	85	82	79	79	76	74
2	80	74	69	78	72	68	70	66	62
3	74	66	59	72	64	58	62	57	53
4	68	58	52	66	57	51	55	50	46
5	62	52	45	61	52	45	50	44	40
6	58	47	40	56	47	40	45	39	35
7	54	43	36	52	42	36	41	35	31
8	50	39	33	49	39	32	38	32	28
9	47	36	30	45	36	29	35	29	25
10	44	33	27	43	33	27	32	27	23

Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixture
0-30	2066	24.2	30.2
0-40	3412	39.9	49.8
0-60	5768	67.5	84.2
0-90	6851	80.1	100.0
90-180	0	0	0
0-180	6851	80.1	100.0

2GT8 4 32 A12 1/4

Report LTL 7425
Lumens per lamp - 2850 – Lum. eff. - 78.6%
S/MH (along) 1.2 (across) 1.4

Coefficient of Utilization

Ceiling	80%			70%			50%		
Wall	70%	50%	30%	70%	50%	30%	50%	30%	10%
0	94	94	94	91	91	91	87	87	87
1	86	82	79	84	81	78	77	75	73
2	79	73	68	77	71	67	68	64	61
3	72	64	58	70	63	57	61	56	52
4	66	57	51	65	56	50	54	49	45
5	61	51	45	60	51	44	49	43	39
6	57	47	40	55	46	39	44	39	34
7	53	42	36	51	42	35	40	35	31
8	49	39	32	48	38	32	37	31	27
9	46	35	29	45	35	29	34	29	25
10	43	33	27	42	32	27	32	26	22

Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixture
0-30	2718	23.8	30.3
0-40	4481	39.3	50.0
0-60	7553	66.3	84.2
0-90	8965	78.6	100.0
90-180	0	0	0
0-180	8965	78.6	100.0

FLUORESCENT: One Lithonia Way Conyers, GA 30012 Phone: 800-315-4963 Fax: 770-981-8191 www.lithonia.com Rev. 12/20/11

The Savoy - 52"

Model: 20517

Traditional
Large Room

MSRP: $219.00

Hunter combines 19th century craftsmanship with 21st century design and technology to create ceiling fans of unmatched quality, style, and whisper-quiet performance. Using the finest materials to create stylish designs, Hunter ceiling fans work beautifully in today's homes and can save up to 47% on cooling costs!

Average User Rating (0 reviews)

Sign in to write a review

Owner's Manual
Parts Guide

Matte Black Finish	Number of Blades: 5	RPM High: 175
Light Cherry / Walnut Blades	3 Position Mounting	Wobble-Free® Canopy
	3 Speeds	ENERGY STAR®
Motor Type: WhisperWind® Motor	CFM High: 5873	Limited Lifetime Warranty

Dimensions	Flush	Standard	Angled
Ceiling to bottom of fan	11 Inches	13.5 Inches	47 Inches
Ceiling to bottom of fan blade	10 Inches	12.5 Inches	46 Inches
Ceiling to bottom of light	4.25 Inches	6.75 Inches	40.25 Inches

Energy Information

Airflow	Electricity Use	Airflow Efficiency
5873	**66**	**89**
Cubic Feet Per Minute	Watts (excludes lights)	Cubic Feet Per Minute Per Watt

Compare:
49" to 60" ceiling fans have airflow efficiencies ranging from approximately 51 to 176 cubic feet per minute per watt at high speed

Money-Saving Tip:
Turn off fan when leaving room

To calculate the impact you can have on your wallet—and the environment—simply answer a few questions on Hunter's Energy Savings Calculator to see how much you can

MSRP: $179.00 MSRP: $209.00

Accessories

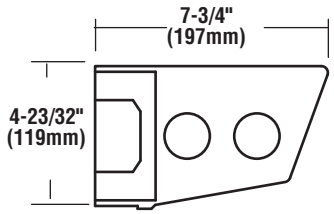
Antique Black Cap and Finial
MSRP: $15.00

Basic On/Off Remote Control
MSRP: $35.00

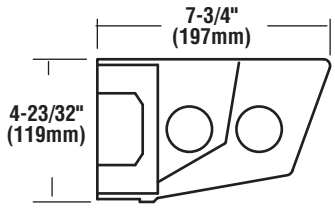
BR/BRB

LINEAR PRISMED ACRYLIC

DIMENSIONS



BR
(2 LAMP)



BRB
(2 LAMP WITH BAFFLE)

PRODUCT HIGHLIGHTS

- Baffled units available for independent control of up or down light
- Enclosed unit ideal for hospitals, corridors, hotels and barracks
- Reflectors equipped with quarter-turn, captive latches for easy access to ballast compartment
- Clear, linear-prismed, acrylic wraparound lens with "DR" (impact-resistant) formulation
- Lens held in place with concealed hinges located in die-formed, white plastic end caps

CONSTRUCTION - Fixture housing, lampholder brackets, end sections and channel cover constructed of code-gauge, die-formed steel. Housing channel crimped along sides for added rigidity/ straight alignment.

c UL us LISTED

ARRA Funding Compliant

American Innovation

American Made

ELECTRICAL - A All devices UL/CUL listed. Suitable for damp locations. Damp location emergency pack must be specified separately. Ballasts are energy saving solid-state electronic. Ballasts and lampholders replaceable without removing from ceiling. Discrete voltage must be specified for emergency pack options when wired with flex.

FINISH - All metal parts painted after fabrication following treatment with phosphate rust inhibitor. Finish coating of housing reflecting surfaces is with white, high reflectance (minimum 92%) polyester powder.

PHOTOMETRICS - Please visit our web site at **www.lsi-industries.com** for detailed photometric data.

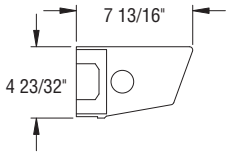
ORDERING INFORMATION

TYPICAL ORDER EXAMPLE: **BR 2 32 SSO10 EM UE**

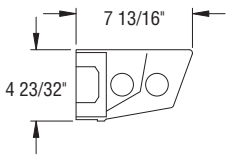
Prefix	Lamps	Lamp Type	Ballasts	Options	Voltage
BR BRB* *for 2-lamp units with 2 each 1-lamp ballasts and center baffle	1 2	T8 Lamps 17 - 17W 24" 25 - 25W 36" 32 - 32W 48"	SSOD - T8 Dimming (specify type) SSOL - T8 Low Watt SSOHL- T8 High Ballast Factor SSOHLR- T8 Program Start High Ballast Factor SSOR - T8 Programmed Start SSO10 - T8 <10% THD Instant Start	F - Fusing EM - Emergency Pack EMDL - Emergency Pack - Damp Location P- Pin Switch (for 120V only) GO - Grounded outlet (for 120V only) S - 3 Amp. On-Off Switch (for 120V only) PS - 4 way Pull Switch for BRB units (for 120V only) CEE - CEE Approved Components installed	120 - 120V 277 - 277V 347 - 347V UE - Universal Electronic (120-277V)

BR / BRB

DIMENSIONS

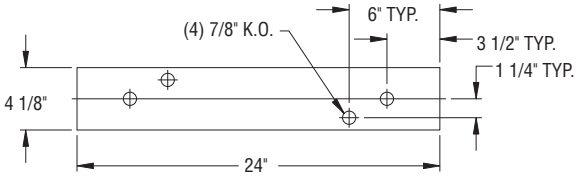


1 LAMP
"BR"

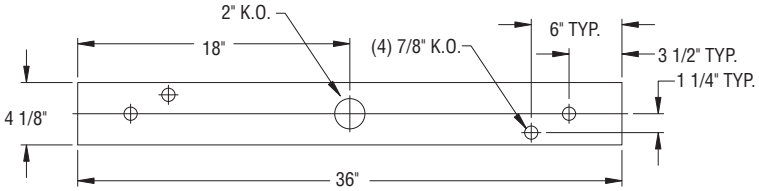


2 LAMP WITH BAFFLE
"BRB"

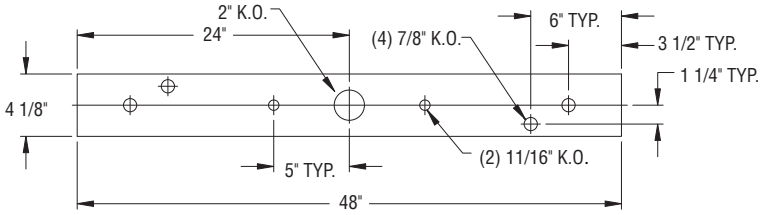
MOUNTING



BR-117, BR-120, BR-217, BR-220,
BRB-217, BRB-220
1-7/8" x 4-1/8" CHANNEL

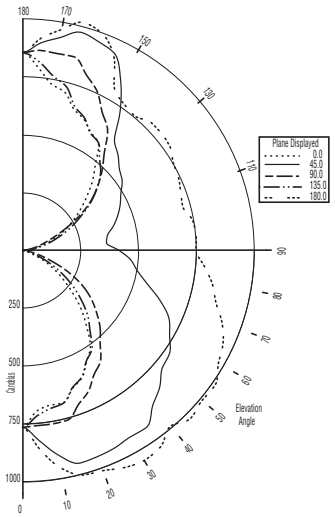


BR-125, BR-130, BR-225, BR-230,
BRB-225, BRB-230
1-7/8" x 4-1/8" CHANNEL



BR-132, BR-134, BR-232,
BR-234, BRB-232, BRB-234
1-7/8" x 4-1/8" CHANNEL

PHOTOMETRICS



Catalog#BR-232-SSO
Report#10795
Spacing Criterion N/A
Yearly Cost of 1000 Lumens, 3000 Hours of 0.08 KWH = 2.64

Candle Power Summary

Vertical Degree	Horizontal Angle 0	45	90	135	180
0	763	763	763	763	763
10	954	898	760	693	679
20	1012	947	707	630	633
30	1048	930	618	551	553
40	991	874	521	453	431
50	1010	788	417	330	279
60	976	733	294	193	150
70	917	632	132	73	43
80	832	503	33	5	0
90	749	417	0	0	0
100	746	372	33	63	47
110	727	437	111	163	140
120	752	490	263	287	247
130	784	546	420	420	362
140	756	617	549	517	490
150	797	847	688	585	589
160	999	959	806	660	648
170	968	933	863	764	728
180	854	854	854	854	854

Efficiency 95.10%

LER FW-91

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Fixt
0-30	650.22	11	11.6
0-40	1086.67	18.4	19.4
0-60	1996.66	33.8	35.6
0-90	2913.97	49.4	51.9
90-120	807.97	13.7	14.4
90-130	1197.36	20.3	21.3
90-150	2021.19	34.3	36
90-180	2695.8	45.7	48.1
0-180	5609.76	95.1	100

Coefficients Of Utilization - Zonal Cavity Method
Effective Floor Cavity Reflectance 0.20

RC	80				70				50		
RW	70	50	30	10	70	50	30	10	50	30	10
0	102	102	102	102	95	95	95	95	80	80	80
1	92	87	83	79	84	80	76	73	68	65	62
2	83	75	68	63	76	69	64	59	59	54	51
3	75	65	58	52	69	60	54	48	51	46	42
4	69	58	50	43	63	53	46	41	45	40	35
5	63	51	43	37	58	47	40	35	40	34	30
6	58	46	38	32	53	42	35	30	36	30	26
7	53	41	33	28	49	38	31	26	33	27	23
8	49	37	30	24	45	35	28	23	30	24	20
9	46	34	27	22	42	32	25	20	27	22	18
10	43	31	24	19	40	29	23	18	25	20	16

04/19/10

Project Name _____ **Fixture Type** _____

Catalog # _____

LSI Industries™
A Company with a Smart Vision

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE — For applications that require the clean appearance of a flat-bottom diffuser. Provides high light levels for storage rooms, offices or retail applications. **Certain airborne contaminants can diminish integrity of acrylic.** **Click here for Acrylic Environmental Compatibility table for suitable uses.**

CONSTRUCTION — Linear side prisms control brightness, pyramidal bottom prisms minimize lamp image. Continuous side flanges on fixture body provide light trap and continuous diffuser support to prevent accidental opening and simplify maintenance. Full depth, white enamel end plates.

Die-formed from code gauge cold-rolled steel. Channel cover snaps into place without the use of tools. Full end cap factory installed to reduce job site labor. Diffuser is extruded clear acrylic.

Finish: Five-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Finished with high-gloss, baked white enamel.

ELECTRICAL — Thermally protected, resetting, Class P, HPF, UL listed, CSA Certified ballast is standard. Energy saving and electronic ballasts are sound rated A.

Luminaire is suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures.

INSTALLATION — For surface or stem mounting, individual or row installation.

LISTINGS — UL listed to U.S. and Canadian Safety Standards. Optional: Canada CSA or Mexico NOM

WARRANTY — 1-year limited warranty. Complete warranty terms located at

www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx
Note: Specifications subject to change without notice.

Square-Basket Wraparound

SB

T8/T5
NARROW BODY
2', 4' or 8' lengths
2 lamps

Specifications

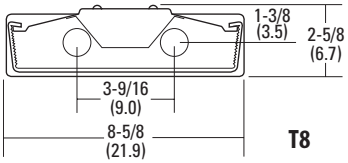
T8 Length: 24 (61.0)
48 (122.0)
96 (243.9)

T5 Length: 22-1/2 (57.2)
46-1/2 (118.1)
92-1/2 (235.0)

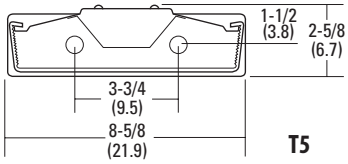
Width: 8-3/8 (21.2)

Depth: 2-5/8 (6.7)

All dimensions are inches (centimeters) unless specified otherwise.



T8



T5

ORDERING INFORMATION For shortest lead times, configure products using standard options **(shown in bold.)**

Example: SB 2 32 MVOLT GEB10IS

SB 2			
Series	**Lamp type**	**Voltage**	**Options**
SB 2 2 lamps, 8-3/8" wide For tandem double-length unit, add prefix T. Example: TSB	17 17W T8 (24") **32** 32W T8 (48") 14T5 14W T5 (22-1/2") 24T5HO 24W T5 HO (22-1/2") 28T5 28W T5 (46-1/2") 54T5HO 54W T5 HO (46-1/2")	120 277 347[1] **MVOLT**[2]	Shipped installed in fixture **GEB10IS** Electronic ballast, ≤10% THD, instant start GEB10RS Electronic ballast, ≤10% THD, program rapid start GEB10PS Electronic ballast, ≤10% THD, program start GEB95 .95 ballast factor T5[3] GEB95S .95 ballast factor T5 step dimming[3] EL Emergency battery pack (nominal 300 lumens, see Life Safety Section)[4] EL14 Emergency battery pack (nominal 1400 lumens, see Life Safety Section)[4] GLR Internal fast-blow fuse[5] GMF Internal slow-blow fuse[5] RE 120V residential electronic ballast[6] CSA Listed and labeled to comply with Canadian Standards NOM NOM certified SSR Specular silver interior finish (95% reflective)

Accessories: *Order as separate catalog number.*

SQ_	Swivel-stem hanger (specify length in 2" increments).
1B	Ceiling spacer (1-1/2" to 2-1/2" from ceiling).
DSH24	Double stem hanger for 4' fixtures, 24" stems[7]

Notes

1. Not available in GEB10PS.
2. Electronic ballast 120 through 277V only.
3. Only available with 14T5 or 28T5.
4. Not available with T5 2' configuration.
5. Must specify voltage.
6. Must specify voltage, 120V. Energy Star® qualified.
7. Only available on 2-lamp 4' SB configuration.

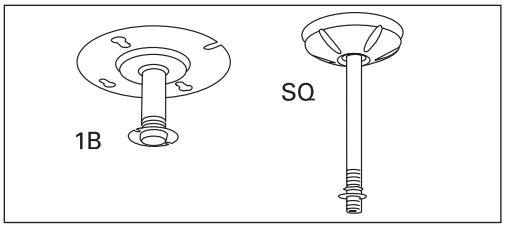
SB Square Basket Wraparound, Narrow Body

MOUNTING DATA

For unit or row installation. Surface or stem mounting. Stem mounting is not available with TSB.

UNIT INSTALLATION — Minimum of two hangers required.

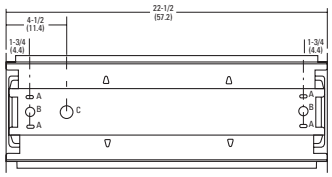
ROW INSTALLATION — One hanger per fixture plus one per row required.

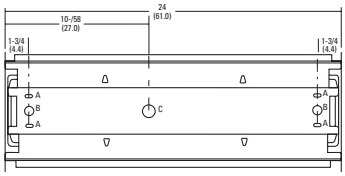


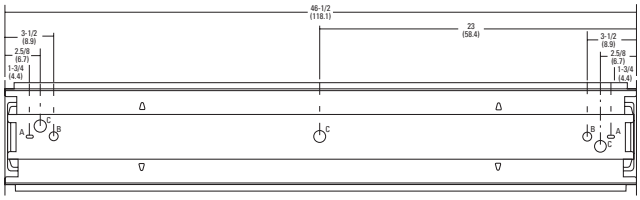
DIMENSIONS

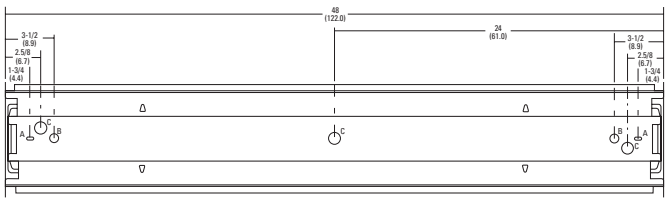
All dimensions are inches (centimeters). Specifications subject to change without notice.

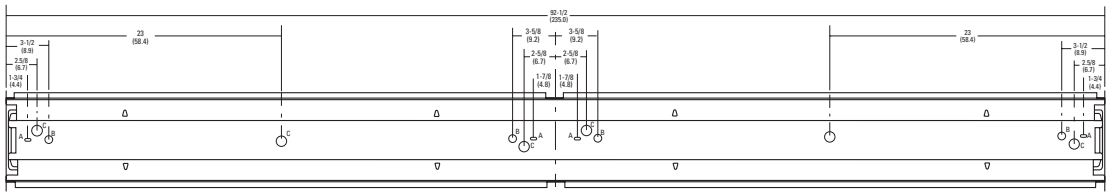
A = 1/4 x 1/2 (64 x 13) Oval Hole
B = 1/4 x 1/2 (64 x 13) K.O.
C = 7/8 (22) Dia.K.O.
D = 11/16 (17) Dia. K.O.
E = 2 (51) Dia. K.O.

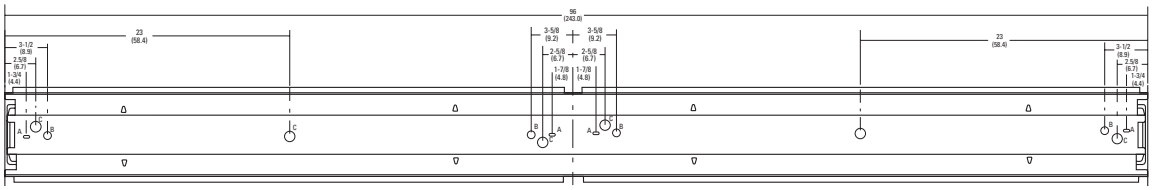












PHOTOMETRICS

Calculated using the zonal cavity method in accordance with IESNA LM41 procedure. Floor reflectances are 20%. Lamp configurations shown are typical. All data based on 25°C. Full photometric data on these and other configurations available upon request.

Test # BAL16519 - SB 2 32 MVOLT GEB101S

Coefficients of Utilization

pf		20%												
pc		80%			50%			30%			10%			0%
pw		50%	30%	10%	50%	30%	10%	50%	30%	10%	50%	30%	10%	0%
RCR	0	107	107	107	97	97	97	90	90	90	84	84	84	82
	1	93	90	86	85	82	79	79	77	75	74	73	71	68
	2	82	76	71	75	70	66	70	66	63	66	63	60	58
	3	73	65	60	66	61	56	62	58	54	59	55	52	49
	4	65	57	51	59	53	48	56	51	47	53	48	45	43
	5	58	50	44	53	47	42	50	45	41	48	43	39	37
	6	52	44	39	48	42	37	46	40	36	43	39	35	33
	7	47	40	34	44	38	33	42	36	32	40	35	31	29
	8	43	36	31	40	34	29	38	33	29	37	32	28	26
	9	40	32	28	37	31	27	35	30	26	34	29	25	24
	10	37	30	25	34	28	24	33	27	24	31	26	23	21

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0° - 30°	1444.3	24.5	26.6
0° - 40°	2374.5	40.2	43.7
0° - 60°	3953.3	67.0	72.8
0° - 90°	4821.6	81.7	88.8
90° - 180°	610.2	10.3	11.2
0° - 180°	5431.9	92.1	100.0

Test # LTL 19931 – SB 2 28 T5 GEB95

Coefficient of Utilization - Zonal Cavity Method

Effective Floor Cavity Reflectance: 20%

RCC%		80%				70%				50%			30%			10%			0%
RW%		70	50	30	0	70	50	30	0	50	30	20	50	30	20	50	30	20	0
RCR	0	1.03	1.03	1.03	1.03	1.00	1.00	1.00	.79	.93	.93	.93	.87	.87	.87	.82	.82	.82	.79
	1	.94	.90	.86	.83	.91	.87	.84	.67	.82	.79	.77	.77	.75	.73	.72	.71	.69	.67
	2	.86	.79	.74	.69	.83	.77	.72	.57	.72	.68	.64	.68	.65	.61	.64	.61	.59	.56
	3	.79	.70	.63	.58	.76	.68	.62	.50	.64	.59	.55	.61	.56	.53	.57	.54	.51	.48
	4	.73	.63	.55	.50	.70	.61	.54	.43	.58	.52	.47	.54	.50	.46	.52	.47	.44	.42
	5	.67	.56	.49	.43	.65	.55	.48	.38	.52	.46	.41	.49	.44	.40	.47	.42	.39	.37
	6	.62	.51	.43	.38	.60	.50	.42	.34	.47	.41	.36	.45	.39	.35	.48	.38	.34	.32
	7	.58	.46	.39	.34	.56	.45	.38	.30	.43	.37	.32	.41	.36	.31	.39	.34	.31	.29
	8	.54	.42	.35	.30	.52	.41	.34	.27	.39	.33	.29	.38	.32	.28	.36	.31	.28	.26
	9	.50	.39	.32	.27	.49	.38	.31	.25	.36	.30	.26	.35	.29	.26	.33	.28	.25	.23
	10	.47	.36	.29	.25	.46	.35	.29	.23	.34	.28	.24	.32	.27	.23	.31	.26	.23	.21

Zonal Lumens Summary

Zone	Lumens	%Lamp	%Fixture
0-30	1,274.4	24.5	27.7
0-40	2,085.0	40.1	45.3
0-60	3,401.4	65.4	73.9
60-90	726.3	14.0	15.3
70-100	483.1	9.3	10.5
90-120	350.6	6.7	7.6
0-90	4,127.8	79.4	89.6
90-180	476.6	9.2	10.4
0-180	5,604.4	88.5	100

LITHONIA LIGHTING®
An AcuityBrands Company

FLUORESCENT: One Lithonia Way Conyers, GA 30012 Phone: 800-315-4963 Fax: 770-981-8191 www.lithonia.com

Rev. 05/08/12

LITHONIA LIGHTING®

Catalog Number	
Notes	Type

FEATURES & SPECIFICATIONS

INTENDED USE

For entrances, stairwells, corridors and other pedestrian areas.

CONSTRUCTION

Cast aluminum backplate. Gasketing between backplate and front cover prevents the entry of water and contaminants. External hardware includes phillips head and tamper-proof hex-head fasteners.

FINISH

Dark bronze (DDB) or white (DWH) front cover available for all wattages.

OPTICAL SYSTEM

Front cover/refractor is injection-molded, one-piece, UV-stabilized polycarbonate. The optical system is sealed and gasketed to inhibit the entrance of outside contaminants.

ELECTRICAL SYSTEM

The 13W fluorescent uses a 120V electro-magnetic ballast and includes a twin tube fluorescent lamp as standard. The 26/42W fluorescent uses a multi-volt electronic ballast and offers the option of 120-277V operation and also the option of 26W, 32W or 42W triple tube fluorescent lamp (not included).

INSTALLATION

Units are for wall mounting and include two 3/4" knockouts for routing electrical conduit.

LISTING

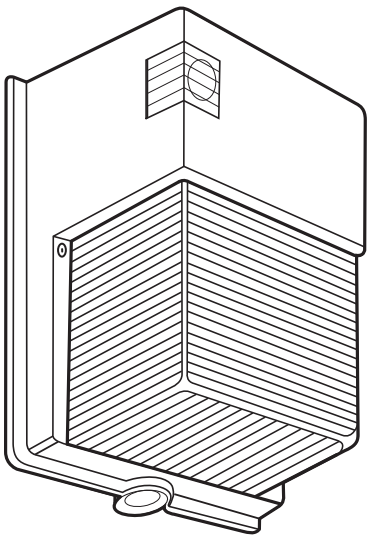
UL listed for wet locations. Listed and labeled to comply with Canadian Standards.

Small Polycarbonate Wall Pack

TWS

COMPACT FLUORESCENT

13TT
26TRT, 32TRT,42TRT
8' to 12' Mounting



Specifications

Height: 11" (27.9cm)
Width: 6-1/2" (16.5cm)
Depth: 5-1/4" (13.3cm)
Weight: 3.3 lbs./1.5 kgs

ORDERING INFORMATION

For shortest lead times, configure product using **standard options (shown in bold).**
Example: TWS 13TT 120 PE LPI

TWS

Series	Wattage/lamp	Voltage	Options
TWS	13TT One 13W twin-tube lamp **26TRT One 26W 4-pin tri-tube lamp[1]** **32TRT One 32W 4-pin tri-tube lamp[1]** **42TRT One 42W 4-pin tri-tube lamp[1]**	**120** **MVOLT[2]**	Shipped installed in fixture **PE Photoelectric cell as standard(N/A with MVOLT)** LPI Lamp included as standard for 13TT only **L/LP Less lamp standard for 26/42TRT** Architectural colors (optional) (blank) **Dark bronze** DWH White

NOTES:

1 Ships as 26/42 TRT. Operates 26-42 watt as standard based on lamp choice.

2 Not available with 13TT.

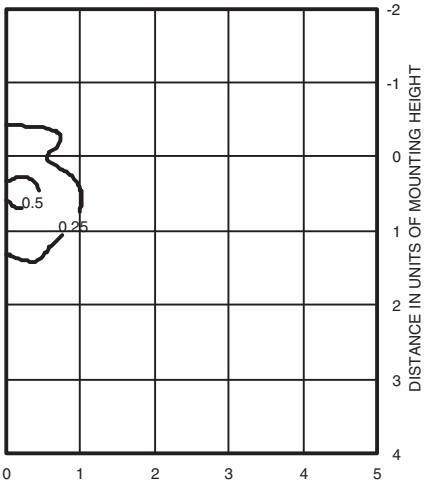
Accessories

Order as separate catalog number

RK1 PEB1 Photocell kit (120V only)
TWSWG Wireguard

TWS 13TT TEST NO : LTL12634

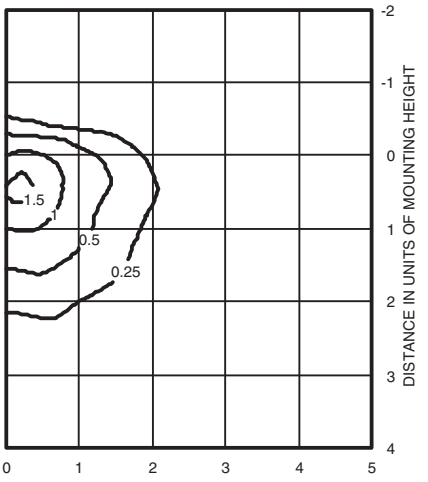
ISOILLUMINANCE PLOT (Footcandle)



Luminaire Efficiency: 52.2%
13W compact fluorescent twin tube lamp
Footcandle values based on 8'
mounting height, 800 rated lumens.

TWS 26TRT TEST NO: LTL12664P

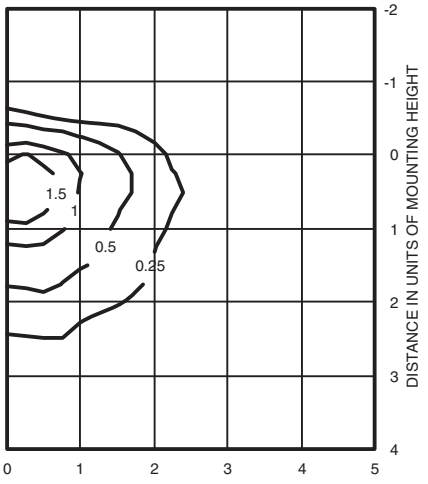
ISOILLUMINANCE PLOT (Footcandle)



Luminaire Efficiency: 55.2%
26W compact fluorescent triple tube lamp
Footcandle values based on 8'
mounting height, 1800 rated lumens.

TWS 32TRT TEST NO: LTL12633

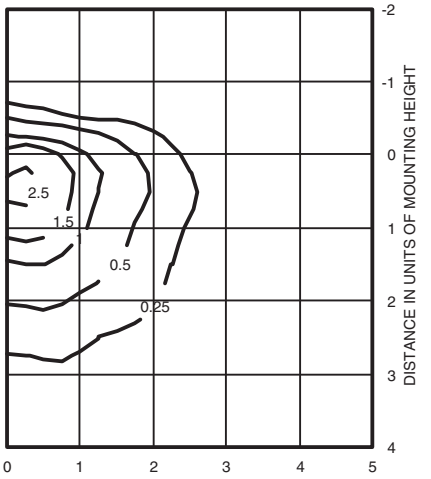
ISOILLUMINANCE PLOT (Footcandle)



Luminaire Efficiency: 55.2%
32W compact fluorescent triple tube lamp
Footcandle values based on 8'
mounting height, 2400 rated lumens.

TWS 42TRT TEST NO: LTL12663P

ISOILLUMINANCE PLOT (Footcandle)



Luminaire Efficiency: 55.2%
42W compact fluorescent triple tube lamp
Footcandle values based on 8'
mounting height, 3200 rated lumens.

Electrical Characteristics

Wattage/ballast	Primary voltage	Maximum line current (amps)	Input watts	Power factor%)
Fluorescent 1-13TT	120	0.41	17 NPF	NPF
Fluorescent 1-26TRT	120 277	.22 .09	26	HPF
Fluorescent 1-32TRT	120 277	.30 .13	36	HPF
Fluorescent 1-42TRT	120 277	.39 .17	47	HPF

Tested to current IES and NEMA standards under stabilized laboratory conditions. Various operating factors can cause differences between laboratory data and actual field measurements. Dimensions and specifications on this sheet are based on the most current available data and are subject to change without notice.

Mounting Height Correction Factor
(Multiply the fc level by the correction factor)
10 ft. = 0.64
12 ft. = 0.44

LITHONIA LIGHTING®
An AcuityBrands Company

Sheet #: TWS-CF

Lithonia Lighting
Outdoor Lighting
One Lithonia Way, Conyers, GA 30012
Phone: 770-922-9000 Fax: 770-918-1209
www.lithonia.com

LITHONIA OUTDOOR ARCHITECTURAL SCONCE

WSQ

QUARTER SPHERE

As the latest addition to Lithonia Lighting's Architectural Sconce Series, the Quarter Sphere shape offers added versatility to the popular product line. This decorative sconce brings another modern element to this series where function meets design.

Precisely engineered to accommodate low wattage HID lamps up to 175-watt metal halide, 150-watt high pressure sodium, as well as compact fluorescent sources, the Quarter Sphere Sconce demonstrates why Lithonia Lighting is the Best Value in Lighting®!

Designed with versatility and performance in mind, the new shape enables precise light placement with the added flexibility of lens-up or lens-down orientation. Including the familiar characteristics of textured finishes and decorative reveals found in the Architectural Sconce Series, the Quarter Sphere meets the rigorous standards for IES full cutoff and offers optional emergency capabilities.

AESTHETICS:

- **Classic Quarter Sphere Shape** – complements a variety of building architectures
- **Accent Reveals** - provide an opportunity for customization using striping
- **Standard Textured, Dark Bronze Polyester Powder Finish** – other architectural color choices are available

PERFORMANCE:

- **Premium Optical Performance** – segmented reflectors provide uniformity and control
- **Multiple Distributions** – three downlight distributions available including forward throw (FT), wide throw (WT) and medium throw (MD)
- **Nighttime Friendly™ Optics** – provide full cutoff lighting when the fixture is mounted in the lens-down orientation
- **Emergency Lighting Options** – offer choice of integral emergency battery pack (ELDW), emergency circuit 120-volt (EC) or emergency circuit 12-volt (DC12); DC12 option is also available as a (2) lamp configuration

CONSTRUCTION:

- **Premium Construction** – die-cast aluminum housing and door frame
- **Wattage Versatility** – one housing size accommodates HID wattages up to 175-watt metal halide, as well as two 42-watt TRT compact fluorescent lamps
- **Easy to Install** – mounting bracket design allows for easy, one-person installation

WSQ

QUARTER SPHERE ARCHITECTURAL SCONCE

INTENDED USE:

Office buildings, schools, retail applications

FEATURES:

Single piece, die-cast aluminum housing with decorative reveals. Die-cast aluminum door frame has 1/8" thick impact resistant, tempered glass lens. Door frame is fully gasketed with one-piece silicone gasket. Standard finish is textured dark bronze (DDBT) corrosion-resistant polyester powder with other architectural colors available.

OPTICS:

Field interchangeable, segmented reflectors are designed for superior uniformity and control. Three full cutoff distributions available: FT (forward throw), MD (medium throw) and WT (wide throw). Compact fluorescent is available with the MD (medium throw) only.

ELECTRICAL SYSTEM:

HID: 50W MH-150W utilizes a high reactance, high power factor ballast. 35W and 50W high pressure sodium utilize a reactance normal power factor ballast. 175W utilizes a constant wattage autotransformer ballast. Socket is porcelain, medium base with copper alloy, nickel-plated screw shell and center contact. CFL: Compact fluorescent utilizes electronic ballasts. Socket is high-temperature thermoplastic with integral lamp retention clip. All utilize Quick-Disconnect® plugs to easily disconnect the reflector from the ballast. HID ballasts are copper-wound and all ballasts are 100% factory tested.

INSTALLATION:

Universal mounting mechanism with integral mounting support allows fixture to hinge down so wiring connections can be made without having to support the fixture. Bubble level provides correct alignment with each installation.

CERTIFICATIONS:

UL listed for wet location in lens-down orientation. WLU option offers wet location listing in lens-up orientation (see Options). Listed and labeled to comply with Canadian safety standards (see Options). IP65 rated.

Ordering Information

Example: **WSQ 175M FT 120 SF LPI**

Series	Wattage	Distribution	Voltage	Options/accessories
WSQ Quarter sphere	High pressure sodium **35S**[1] **50S** **70S** **100S** **150S** Metal halide **50M** **70M** **100M** **150M** **175M** Compact fluorescent[2] **26DTT** **2/26DTT** **26TRT** **2/26TRT** **32TRT** **2/32TRT** **42TRT** **2/42TRT**	Downlight distributions **FT** Forward throw **MD** Medium throw (coated lamp standard) **WT** Wide throw	**120** **208**[3] **240**[3] **277** **347** **TB**[4] **TBV**[5] **MVOLT**[6]	Installed **SF** Single fuse, 120V, 277V, 347V (n/a TB or TBV) **DF** Double fuse, 208V, 240V (n/a TB or TBV) **GMF** Internal slow-blow fusing[7,8] **EC** Emergency circuit (25W max., lamp included)[9] **DC12** Emergency circuit 12 volt (35W lamp included standard)[10] **2DC12** Emergency circuit 12 volt (2) 35W lamps included standard)[10] **DC2012** Emergency circuit 12 volt (20W lamp included standard)[10] **2DC2012** Emergency circuit 12 volt (2) 20W lamps included standard)[10] **ELDW** Emergency battery pack (120V or 277V only)[7,11] **ELDWR** Remote battery pack ready (by others) for compact fluorescent lamps[12] **QRS** Quartz restrike system (100W max., lamp not included)[13] **CR** Enhanced corrosion resistance **CRT** Non-stick protective coating[14] **PE** Photoelectric cell-button type (n/a TB, TBV or MVOLT)[15] **WLU** Wet location door for up orientation **IBS** Internal backlight shield[16] **DFL** Diffusing lens **LPI** Lamp included **L/LP** Less lamp **CSA** Listed and labeled to comply with Canadian Standards *Architectural colors*[17] Standard textured colors **DDBT** Dark bronze (std.) **DSST** Sandstone **DNAT** Natural aluminum **DWHG** White **DBLB** Black Shipped separately **WSBBW** Surface-mounted back box[18] **UT5** Uptilt 5 degrees[18] **WSRWG** Wire guard (WSQ)[15] **WSRVG** Vandal guard (WSQ)[15]

NOTES:
1. 120V only, NPF only.
2. Only available with MD distribution.
3. Not available in Canada.
4. Optional multi-tap ballast (120V, 208V, 240V, 277V). In Canada 120V, 277V, 347V; ships as 120V/347V.
5. Optional 5-tap ballast (120V, 208V, 240V, 277V, 480V; n/a in Canada). 175M only.
6. Optional multi-volt electronic ballast (for compact fluorescent lamps only) capable of operating on any line voltage from 120V-277V.
7. Available for compact fluorescent units only.
8. Must specify voltage, n/a MVOLT or TB.
9. Not available with QRS.
10. Not available with SF, DF or QRS.
11. Not available with 2/32TRT or 2/42TRT.
12. Battery pack by others and mounted external to luminaire. Pilot light/test switch mounting plate included. Consult factory for availability.
13. Not available with compact fluorescent.
14. Black finish only.
15. Must be ordered with fixture; no field modifications.
16. IBS not available with MD distribution.
17. Additional architectural colors available; see www.lithonia.com.
18. Must specify finish.

USA: One Lithonia Way | Conyers, GA 30012 | TEL 800 279 8041 | FAX 770 918 1209 | www.lithonia.com

 05/06 OP6356 Form No. 807.54

LITHONIA LIGHTING

FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for architectural applications where aesthetics and superior performance are required.

CONSTRUCTION — High-polish, injection-molded virgin acrylic panel, ultrasonically welded to eliminate visible hardware. Graduated depth of molded letters provides uniform light distribution on graphics. Standard housing finish is brushed aluminum.

Precision-molded, textured letters – 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL924 standard. Chevron indicator direction must be specified.

Recessed rough-in section constructed of 20-gauge, die-formed galvanized steel. Extruded aluminum housing trim mounts flush onto wall or ceiling.

ELECTRICAL — Sealed, maintenance-free nickel cadmium battery delivers 90 minutes capacity to lamp. Constant-current series charger, 24-hour recharge after 90-minute discharge.

Polarized battery connector simplifies installation and maintenance; prevents charger damage due to improper connection.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 10 years.

Low energy consumption – only 2.3W for 120V single-face red sign; 1.7W for 120V single-face green sign.

INSTALLATION — Recessed mount – rough-in section for back, ceiling or end mounting. Fits into minimum wall or ceiling opening 13-5/8" L x 4-1/2" W x 3-1/8" D.

Adjustable T-bar hangers adapt mounting tray for mounting in suspended ceilings or variable-size framed openings. Trim ring has 3/4" variable depth adjustment to ensure flush fit against surface of wall or ceiling.

Plug-in wire connections and self-captive mounting screws for mounting panel/trim to rough-in section.

LISTINGS — UL listed. Non-IC recessed mounting. Meets UL 924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards, and State of Minnesota requirements for less than 20W energy consumption. NEMA Premium certified.

WARRANTY — Five-year limited warranty, including lamps.

Note: Specifications subject to change without notice.

Actual performance may differ as a result of end-user environment and application.

Catalog Number	
Notes	
Type	

PRECISE® COLLECTION

Edge-Lit Exits

LRP EL N

LED LAMPS EMERGENCY

LED

NEMA Premium

ORDERING INFORMATION For shortest lead times, configure products using **bolded options.**

Example: LRP 1 RMR LA 120/277 EL N

LRP					120/277
Family	**Housing color**	**Number of faces**	**Letters/background**	**Directional indicators[1]**	**Input voltage**
LRP LED	**(blank)** Brushed aluminum W White B Black BZ Bronze BS Polished brass CR Chrome U Unfinished	**1** Single face **2** Double face	RW Red on white **RC** Red on clear (single face only) **RMR** Red on mirror (simulates clear background for double-face exits) GW Green on white **GC** Green on clear (single face only) **GMR** Green on mirror (simulates clear background for double-face exits)	**(blank)** None **LA** Left[2] **RA** Right[2] **LRA** Left and right **DA** Double face[3]	**120/277** Dual voltage

EL N			
Emergency operation	**Mounting**	**Item type**	**Options[4]**
EL N Nickel cadmium battery	**(blank)** Ceiling or back mount EM Recessed end mount	**(blank)** Complete exit panel and rough-in section **PNL** Panel assembly only	FI Fire alarm interface[5] F Flashing emergency operation (one flash/second)[5] FA Flashing emergency operation and intermittent audible alarm

Accessories[4,6]: *Order as separate items.*

ELA R LRIS 120/277 EL N	Single-face, red LED emergency rough-in section
ELA G LRIS 120/277 EL N	Single-face, green LED emergency rough-in section
ELA R 2LRIS 120/277 EL N	Double-face, red LED emergency rough-in section
ELA G 2LRIS 120/277 EL N	Double-face, green LED emergency rough-in section

Notes
1. See chart on back for more information.
2. Only available with single face.
3. Only available with double face.
4. When ordering rough-in separately, all options must be included with rough-in nomenclature. Example: ELA R LRIS 120/277 EL N FA.
5. Choice of F or FI. Not available with both.
6. Rough-in supplied standard with exit unless PNL suffix is specified. Order separately only if needed for early installation.

SPECIFICATIONS

ELECTRICAL

Primary Circuit

Type	Typical LED life[1]	Supply voltage	Number of faces	Input watts	Max. amps
Red	10 years	120	1	2.3	.093
		277	1	2.7	.095
Red	10 years	120	2	3.2	.084
		277	2	3.9	.094
Green	10 years	120	1	1.7	.07
		277	1	1.9	.07
Green	10 years	120	2	3.7	.14
		277	2	3.8	.14

BATTERY

Sealed Nickel-Cadmium

Shelf life [2]	Typical life [2]	Maintenance[3]	Optimum temperature[4]
3 yrs.	7–9 yrs.	none	32°–100°F (0°-38°C)

Notes

1 Based on continuous operation. The typical life of the exit LED lamp is 10 years.

2 At 77°F (25°C).

3 All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.

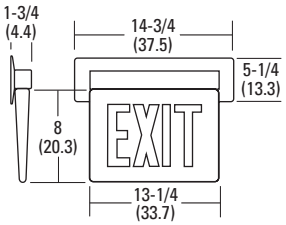
4 Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

MOUNTING

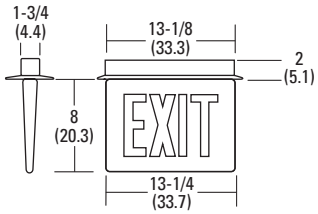
All dimensions are in inches (centimeters).

Shipping weight for panel: 5 lbs. (2.3 kgs.)

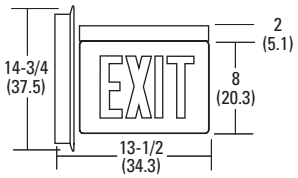
Shipping weight for rough-in section: 5.8 lbs. (2.6 kgs.)



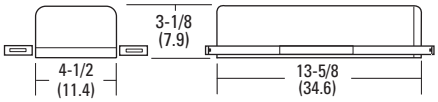
Back Mount



Ceiling Mount



End Mount

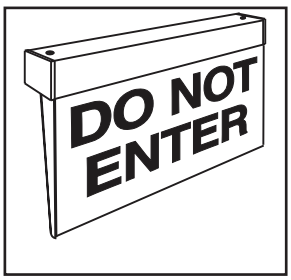


Rough -In Section

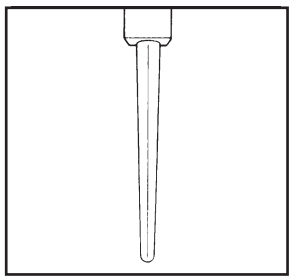
Directional Indicators

Specification (add to catalog number)	Graphics	
	Back	Front
LA		
RA		
LRA (single face)		
DA		
LRA (double face)		

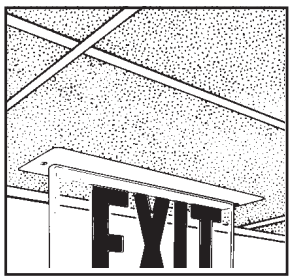
KEY FEATURES



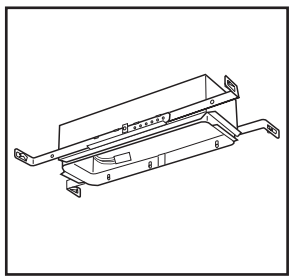
Silk-screening process allows customized text and/or graphics.



Unique wedge-shaped panel design concentrates light for uniform letter illumination.



Trim fits flush against wall or ceiling for clean, attractive appearance.



Small rough-in section.

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800.334.8694 Fax: 770-981-8141 www.lithonia.com

SECTION 270528.34

TELEPHONE RACEWAY SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the telephone raceway system as shown on the Drawings or as required to support the systems defined in these Specifications. The Work under this Section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the telephone raceway system required for the communications system.

B. Related Work Specified Elsewhere: Refer to all other Division 26 and 27 Specification sections and Drawings, and to the Specifications and Drawings under the General Construction Contract to ascertain the extent of work included.

C. Related Sections
1. Section 06 10 00 - Rough Carpentry.
2. Section 09 90 00 - Painting and Coatings.
3. Section 26 05 00 - Common Work Results for Electrical.
4. Section 26 05 34 - Outlet and Junction Boxes for Electrical Systems.
5. Section 26 05 35 - Raceway for Electrical Systems.
6. Section 26 27 26 - Wiring Devices.
7. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
8. Section 26 05 29 - Hangers and Supports for Electrical Systems.
9. Section 26 05 53 - Identification for Electrical Systems.

1.2 SUBMITTALS

A. Submit in accordance with Division 1.

B. Closeout Submittals
1. Project Record Documents
   a. Accurately record location of service entrance conduit, termination backboards, cabinets, and junction and pull boxes.
   b. Accurately record location and size of all junction and pull boxes.

1.3 DELINEATION OF RESPONSIBILITY

A. The Contractor shall provide a complete and functional system.

1.4 SYSTEM DESCRIPTION

A. A complete telephone raceway system and supporting material shall be prepared for the installation of telephone and data system wires and cables by others.

PART 2 PRODUCTS

2.1 TELEPHONE TERMINATION BACKBOARDS

A. Material: Plywood.

B. Size: 4 x 8 feet, 3/4 inch thick unless otherwise indicated.

C. Fire Retardant: In accordance with Section 06 10 00.

2.2 TELEPHONE TERMINATION CABINETS

A. Cabinet Boxes: Galvanized steel 24 inches wide, 36 inches high, 6 inches deep unless otherwise indicated or required by utility company. Provide plywood backboard inside cabinet for mounting telephone termination devices.

B. Cabinet Fronts: Steel, surface type, concealed hinge, and flush lock keyed to match branch circuit panelboard.
   1. Provide six keys for each type lock.

C. Finish: Gray baked enamel.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions
   1. Verify that surfaces are ready to receive the Work.
   2. Verify that field measurements are as shown on the Drawings.
   3. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Finish paint termination backboards with durable white fire retardant enamel in accordance with Section 09 90 00 prior to installation of telephone equipment.

B. Support raceways, backboards, and cabinets in accordance with Section 26 05 29.

C. Install termination backboards and cabinets plumb, and attach securely at each corner. Install cabinet trim plumb.

D. Install pullwire string in each empty telephone conduit in accordance with Section 26 05 35.

E. Mark all backboards and cabinets with the legend “TELEPHONE” under the provisions of Section 26 05 53.

F. Install conduits from indicated telephone locations to telephone backboard or cabinet as indicated for installation of cable by others. Install conduit in accordance with Section 26 05 35. When destination is to terminal board, terminate conduit below ceiling near the top of the terminal board. Terminate all conduits in an insulating bushing or insulated throat type fitting. Terminate instrument end of conduit in 4 inch square, 2½ inches deep, metal box with a single gang mud ring supplied in accordance with the requirements of Section 26 05 35.

G. Install box for 'desk' type telephone jack 18 inches above finished floor unless otherwise indicated. (Jack and plate, owner furnished and installed)

H. Install box for wall telephone 48 inches above finished floor unless otherwise indicated. (Jack and plate, owner furnished and installed)

I. Provide a dual-duplex receptacle near each terminal board. Install in accordance with Section 26 27 26.

J. Provide a ground near each terminal board and cabinet. Leave 6 feet of #6 CU wire coiled on floor of electrical room near telephone terminal backboard for connections by others. Install in accordance with Section 26 05 26.

K. All junction boxes and pull boxes shall be accessible and shall conform to provisions of Section 26 05 35.

L. Telephone Conduits:
   1. Conduits exiting a building shall pass a mandrel 12 inches long by 3-5/8 inches in diameter but shall have the following minimum radii;
      a. 5 inch C - 5 foot radius
      b. 4 inch C - 4 foot radius
      c. Other sizes: 12 times trade size.
         1) Mandrel requirement is deleted where sizes less than 4 inches are indicated.
         2) Sweep bends shall not exceed 180 degrees total from manhole or handhole to backboard.

M. Telephone conduits exiting the building shall be separated a minimum of 12 inches from electrical power conduits.

3.3 FIELD QUALITY CONTROL

A. Site Tests
   1. Test in accordance with Section 26 05 35.
   2. Demonstrate that a mandrel 12 inches long by 3-5/8 inches in diameter will pass through 4 inches and larger conduits exiting the building.

B. Inspection
   1. Inspect in accordance with Section 26 05 35.

END OF SECTION

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SECTION 272100

COUNTY TELECOMM CABLING AND PATHWAY SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specifications Sections, apply to Work of this Section.

B. The general conditions for contracts of construction, referred to in the contract documents as the General Conditions, together with the following articles of the Telecommunications Cable and Pathways Specification, that amend, modify and supplement various articles and provisions of the General Conditions, are made part of the Contract and shall apply to all work under the Contract.

C. All articles or parts of articles of the General Conditions not so amended, modified or supplemented by this Telecommunications Cabling Specification shall remain in full force and effect. Should any discrepancy become apparent between the General Conditions and the Telecommunications Cable and Pathways Specification, the Contractor shall notify the Architect, in writing, and the Architect shall interpret and decide such matters in accordance with the provisions of the General Conditions.

1.2 SPECIAL CONDITIONS

A. Standards, materials specifications, related drawings, cable schedules, industry guidelines, and codes referred to herein shall be considered part of these specifications and shall apply to the Work described or implied, herein.

B. All local fees, permits and services of inspection authorities shall be obtained and paid for by the Contractor, The Contractor shall cooperate fully with local utility companies with respect to their services.

C. It is the intent of these specifications for the Contractor to provide a complete, functional, standards-based cabling infrastructure for the County's use utilizing category 6 cabling to support high speed data applications up to and in excess of 100Mbs horizontally and up to ten gigabit Ethernet in the backbone system.

D. Any item not specifically shown on the drawings or called for in the specifications, but normally required to conform to the system design intent as presented, are to be considered as part of the Contract and required to be furnished and installed by the Contractor.

E. Any given item of equipment or material shall be the product of NextLan one manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise or approved in writing by the Designer prior to purchase and use.

F. This specification is an equipment and performance specification. Actual installation shall be as indicated on the Telecommunications Drawings and in the Specifications

governing the Work. Any discrepancies found between the Specifications and the Drawings shall be immediately brought to the attention of the Architect for interpretation.

G. Contract Documents and Drawings depict equipment installation and wiring in a diagrammatic fashion and indicate the general arrangement of equipment and wiring. The most direct routing for conduits and telecommunications pathways is not assured. Exact requirements shall be governed by architectural, structural and mechanical condition/features of the job. Consult all other drawings and specifications.

1.3 PRICING

A. Provide total cost and unit pricing as per the General Conditions and Bid instructions.

1.4 CONTRACTOR EXPERIENCE

A. The selected Contractor shall be fully capable and experienced in the telecommunications distribution system specified. To ensure the system has continued support, the County will contract only with Contractors having a successful history of sales, installation, service, and support.

B. During the bid evaluation process, the Customer may, with full cooperation of the Contractor, visit the Contractor's places of business, observe operations, and inspect records. The Contractor must have a minimum of five (5) years of experience. The Contractor must have a Registered Communications Distribution Designer (RCDD) on staff that will be ultimately responsible for this project in the Project Manager role. The RCDD must have sufficient experience in this type project as to be able to lend adequate technical support to the field forces during installation, during the warranty period, and during any extended warranty periods or maintenance contracts. A resume of the responsible RCDD must be attached to the Contractor's response for evaluation by the County. Should the RCDD assigned to this project change during the installation, the new RCDD assigned must also submit a resume for review by the County. If, in the opinion of the County, the RCDD does not possess adequate qualifications to support the project, the County reserves the right to require the Contractor to assign an RCDD who, in the County's opinion, possesses the necessary skills and experience required of this project.

1.5 WORK INCLUDED

A. The work covered by this Contract includes the construction described and implied, all labor required to perform and complete such construction, all materials required to perform and complete such construction, all services, facilities, tools and equipment required to perform and complete such construction, and coordination with the General Contractor and all other trades.

B. The scope of this work includes, but is not limited to:

1. Provision, installation, termination, identification, and testing of optical fiber backbone cable, and high pair count UTP copper between the BDF and all IDFs.
2. Provision, installation, termination, identification, and testing of inside plant UTP workstation cables between the IDFs/BDF and the workstations located in the

building. This includes all termination components to complete the horizontal links to each workstation outlet.

3. Provision, installation and grounding of all telecommunications racks, cabinets, cables (as required), and all cable pathways requiring grounding under TIA standards and BICSI guidelines.
4. Provide labeling and documentation of all cables, racks, grounding buss-bars, pathways and spaces, faceplates, patch panels and termination blocks installed under this Work.
5. Provision and installation of wire management components, ladder-type cable runway, any surface-mount raceways and miscellaneous "nuts & bolts" type components to provide a complete and working cable system.
6. Fire stopping of floor and rated wall penetrations specifically provided for the distribution of telecommunications cables. Required floor and wall ratings shall be maintained.
7. Preparation and submission of shop drawings, termination schedules, test results, as-built drawings, and component documentations described within this Specification.

1.6 RELATED WORK NOT INCLUDED IN THIS SECTION AND SPECIFIED ELSEWHERE, UNLESS OTHERWISE NOTED

A. Installation of conduits, pull-boxes and floor-boxes (provided under electrical Work).

B. Installation of workstation devices, computers, terminals and similar equipment (installed by County representatives and their additional representatives).

C. Installation, provisioning or supply of active data and telephone switch equipment is not included in this scope of work.

D. Provision and installation of AC grade or better plywood on the BDF and IDF walls, as indicated in the drawings. Plywood shall be at least ¾" thick and treated on all sides with at least two coats of fire-resistant paint, white color.

1.7 SITE VISIT & FIELD CONDITIONS

A. Since the work will be performed on an existing structure, the Contractor shall visit and examine the site of the proposed work to determine the existing conditions that may affect the work. The Contractor shall be held responsible for any assumptions in regard thereto.

B. The Contractor shall verify all dimensions and distances in the field and document the cable lengths and materials to be furnished and installed. The provision and installation of non-specified miscellaneous components and hardware, i.e. drag lines, nuts, bolts and tie wraps shall also be the Contractor's responsibility.

C. Existing site conditions, Contract Documents and the overall construction schedule must be carefully reviewed to determine all required interfacing and timing of the work. All such documents shall be available through the General Contractor or Construction Management.

1.8 ABBREVIATIONS AND DEFINITIONS

A. The Work specified herein shall conform to the following codes, regulations, standards, and guidelines:

B. FCC:
   1. Part 15: Unlicensed Radio Frequency Devices
   2. Part 68: Terminal Equipment Certification Requirements

C. NEC 2008 or latest edition utilized by AHJ.

D. NESC 2008 or latest edition utilized by AHJ.

E. NFPA codes (latest edition utilized by AHJ).

F. State and Local Municipal Construction-Related Codes

G. Underwriters Laboratory (UL)

H. IEEE:
   1. IEEE 802.3: 10Base-T Ethernet Standard
   2. IEEE 802.12: 100Base-TX Ethernet Standard
   3. IEEE 802.3ab: 1000Base-T Ethernet Standard
   4. IEEE 802.3ae: 10Gb/s Ethernet Standard
   5. IEEE 802.3af: Power Over Ethernet Standard
   6. IEEE 802.11: All Wireless Ethernet Standard(s)

I. BICSI:
   1. TDMM: 2010, 12th Edition
   2. TCIM: 2002, 3rd Edition
   3. C-O OSP: 2006, 4nd Edition

J. TIA/EIA: (includes all related addenda to each standard)
   1. TIA/EIA 310-D: Racks, Panels and Associated Equipment
   2. TIA/EIA 455-13-A: Visual and Mechanical Inspection of Optical Fibers, Cables, Connectors and other Optical Devices.
   3. TIA/EIA 455-57-B: Optical Fiber End Preparation and Examination.
   4. TIA/EIA 455-59: Measurement of Optical Fiber Cable Point Defects with an OTDR.
   5. TIA/EIA 455-61: Measurement of Optical Fiber Cable Attenuation
   6. TIA/EIA 455-95: Absolute Optical Power testing of Fiber Cables.
   7. TIA/EIA 4720000-A: Generic Specification of Optical Fiber Cables.
   8. TIA/EIA 472C000-A: Generic Specification of Optical Fiber Cables for Indoor Use.
   9. TIA/EIA 492AAAA: Specification for 62.5/125-µm Class1a Graded- Index Multimode Optical Fiber.
   10. TIA/EIA 492AAAC: Specification for 850-nm Laser-Optimized 50/125- for Class 1a Graded-Index Multimode Optical Fiber.
   11. TIA/EIA 492CAAA: Specification for Class 1va Dispersion-Un-Shifted (Zero Water Peak) Single Mode Optical Fiber.
   12. TIA/EIA 526-7: Optical Power Loss Measurement of Single Mode Optical Fiber Cable Plant.
   13. TIA/EIA 526-14: Optical Power Loss Measurements of Installed MMF Cables.

14. TIA 568 C.0 Commercial Building Telecom Wiring Standard Part-0: Generic Requirements.
15. TIA/EIA 568-C.1: Commercial Building Telecom Wiring Standard Part-1: Commerical Cabling Requirements.
16. TIA/EIA 568-C.2: Commercial Building Telecom Wiring Standard Part-2: Balanced Twisted Pair Cabling Standard.
17. TIA/EIA 568-C.3: Commercial Building Telecom Wiring Standard Part-3: Optical Fiber Cabling Standard.
18. TIA/EIA 598: Color Coding of Optical Fiber Cables and Strands.
19. TIA/EIA 606-A: Administration Standard for Telecommunications Infrastructure within Commercial Buildings.
20. TIA/EIA 607-A: Commercial Building Grounding and Bonding Requirements for Telecommunication Systems.
21. TIA/EIA 758: Customer-owned OSP Telecommunications Cabling Standard.

K. ANSI/ICEA:
   1. ANSI/ICEA S-83-596: Fiber Optic Premise Distribution Cable Technical Requirements. (1994)
   2. ANSI/ICEA S-90-661: Standard for Individually UTP Cables for Use in Communications Wiring Systems (1997).

L. The installation shall comply fully with all National, State, and Local government authorities, laws and ordinances, as well as, all regulations, codes, and industry guidelines governing the work or interpreted to govern the work by the authority having jurisdiction (AHJ) at the site. This includes all Owner-specific standards and guidelines related to the Work.

M. Should any change in the current plans or specifications be required to comply with any Code, Regulation or Standard noted above, the Contractor shall notify the Designer and Architect in writing at the time of submitting the construction schedule.

N. All equipment and installation methods shall be equal to or exceed the minimum requirements of NEMA, IEEE, ASME, ANSI, TIA BICSI, and Underwriters' Laboratories, where applicable.

1.9 SUBMITTALS

A. Provide submittals in accordance with schedule and general requirements defined in the General Conditions.

B. Product Data:
   1. Provide, as part of the bid, manufacturers' product data sheets for all material and equipment whose products are proposed. Only specified or accepted manufacturers or suppliers shall appear in the Product Data Submittal. Bid shall not be considered without a complete Product Data Submittal.
   2. Approved suppliers of the structured cabling system are Superior Essex and Leviton NexLAN. Approved supplier of the support infrastructure components is Chatsworth Products.
   3. Provide, as part of the bid, manufacturer's product data sheets for all fire stopping materials proposed for use on the project.

4. Mark each copy to show applicable choices and options. Where product data includes information on several products, some of which are not required, mark copies to indicate the applicable information.
5. Requests for substitutions of equipment or materials must be made and approved prior to the bid submittal. Unapproved substitutions may constitute a non-compliant bid return.

C. Shop Drawings:
1. Provide, for Architect's action, shop drawings for the installation of the Work prior to beginning Work
2. Provide detailed plan views and elevations of all equipment racks, termination blocks, patch panels and cable paths, if the elevation and plan views are not identical to the T-series bid drawings.
3. Provide drawings to show evidence of coordination with other trades.
4. Acceptance of any submitted data or Shop Drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve Contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details to perform efficiently the requirements and intent of the Contract. Such acceptance shall not relieve Contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or Shop Drawing.
5. All Shop Drawings shall be submitted sufficiently in advance of field requirements to allow ample time for review and re-submittal as may be required. All Submittals shall be complete and contain all required and detailed information.
6. All Shop Drawings shall contain job name/title and reference to the applicable Drawing and Specification article for reference by the reviewer.
7. Provide for County's documentation, a Finish Statement in form stipulated by the Architects, signed by the Contractor, stating that the Work was provided in compliance with the Contract Documents and that the installation was proper for the conditions of application and use.

D. Record Drawings – Submit for County's representative's documentation:
1. Provide Record Drawings annotated with the changes made during the installation of the Work so as to be a complete set of "as installed" plans. Drawings shall be in printed form and on compact disk in AutoCAD 2004 dwg format.
2. Provide County representative with two (2) sets of Operation and Maintenance Manuals including wiring diagrams, parts lists, shop drawings and manufacturers' information on all equipment and cables provided under this Work. Provide manuals in a high quality, 3-ring binder, completely indexed. Provide manuals to the County representative not more than 1 week after project completion.

E. None of the firms or individuals performing tests and inspections are authorized to accept or reject any Work, to modify any Construction Document requirement, to advise or instruct Contractor as to prosecution of the Work, or to perform any duty or service for the Contractor. Inspections shall not relieve the Contractor of the obligation to fulfill all requirements of the Construction Documents.

1.10 QUALITY ASSURANCE

A. Contractor is solely responsible for quality control of the Work. Comply with any Quality Control requirements specified in the General Conditions.

B. All materials furnished shall be new and unused. All materials shall meet all applicable codes provided a standard has been established for the material in question.

C. At a minimum, fifty percent (50%) of Contractor-provided field technicians at any time shall be factory-certified within 12 months by the manufacturer of the telecommunications system components to install the Contractor-selected and Owner-approved system components. Proof of certification shall be available on site for review at all times for each field technician.

D. Contractor shall be in good standing with the selected manufacturer(s) of system components and be able to provide the Owner with the extended warranty for the installation offered by the manufacturer.

E. All work performed by the Contractor shall be available for observation and approval by the Manufacturer, the Owner, and the system Designer in order to verify the systems integrity and increase the performance of the system under the installation and performance guidelines described in the Contract Documents.

1.11 CODES, REGULATIONS & STANDARDS

A. The installation shall comply fully with all government authorities, laws and ordinances, regulations and codes applicable to the installation.

B. Should any change in plans or specifications be required to comply with governmental regulations, the Contractor shall notify the County representative and Architect at the time of submitting the construction schedule.

C. Local electrical and building codes may differ with national codes. Follow the most stringent code or recommendations. Where there are instances of ambiguity refer to the Architect for interpretation.

1.12 COORDINATION OF THE WORK

A. Carefully check space requirements and the physical confines of the area of work to insure that all material can be installed in the spaces allotted thereto, including conduits and cable supports.

B. Transmit to other trades in a timely manner all information required for work to be provided under the respective Sections in ample time for installation.

C. Wherever work interconnects with or contacts the work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment.

1.13 DELIVERY, STORAGE AND HANDLING

A. Procedure: In Accordance with Division One, General Requirements.

B. Deliver materials (except bulk materials) in manufacturer’s unopened container fully identified with the manufacturer’s name, trade name, type, class, grade, size and color.

C. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store all items subject to moisture damage in dry spaces. Provide space requirements for storage in submittals list. The General Contractor shall assign storage space.

1.14 CERTIFICATION & WARRANTY

A. All work and all items of equipment and materials shall be warranted for a minimum period of one year from the date of acceptance of the work. Where a manufacturer's warranty is longer than one year, the Contractor shall offer the extended warranty. The Contractor shall, upon notification of any defective items, repair or replace such items within 24 hours without cost to County, all to the satisfaction of the Architect.

B. The installed passive components of the Work described in the Contract Documents shall be covered under a manufacturer supported Lifetime Warranty related to installed materials, supported applications and the installation workmanship. This guarantee and extended warranty shall be supported in writing by both the connectivity and cable manufacturer and shall address and cover the following:
   1. All defects in wire, cable, components and/or other materials in the Voice and Data Communication System.
   2. All specification and performance parameters of system components as presented in the Construction Documents at the time of installation completion will be warranted/ guaranteed to provide margins of 3.0 dB for all frequencies swept from 1 – 250 MHz for the published TIA/EIA 568C parameters for NEXT, PSNEXT, ELFEXT, PSELFEXT, and Return Loss performance standards as published in TIA/EIA for more than one manufacturer.
   3. All installed components of the data backbone system shall support ten (10) Gigabits per second Ethernet applications that use 850 nm transceivers for serial transmission in LOMMF (OM3) at distances up to three hundred (300) meters.
   4. All workmanship associated with any warranty issues related to providing, installing, certifying and documenting the Work described in the Construction Documents shall be covered by this warranty.

C. Contractor shall respond to the Owners request and correct any problems, malfunctions, and warranty issues associated with the Work described in the Construction Documents without additional charge to the Owner within three (3) calendar days for the entire warranty period, as stated in the Warranty.

D. The Owner considers the Voice Data Communications System components a whole, complete system and requires an integrated component/cable warranty from both the cable manufacturer and the connectivity manufacturer for material and installation workmanship as described in the Construction Documents.

1.15 PROJECT CLOSEOUT

A. The installed Voice Data Communications System will not be accepted until all work is complete and properly documented and all punch list items discovered are completed to the Designer and Owner's complete satisfaction.

B. The warranty will not begin until after a thirty (30) day acceptance period (See below for Acceptance Period information) to judge the performance of the installed Voice Data Communication System. If during this thirty (30) day period the installed system does not

perform adequately, the Trade Contractor must repair the installation within two (2) days to the satisfaction of the Designer and Owner and/or the Contract Documents and the thirty (30) days will restart from the date of the resolution.

C. The Trade Contractor's project manager must be available to answer questions about the installation and to attend site visits and meetings during the acceptance period.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Provide telecommunications cable and termination equipment with performance levels and capacities as noted herein.

B. Any item not specifically shown on the drawings or called for in this section of the project specifications, but normally required to conform with the system design intent, are to be considered as part of the Contract and shall be included in the Contractor's scope of work.

C. The Construction Documents define the minimum acceptable quality by designating a manufacturer's trade or brand name and part number, by describing attributes, performance, or other standards. It is the responsibility of the Contractor to verify that all Contractor-proposed products and system components meet or exceed the minimum acceptable performance requirements outlined below, even for those listed in the "material" section(s).

D. All products designated as "or equal", "or equivalent", and "or acceptable substitute" indicate that an alternate product that equals or exceeds the product attributes may be substituted for that product so specified. The proposed alternate component(s) performance must be independently verified and documented. This independent verification documentation must be presented to the Designer for review and approval during the bid submittal process. The alternate product must be approved by the Designer and Owner prior to purchase, installation, and/or certification. Purchase and/or installation of any component without written approval of materials by the Designer and/or Owner is done at the Contractor's own risk.

E. Any part numbers provided in this Specification have been coordinated with the manufacturers latest available product literature. Part numbers are subject to change without notice by the manufacturers. Where a specific part number is invalid, provide product meeting component description.

F. Contractor shall provide product submittals adequate to clearly demonstrate the conformance of the specific product to the attributes, performance, and standards set forth within the Construction Documents for all products prior to use after the bid submittal phase. Alternates proposed after the bid submittal phase are required to have written approval for use by the Designer.

G. All cable shall be rated and installed for the specific construction environment, unless otherwise noted in the Construction Documents. It is the responsibility of the Contractor to verify the installation environment prior to bid.

H. All products shall be new, unused, in perfect working condition, and in the original packaging containers upon arrival at the Project Site and also prior to installation. It shall be the Contractor's responsibility to verify the status of the products and report, in writing to the Designer and Owner, any products that do not conform to the requirements described within the Construction Documents. Commencement of the Work described herein constitutes the Contractor's acceptance of new, unused products as stated, being installed. Any products found to be non-conforming shall be replaced with conforming products by the Contractor at their expense immediately.

2.02 COMPONENT MANUFACTURERS

A. Subject to compliance with technical requirements of this section and the bid requirements provided in General Conditions, provide cable and equipment from the manufacturers as indicated herein as a connectivity and distribution "system".

B. Horizontal cables and terminations must be certified as a system. Manufacturers' specifications and guarantees of system compliance must be provided for acceptance.

C. Approved suppliers of the structured cabling system are Superior Essex and Leviton only. Approved supplier of the support infrastructure components is Chatsworth Products.

2.03 MATERIALS

A. Where specific items are called out in the specification or indicated on the drawings for a specific application, use those products or materials, or approved substitutes. Where no specific call outs are made use premium products and materials.

2.04 SUBSTITUTIONS

A. All products described by attributes and noted with the optional "or equal", "or equivalent", and "or acceptable substitute" indicate that an alternate product that equals or exceeds the specified product attributes may be substituted for that product so specified if approved by the Designer in writing prior to bid.

B. The alternate or equal designated products must be submitted for review and judgment to the Owner and Designer prior to inclusion in a Contractor's bid. The Contractor-proposed alternate products or components that meet or exceed the specified attributes must be verified by two (2) independent sources within the past 6 months.

C. The Contractor shall submit a written request for Designer and Owner approval of their use fourteen (14) elapsed days after the first pre-bid meeting date. This request shall include the two (2) independent sources, the original product's specification sheet, the proposed substitute product cut sheet, and a written request to review the substitute product that includes any cost impact (increase or decrease) associated with the request.

2.05 CABLE MEDIA

A. 4-Pair Cable Unshielded Twisted Pair Plenum – CMP:
   1. Physical Specifications: 4 twisted pair – 24 AWG, solid copper conductors, 100 ohm nominal impedance +/-15% and independently verified as TIA/EIA category-6 performance.

2. Electrical characteristics: Superior to the individual characteristics proposed in TIA/EIA Category 6 cable performance specification.
3. Cable Construction: conductors shall be individually insulated with 100% Fluorinated-Ethylene-Propylene (FEP) and jacketed with an approved material per the installation environment.
4. Colors are outlined in the T-series drawings.
5. Manufacturer: Superior Essex.

B. Multi Pair Voice Riser Cable:
1. Physical Specifications: 100 twisted pair – 24 AWG, solid copper conductors, 100 ohm nominal impedance +/-15%.
2. Electrical characteristics: All pair counts must meet Category 3 transmission requirements.
3. Cable Construction: individually insulated conductors with standard UTP color code markings, a minimum of two twists per foot under a rated sheath.
4. Manufacturer: Super Essex.

C. Multi Mode Horizontal/Backbone Fiber:
1. Physical Specifications: Core Diameter 50 æm, Cladding Diameter 125µm.
2. Optical Characteristics: maximum fiber loss 3.0dB/km @850nm & 1.5dB/km @ 1300nm, minimum modal Bandwidth 200MHz @ 850nm @ 500MHz @ 1300nm. Must be able to support 1 Gb/s at distance up to 1,000 meters for 850nm and 600 meters for 1300nm.
3. Cable Construction: cable shall be rated for use in plenum applications with fiber counts of 2 through 24 available. Cable shall have a dielectric strength member for strength member for strength and be contained within a metallic wrap from end-to-end for protection.
4. Manufacturer: Superior Essex.

D. Single Mode Backbone Optical Fiber cable:
1. Physical Specifications: Core Diameter 8.3µm, Cladding Diameter 125µm.
2. Optical Characteristics: maximum fiber loss 0.70dB/km @ 1310nm & 0.70dB/km @ 1550nm.
3. Cable Construction: cable shall be rated for use in plenum applications with fiber counts from 2 to 24 available. Cable shall have a dielectric strength member for strength and be contained within a metallic wrap from end-to-end for protection.
4. Manufacturer: Superior Essex.

2.06 TERMINATION HARDWARE

A. Modular Insert Copper Termination Panels:
1. All copper termination panels shall be modular metal frame, 48 port panels that accept modular category-6 RJ45 jack inserts or blank inserts from the same manufacturer.
2. Panels shall be 19” rack-mountable and provide labeling space for each port.
3. Metal modular panels shall be black in color. Modular jack inserts shall correspond with the colors outlined in the T-series drawings.
4. Manufacturer: Leviton.

B. Fiber Termination Panels
1. Fiber combination shelf for terminating SC connectors in a rack mount frame for mounting into a 19” rack. The combination shelf shall be able to support the

terminations associated with the fiber cables and connectors as well as any splice cases required.
2. Fiber termination panels shall be either 2 rack units of 4 rack units to support the cable and connectivity requirements outlined in the T-series drawings.
3. Manufacturer: Leviton

C. Modular Connectors/Jacks:
1. Wall Outlets & faceplates, containing 8-pin modular connectors, non- keyed, angled front. 8-pin connectors; complies with EIA/TIA – Category 6, performance specifications. Outlet wired with standards compliant T568-B pinning. Coordinate jack colors with T-series drawings.
2. IDF Patch panel modular jacks shall match the outlet jacks at each workstation location (color, performance, and labeling).
3. Manufacturer:: Leviton

D. Equipment Racks:
1. 19” EIA-310 standard steel equipment rack, 7 ft. high, complete with vertical cable raceways and horizontal cable management panels. Suitable for mounting approved modular patch panels, wire management and active network equipment. Must be seismically rated and restrained.
2. Manufacturer:: Chatsworth

E. Four Post Rack Frame:
1. 19” EIA-310 standard steel, 4-post equipment frame, 7 ft high, complete with vertical cable raceways and horizontal cable management panels (if indicated in the T-series drawings). Suitable for mounting approved modular patch panels, wire management and active network equipment. Must be seismically rated and restrained.
2. Manufacturer:: Chatsworth Quadra Frame

F. Wall-Mount Cabinet:
1. 19” EIA-310 standard steel, internal 4-post reinforced frame, 3 ft high, complete with vertical cable raceway channels and horizontal cable management panels (if indicated in the T-series drawings). Suitable for mounting approved modular patch panels, wire management and active network equipment.
2. Chatsworth Cur-IT Plus Cabinet

2.07 MANAGEMENT HARDWARE

A. Cable Managers:
1. Rack mounted, Double sided Slotted vertical cable manager, 6in Clear.
   a. Manufacturer: Chatsworth Products. Inc.
2. Rack mount, Double sided 2 U 19” Horizontal Wire Management Panel
   a. Manufacturer: Chatsworth
3. Four post frame- mounted, Single sided Slotted vertical cable manager, 4in Clear
   a. Manufacturer: Chatsworth Products Inc.

2.08 CABLE PATHWAYS

A. EMT Steel Conduit for horizontal cable. (Installed by Others). The horizontal cable system will be totally enclosed. The cable will run in conduit and through junction boxes. The conduit system will extend from the station outlet box to the telecommunications Rooms.

B. Non-Continuous Cable Supports (Multi Tiered J Hook Assemblies) for cables not in conduit.
   1. Multi- tiered non-continuous cable support assemblies shall be used to support telecommunications cables in accessible ceiling areas. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL Listed.
   2. Provide all necessary hardware for installing multi-tiered support brackets in accessible ceiling spaces. These spaces may include T-bar ceiling, threaded rod spaces, and or direct mounting to concrete wall or ceiling.
      a. Manufacturer: Chatsworth

C. Cable Runway Support and Pathway System.
   1. All industry standard cable runway shall be manufactured with tubular steel rails twelve inches (12”), fifteen inches (15”), eighteen inches (18”) or twenty-four inches (24”) in width configures with industry standard on and on-half inch (1.5”) ladder cross bars positioned twelve inches (12”) on center perpendicular to the rails, as indicated in the Project Drawings.
   2. Cable runway system shall include structural engineered and approved components to provide and install the necessary zon-4 seismic support system including end caps, wall angle support brackets, bonding straps, butt splice kits, junction splice kits, and rack-to-runway mounting kits.
   3. The cable runway system shall include a corner section at each intersection that creates a radius “L”, “X”, and/or “T” formed when two (2) or more pieces of cable runway are connected together with a junction splice assembly.
   4. The cable runway system shall include all components indicated in the T- series drawings to complete the system. These components shall be available from the same manufacturer and shall include, but may not be limited to:
      a. Cable runway bend radius drop assemblies (sized per runway section)
      b. Cable runway movable cross member assemblies to support cable runway bend radius drop assemblies (sized per runway section).
      c. Runway butt-splice kits
      d. Runway junction splice kits
      e. Cable runway corner brackets (sized per runway and site conditions)
      f. Swivel splice kits
      g. Rack-to-runway mounting plates (sized per runway section)
      h. Cable elevation kits (sized per site conditions)
      i. Wall angle support brackets (sized per runway section)
      j. Runway foot kits
      k. Threaded rod assemblies for attachment
      l. Slotted Support brackets for runway attachment to threaded rod assemblies
      m. Vertical wall brackets
      n. Cable retaining posts (6” as required)
      o. Runway grounding kits
      p. Protective end caps
   5. All cable runway components shall be black in color, unless otherwise noted in the Project Drawings.
   6. Cable Runway System Manufacturer
      a. Chatsworth Runway System and Components.

2.09 LABELS

A. Labels:
   1. Laser printed self-adhesive, smudge resistant self-laminating labels for cables and faceplates. Labels shall be appropriately sized for cable diameter. Labels shall be appropriately colored for faceplate color contrast.
   2. Manufacturer: Rhino 6000/6500 Labeler and Labels

PART 3 – EXECUTION

3.01 EXAMINATION

A. Contractor shall examine the site conditions and telecommunications spaces associate with the work and the conditions under which the Worth would be performed prior to beginning work. Contractor shall remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 METHODS AND PROCEDURES

A. Examine and compare the Telecommunications Drawings and Specifications with the Drawings and Specifications of the other trades. Report any discrepancies between them to the Architect, and obtain from them written instructions for changes necessary in the work. At time of bid, the most stringent requirements shall be included in the bid.

B. Install and coordinate the telecommunications cabling Work in cooperation with other trades installing interrelated work. Before installation, make proper provisions to avoid interference in a manner accepted by the Architect. Any repairs or changes made necessary in the Contract Work, caused by the Contractor's neglect, shall be made by him at his own expense.

C. The Contractor shall maintain a complete file of Shop Drawings and other submissions, including the Project specifications and the drawings, at the job site at all times. Shop Drawings and all other submissions shall be made available to the Architect and County representative at their request.

D. The Contractor shall follow manufacturers' instructions for installing components and adjusting all equipment and telecommunications cables. Submit two (2) copies of such instructions to the Architect before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.

E. Perform all tests required by local authorities in addition to test specified herein.

F. Do not allow telecommunication cables to run parallel with electrical cables/conduits, unless they are separated by a minimum of 12 inches. Note: any telecommunications cables that must cross over electrical cables/conduits shall do so only at 90-degree angles.

G. Ensure that all telecommunications cable supports (conduits, support grips, J hooks) are fully installed before proceeding with cable installation. At no times shall cables be installed and left unsupported. At no times shall cables be tie- wrapped to any other supporting structure in lieu of specified cable supports. Do not bundle or tie-wrap the cables even within the approved cable supports.

H. For installation of Non-Continuous Cable supports (Multi Tiered J Hook Assemblies), ensure cable is supported with a J Hooks every 4 to 5 feet. No cable shall remain unsupported for more then 5 feet.

I. Do not lay telecommunications cables unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top of them at any time.

J. Maintain manufacturers' recommended minimum bend radius of the cables, at all times (minimum bend radius may be as small as 1 inch for 4-pair UTP). Do not stretch, stress, tightly coil, bend or crimp the workstation cables during the installation or when leaving them out of the way of other trades during the staging work. The Contractor, at the Contractors expense, shall replace all abused or stressed cables.

K. Keep all items protected before and after installation, with dust and waterproof barrier materials as necessary. The Contractor shall be responsible to ensure the integrity of the protective measures throughout the life of the project.

L. Clean up and remove all debris generated by installation activities. Keep the telecommunications areas free of debris at all times.

M. Deliver to County's representative two sets of all special tools specifically needed for proper operation, adjustment and maintenance of cable and cable termination hardware installed under this Contract.

N. Upon project completion, provide as-built drawings and documentation as defined herein.

O. Craft personnel shall be qualified to perform the work activities and be knowledgeable of the following:

1. Color coding of standard UTP cables.
2. Bonding and grounding of cable tray and equipment racks.
3. Testing conductors for electrical continuity.
4. Testing of copper conductors for wire mapping, attenuation and worst case near end cross talk and other tests as required by ANSI/EIA/TIA 568-B.1 and B.2
5. Termination or connectorization of unshielded twisted pair cable on all specified connectors and termination.
6. Generally accepted industry standards, as well as manufacturers written installation instructions, will be used for in-process quality control and final acceptance of the work installation.

P. Check actual job conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system in accurate before proceeding with the installation. The Contractor will be responsible for inspecting the previously performed work of other trades, and commencement of work will serve as evidence of the acceptance of this work as suitable for the work to follow. Notify in writing the Owner and Designer of any discrepancies that will impact the telecommunications system prior to commencement of said work. Examples of work which must be checked include, but are not limited to:
1. Electrical requirements (conduit installation and capacity)
2. The telecommunications rooms are the size shown on the Project Drawings.

3. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.

3.03 INSTALLATION

A. Equipment Racks and Cabinets
   1. Provide, as shown on drawings, rack and cabinets in the respective IDF rooms or termination locations for the mounting of termination panels and IT equipment. Bolt each rack to the floor slap and attach the cable runway system overhead via cable runway elevation kits per the manufacturer's recommended installation instructions. Found each individual rack and cabinet to the grounding busbar located within the room/space.

B. Termination Components:
   1. Provide fiber combination shelf in rack mount frame for mounting into racks and cabinets as indicated in the project drawings with a minimum of 48 port capacity. Provide and install correct adapters for fiber termination, complete with designation strips & any required cable managers.
   2. Provide Wall Outlets & faceplates containing 8-pin modular connectors, non-keyed, 8-pin connectors; complies with ANSI/EIA/TIA-568C.2 – Category 6, performance specifications. Outlet wired with standards compliant T568-B pinning. Coordinate faceplate color and jack color with T-series drawings.
   3. Provide IDF modular termination jacks at patch panels as 8-pin modular connectors, non-keyed, 8-pin connectors; complies with ANSI/EIA/TIA 568C.2 – Category 6, performance specifications. Wired with standards compliant T568-B pinning. Coordinate jack colors with T-series drawings. Install black colored blank modular inserts into unused patch panel ports.

   4. Provide required amount of patch cords for connectivity as specified above.

C. Cable Media:
   1. Install riser UTP cable in accordance with this Specification in quantities indicated in the project drawings and terminate all UTP cable pairs (except the 25" pair in each binder group – coil for future use) on patch panels as indicated in the T-series drawings. Comply with the manufacturers' recommendations, and the Telecommunications Distribution Plan Drawings.
   2. Install riser fiber cable in accordance with this Specification in quantities indicated in the T-series drawings from each IDF and to the BDF. Comply with the manufactures recommendations, and the Telecommunications Distribution Plan Drawings.
   3. After dressing the cable to its final location, remove only enough sheath to allow the conductors to be splayed and terminated in a neat and uniform fashion. Every effort will be made to maintain sheath integrity by removing only as much sheath as is practical, to accomplish termination. For UTP cables, maintain the manufacturers twisting of the wire pairs through to the point of termination, with a maximum untwist of 1/8".
   4. There shall be no splices or mechanical couplers installed between the cable points of origin and termination for the inter-building and intra- building cable.

D. Cables:
   1. For standard type outlets, provide 4-pair Category 6 cables from each workstation telecommunications outlet location to the respective termination location as indicated in the project drawings. Cables to be color-coded consistent with T-series drawings.

For additional workstation types as indicated on the telecommunications drawings route the correct amount of Category 6 cable from each workstation telecommunications outlet location to the respective termination location. Utilize the cable tray system for the routing of cables whenever possible. Terminate all cables onto 8-pin modular connectors at the outlet location. Terminate the four cables onto rack mounted metal modular data jack insert patch panels.

2. Where telecommunications outlets are wall mounted inside enclosed offices, route cables overhead from the termination location (IDF) via the overhead cable tray network to the outlet area, and down a conduit stub-up to a junction box at the bottom of the conduit. Mount outlets with an appropriate faceplate.
3. Where workstation outlets are mounted in drywall partitions to support seating in the common areas, route cables from the termination location (IDF) to the accessible ceiling area within the commons area and down a conduit stub-up to a junction box at the bottom of the conduit. Mount outlets with an appropriate faceplate.

E. Cable Runway and Non-Continuous Cable Supports (Multi Tiered J Hook Assemblies):
   1. Provide cable runway and associate runway components in the IDFs/BDF and termination locations are shown on the T-series drawings. Mount cable runway overhead at the indicated height follow manufacture's installation instructions at all times.

   2. Provide threaded rod ceiling support assemblies, spaced 5' on center, wall angle support kits, or triangular support brackets to support the cable runway over head (where required) as indicted in the T-series drawings.

   3. Ground each cable runway section to the next. Ground each cable runway to the nearest grounding busbar located within the respective rooms. Provide waterfall pieces for the gradual transition from end of cable runway or whenever cables exit the cable runway.

F. Identification:
   1. Provide on all outlet faceplates installed under this Work. Labels should be machined-generated labels with the outlet ID as per EIA/TIA-606A standards that is approved by the Owner prior to use.
   2. Provide on all termination panels installed under this Work, machine- generated designation strips with the cable ID and pair number, in uppercase lettering.
   3. Provide on all patch panels installed under this Work, machine-generated label with the cable ID, and fiber strand number in uppercase lettering.
   4. Provide on all telecommunications cables installed under this work a machine-generated label with the cable ID, in black uppercase lettering on a permanent adhesive, white label stock, covered with permanent water resistant sealer. Labels shall be placed on both ends of the cable and no more then 6" from the point at which the cable is broken out into individual copper pairs or strands from the connector or termination block or patch panel. Labels shall be placed parallel with the cable. All labels shall be readily visible.
   5. Hand lettered label stock will not be accepted for final installation. Hand lettered stock is only acceptable for use with temporary labeling required during construction phases.
   6. If at any time during the project, the label becomes illegible or removed, the Contractor shall immediately replace it with a duplicate preprinted label.
   7. All cable IDs shall be both physically and visually accessible upon completion of the project.

3.04 COPPER CABLE TESTING AND VERIFICATION

A. Verify and test all catefory-6 cables with a Fluke DSP 4300 series Level III tester that has been properly calibrated by the manufacturer within the recommended time frame for factory-certification. Verification and documentation of latest factory certification must be provided by the Contractor prior to testing.

B. The tester interface adapters shall be PM06 universal permanent link adapters and must be in new condition with the adapter cable and assembly not indication any twisting or kinking resulting from coiling and storing of the tester interface adapters.

C. Baseline accuracy of the copper test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

D. Copper Test equipment must be capable of verifying Category 3, Category-5E and Category-6 links or channels independent of termination hardware configuration (IDC or 110-style) for levels of performance.

E. Copper Test equipment shall be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.

F. The testing device shall be provided by the Trade Contractor and approved by the Designer, and Owner prior to use. It is the responsibility of the Trade Contractor to get written authorization from the Designer and Owner to commence testing with their proposed device. Failure to gain approval is at the Trade Contractor's risk and expense.

G. All category-6 cables shall be tested for, and comply with, TIA/EIA 568-C.2 standards related to the following:
   1. Wire Map
   2. Continuity
   3. Length
   4. Attenuation/Insertion Loss
   5. Near End Cross Talk (NEXT)
   6. Power Sum (PS) Next
   7. PS Next to 100Mhz
   8. Equal Level Far End Cross Talk (ELFEXT) Loss
   9. PS ELFEXT Loss
   10. Return Loss
   11. Propagation Delay
   12. Delay Skew
   13. Attenuation to Cross Talk Ration (ACR)
   14. PS ACR
   15. Proper Labeling
   16. Others as may be noted in the Contract Documents

H. Category-3 testing of every copper cable pair shall be tested for, and comply with, TIA/EIA 568-C.2 standards and must include each of the following:
   1. Wire Map
   2. Length
   3. Opens

4. Shorts
5. Continuity
6. Polarity, or Pair Reversals

3.05 FIBER CABLE TESTING AND VERIFICATION

A. All optical fiber cables/strands must be tested in the end-to-end, completed system with a Fluke OpifiberTier-2 optical fiber testing device and appropriate fiber mandrel that provides the following:
   1. Measuring insertion loss
   2. Analyzing the OTDR trace
   3. Grading the connector end face
   4. End face image of connector(s) embedded into certification report.

B. All tested fiber strands must meet the FOTP requirements put forth by TIA/EIA 526, TIA/EIA-455 (method-B), TIA/EIA 492AAAC, TIA/EIA TSB-63, and TIA/EIA TSB-140 requirements and the TIA/EIA 568-C.3 standard. Any optical fibers failing to meet these standards or the more stringent performance requirements stated above, must be removed and replaced, at no cost to the Owner, with fibers that prove, in additional testing, to meet or exceed the performance standards set forth.

C. Optical fiber splices, fusion or mechanical, shall not exceed a maximum optical attenuation stated in section 2, above, when measured in accordance with field testing procedures

D. The system loss measurements shall be provided at 850 and 1310 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.

E. The testing of all optical fiber cables shall include bi-directional, end-to-end tests using both a hand-held Optical Time Domain Reflectometer (OTDR) and a light power meter testing device. The signature trace of the cable must include each of the following:
   1. Attenuation per kilometer
   2. Attenuation uniformity
   3. End-to-end integrity
   4. Total length of each strand
   5. Total insertion light loss
   6. Insertion loss at each incident throughout the cable path

F. After Optical fiber verification testing in one (1) direction has been completed and certified, all optical fiber strands are to be measured in the opposite direction. All test parameters shall be indicated for both directions on each strand in the test documentation.

G. All fiber test results shall include an image of both connector end faces embedded into the final test report (hard and soft copy) for a baseline reference of each connector.

H. The allowable loss budges shall be as follows:
   1. MMF: (All cable loss per km)(km of fiber in link) + (.35dB LOMMF)(number of connectors) = maximum allowable loss
   2. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.
   3. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, and no charge to the Owner.

I. Any installed component in the TIA/EIA fiber-related and/or industry standard verifications testing parameters found to be below performance standards for that particular channel and/or link, testing procedure, and manufacturer specified performance criteria shall be immediately replaced and retested by the Trade Contractor at no additional cost to the Owner until all deficiencies are rectified to the satisfaction off all testing procedures.

3.06 TEST DOCUMENTATION

A. A complete set of test results shall be presented to the Designer and Owner at least one(1) week before the placement of active electronics in the IT spaces. The Trade Contractor shall identify the types of cable tester(s) used during the testing and verification when presenting the results for each type of cable and each test procedure, unless otherwise indicated.

B. All verification and test results shall be submitted to the Designer and Owner in both paper and electronic formats printed directly from the testing device software application. Paper results must be neatly presented in a three (3) ring binder and sectioned according to floor and cable type, OSP, category-6, category-3, and optical fiber cables must be divided into separate sections with each floor. Electronic results must be presented on CD-Rom disc(s) in the testing device's native file type with a copy of the electronic software used to generate the test results for review by the Owner, Designer and the contractor selected connectivity and cable group representative(s).

C. Trade Contractor shall warrant in writing that one hundred percent (100%) of the installation meets requirements specified under subsection above sections. Owner reserves the right to conduct. Using Trade Contractor equipment and /or labor, a random re-test of up to five (5) percent of the cable plant to confirm documents results. Complete (100%) random re-testing, if performed, shall be at the expense of the Owner, using standard labor rates if no failures are found. If any failures are found in the 5% verification testing performed by the Owner, the re-testing expense shall be the Trade Contractor's. Any failing cabling shall be re-tested and restored to a passing condition. In the event more then two percent (2%) of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.

3.07 FIRE STOP – PENETRATION SEALANT

A. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall or floor ceiling penetrations. Material must be properly classified and meet all national and local codes.

B. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of cold smoke, fire, toxic gas or water through the penetrations, before, during or after a fire. The fire rating of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code.

C. No flammable material may be used to line the chase or hole in which the fire stop material is to be installed.

D. All damming materials to be left in place after the seal is complete shall be non-flammable.

E. The sealant shall remain resilient and pliable to allow the removal and or addition of cable without necessity of drilling holes. It shall adhere to itself perfectly to allow any and all repairs to be made with the same material. It shall allow for vibration, expansion and/or contraction of anything passing through the penetration without affecting the seal, or cracking, crumbling and spalling.

F. When sealant is injected into a penetration, the material shall expand to surround all the items within the penetration and maintain pressure against the walls of the penetration as well as the pass-through items. The material shall cure within five minutes and be fire resistant at that time. No heat shall be required to further expand the material to prevent the passage of fire and smoke or water.

G. The materials shall have been subjected to fire exposure in accordance with standard time-temperature curve in the Standard, UL ASTM E 119 and NFPA 251. The fire stop material shall have also been subjected to the hose stream test in accordance with UL 10B.

3.08 AS BUILT DRAWINGS AND CABLE LIST

A. The Contractor shall provide the following "As-Built" drawings to the owner. These as-built drawings shall include all work described within this specification section, including, but not limited to the following:
   1. A complete backbone connectivity diagram showing backbone interconnection and cable routing. Each cable type and routing shall be noted.
   2. Finalized, detailed elevations of the Voice and Data MDF illustrating all punch-down locations and rack elevations.
   3. Finalized, detailed elevations of the IDF(s) illustrating punch-down locations and equipment rack locations
   4. Finalized equipment rack elevations illustrating vertical location of termination hardware (e.g. fiber boxes, patch panels, ect.) within all telecommunications areas.
   5. Finalized outlet layout floor plans including room/area numbers, outlet numbers and the corresponding cable identification numbers.

3.09 MANUFACTURER'S LITERATURE

A. Where the Specifications and/or Project Drawings call for an installation to be made in accordance with the Manufacturer's recommendations, a copy of such recommendations shall always be kept on the job site, and shall be available to the Owner.

B. Contractor shall follow manufacturer's instructions where they cover points not specifically indicated on Project Drawings and Specifications. If said instructions differ from the Project Drawings and Specifications, it is the responsibility of the Contractor to obtain clarification from the Owner in writing before commencing work.

3.10 TRAINING

A. Provide training for the Owner-appointed employees to operate and maintain the installed technology utility system. Training will include two (2) full day sessions that include, but

are not limited to: a description of the system, a tour of the facilities, and a manufacturer-provided tutorial on using the cable testers and documentation software.

3.11 ACCEPTANCE

A. The installation will not be accepted until all work is complete and properly documented, as noted above and in the Project Drawings and not until all punch list items discovered are completed to the Owner's satisfaction and after the successful completion of the Acceptance period.

B. Following the completion and compliance of all requirements noted above and in Division One, the Owner will issue a Notice of Completion confirming that the Technology Portion of the project is complete. A forty-five (45) day Acceptance period will begin immediately following the issuance of this Notice of Completion

C. During the acceptance period, the Voice data Communication System, as described herein and in the Project Drawings, must be up and operational. If there is a major system failure, the Acceptance period will begin again, once the failure is resolved and the system is back up and running. Major system failures are defined as failures that impact 10% or more of the user connections.

D. This Acceptance period shall be considered outside any Warranty period provided by the Contractor or Manufacturer. Once the forty-five (45) days Acceptance period has successfully passed, the Warranty period shall begin.

E. The project manager must be available to answer questions about the installation and to attend site visits and meetings during the acceptance period, as deemed necessary by the Owner.

END OF SECTION

SECTION 280513

CONDUCTORS AND CABLES FOR ELECTRONIC SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the conductors and cables for the fire detection and alarm system as shown on the Drawings or as required to support the systems defined in these Specifications. The Work under this Section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the conductors and cables required for the fire detection and alarm system.

B. Related Work Specified Elsewhere: Refer to all other Division 28 Specification sections and Drawings, and to the Specifications and Drawings under the General Construction Contract to ascertain the extent of Work included.

1.2 REFERENCES

A. ASTM E84 - 08A - Test Method for Surface Burning Characteristics of Building Materials.

B. NEMA VE2- Cable Tray Installation Guidelines.

C. National Electrical Code (NEC).

D. NFPA 72- National Fire Alarm Code.

E. UL 1581- Reference Standard for Electrical Wires, Cables, and Flexible Cords.

F. UL 2196-Tests for Fire Resistive Cables.

1.3 SUBMITTALS

A. Submit in accordance with Division 01.

B. Product Data:
   1. Submit product data for conductors and cable.
   2. Indicate item proposed and area of application.
   3. Submit product data approved by state fire marshal for fire alarm cable.

1.4 DELINEATION OF RESPONSIBILITY

A. The Contractor shall provide a complete and functional system.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver conductors and cable to the site on original cable reels or original unbroken packages.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conductor and Cable Insulation: Permanently marked with the U.L. approval listing, insulation type, size and voltage at regular intervals.

B. Wire Rated for 600-volt unless otherwise specified.

C. Wiring in accordance with the specifications except where more restrictive, in accordance with the manufacturers recommendations.

D. Conductors: Copper unless indicated otherwise specified.

E. Fire Alarm:
   1. 18 AWG tinned copper conductors.
   2. Individually insulated conductors, PVC, color coded, rated 600 volts.
   3. Two conductors shall be twisted together and shall be shielded with a spiral-wound metal foil tape overlapped for 100 percent shielding.
   4. Custom manufactured to provide waterproof, polyethylene outer jacket over standard inner jacket. Retain all markings on inner jacket.
   5. Cable shall be constructed in accordance with Article 760 of NEC.
   6. Cable shall be UL listed and State Fire Marshal approved.
   7. Manufacturer:
      a. West Penn type 975 (customized).
      b. Atlas 212-18-i-2J (customized).
      c. Or equal.

2.2 ACCESSORIES

A. Cable and Wire Tags: Pre-marked, self-adhesive, wraparound cloth type.
   1. Manufacturer:
      a. E-Z Code.
      b. Brady Perma Code.

B. Lubricant: Suitable for conductor and cable insulation in conduit. Non-hardening, not becoming adhesive with age.

C. Sealant: Moisture resistive type.

D. Cable Ties:
   1. Scotch flex #760
   2. Thomas & Betts “Tyrap”.
   3. 3M Standard.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that raceways and enclosures are ready to receive the Work.

3.2 INSTALLATION

A. Make wiring connections mechanically secure.

B. Clearly identify wiring and terminals to facilitate installation and maintenance.

C. Terminate coaxial cabling with compression terminals. Use tooling approved by the terminal manufacturer.

D. Terminate wire with solderless, crimp-on insulated terminals, sized for the gage, wire type, and screw terminal.

E. Seal around conductors in conduit, which pass through exterior walls and floors.

F. Color code wiring by function.

G. Neatly group and tie together wiring within equipment and panel enclosures.

H. Install conductors with wire lubricating compound.

I. Tag conductors, in each junction box, pull box, wire way, manhole, handhold and at each device or conductor termination.

J. Use lugs at screw terminations.

3.3 TESTING

A. Check each home run cabling system thoroughly for opens, shorts, faults, and other discontinuities.

B. Test each system receptacle for continuity, ground condition, and voltage level prior to allowing plug-in of system equipment.

END OF SECTION

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SECTION 283100

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire alarm system and components.

B. Products Furnished and Installed Under This Section:
   1. Fire alarm control panels including power supplies.
   2. Signal initiating devices (smoke detectors, duct smoke detectors, pull stations, etc.).
   3. Automatic control devices.
   4. Alarm signal notification appliances (audible devices, visual devices, etc.).
   5. Special backboxes.
   6. System interface hardware.
   7. Fan control relays.
   8. Input/output modules.
   9. Fire alarm control panel batteries.
   10. Remote power supplies.
   11. Standard backboxes for fire alarm devices.
   12. Conductors and cable for local building fire alarm system.
   13. Conduit system.
   14. Annunciators on housing door control panels.
   15. Power from power panel to FACP.

C. Related Sections:
   1. Section 26 05 00 – Common Work Results for Electrical.
   2. Section 26 05 35 – Raceway for Electrical Systems.
   3. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables (600V and Below).

1.2 REFERENCES

A. FM - Factory Mutual.

B. NEC – National Electrical Code

C. NFPA 72 - National Fire Alarm Code.

D. UL - Underwriters Laboratories, Inc.

E. NFPA 101 - Life Safety Code.

F. UL 38 - Manual Signaling Boxes for Fire Alarm Systems.

G. UL 217 - Single and Multiple Station Smoke Alarms.

H. UL 268 - Smoke Detectors for Fire Alarm Signaling.

I. UL 268A - Smoke Detectors for Duct application.

J. UL 464 - Audible Signal Devices.

K. UL 1971 - Signaling Devices for the Hearing Impaired.

L. UL 864 - Control Units and Accessories for Fire Alarm Systems.

M. ADAAG - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.

1.3 SYSTEM DESCRIPTION

A. The building will require a code compliant (local and national), fully functional fire protection system. In addition to providing and installing the building's fire protection system, this subcontractor shall also furnish column or wall-mounted fire extinguisher as required.

B. Local Building Fire Alarm System:
   1. Activation of any manual or automatic fire alarm initiating device activates building general alarm audible and visual devices through the FACP. The FACP indicates device or devices in alarm.
   2. System trouble activates common audible trouble signals at the FACP. The FACP indicates device or devices in trouble condition and activates the central fire alarm monitoring system.
   3. Alarm and trouble signals operate until the condition is corrected and the FACP is manually reset at the FACP itself by key or code (remote reset is not allowed).
   4. An FACP front panel switch silences audible trouble signals. Visual trouble indication remains on the FACP LCD display until trouble condition is corrected and system is restored to normal by the reset function at the FACP. The following conditions initiate a trouble signal:
      a. Ground or open on an initiation or alarm circuit.
      b. Loss of 120 volt operating power to FACP.
   5. Alarms annunciate as specified until the initiating device returns to normal and the system is reset at the FACP. The FACP may silence audible alarms without resetting the system. System continues to monitor all initiating points as specified after alarm signal silencing. Additional alarms initiate the audible tone until silenced again.
   6. Individual designated non-fire alarm monitoring points shall not cause the FACP to enter the "alarm" state. The FACP monitors the status of the relay contact and automatically clears or resets when the relay contact returns to its normal state. Manual reset of the FACP is not required. Alarm verification feature shall not be implemented for non-fire alarm monitoring points.
   7. Each local FACP shall be an addressable NFPA 72 Class A fire/smoke detection and alarm system that complies with NFPA 72 as a Protected Premises Fire Alarm System.
      a. Automatic detector circuits: Addressable Style 6 signaling line circuits with remote sensitivity monitoring and adjustment.
      b. Notification appliance circuits: Style Z circuits.

8. The FACP will provide the functions specified for the building if the communication link between the local FACP and central fire alarm monitoring system is lost. This includes monitoring detection devices, annunciating audible and visual signaling devices, providing remote annunciation where specified, providing TROUBLE indications and operation in the TEST mode.
9. Auxiliary contacts on duct smoke sensors will be used to activate/deactivate the associated mechanical equipment unless otherwise noted in these specifications or on the riser diagrams. Contractor shall extend control circuits to the duct smoke sensor auxiliary contact and affect the required control sequence.
10. Each FACP includes a power supply with battery back-up. Both the power supply and battery back-up shall be sized to independently provide power for the fire alarm system as specified plus 20% spare capacity for future system expansion.

1.4 SUBMITTALS

A. Submit under provisions of Division 1, Section 26 05 00, and Section 27 05 00.

B. Submit product data for all equipment furnished by Contractor.

1.5 QUALITY ASSURANCE

A. Qualifications: Company specializing in installation of work in this Section with minimum three years documented experience, approved by manufacturer.

B. System Standards:
1. National Electrical Code, Article 760.
2. NFPA 72.

C. Design Criteria:
1. Comply with all system standards.
2. Meet all requirements of fire authorities having jurisdiction.
3. The installing building fire alarm subcontractor shall communicate with the plant-wide fire protection subcontractor to coordinate tie-in of the building system with the site monitoring system.

D. All equipment shall be:
1. UL listed for application as component part of system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Notifier by Honeywell or approved equal.
1. Notifier numbers are used for reference unless otherwise noted.

B. System Sensor.

2.2 FIRE ALARM CONTROL PANEL (FACP)

A. FACP shall be Notifier NFS-320 addressable fire alarm control panel with enclosure.

B. Power supply will be furnished with the control panel and rated for 120 volt, single phase AC.
   1. Battery backup shall consist of (2) 18 AH 12180 batteries.

C. Interfaces:
   1. FACP shall interface with appropriate DCS cabinet using (2) ST to ST duplex multimode 62.5 UM optical fiber patch cords. Minimum 5 meters long.
   2. Relays shall consist of FRM-1 relays.
   3. Network control shall consist of (1) NCM-F network control module (fiber).

2.3 SIGNAL INITIATING DEVICES

A. Manual Fire Alarm Boxes:
   1. Shall consist of NBG-LX Addressable manual pull stations.

B. Smoke Sensing Fire Detectors:
   1. Shall consist of FSP-851 intelligent addressable photoelectric smoke detectors.

C. Smoke Sensing Duct Detectors:
   1. Shall consist of System Sensor DNR intelligent addressable photoelectric duct detectors.

2.4 ALARM SIGNAL DEVICES

A. Combination Audible/Visible Appliance:
   1. Shall consist of System Sensor P2R wall-mounted devices.

2.5 EQUIPMENT SUMMARY

A. See building fire alarm riser diagrams and device schedule included in the drawings for device types and quantities required for the building fire alarm system.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with Sections 26 05 00 and 27 05 00.

B. Power Wiring:
   1. Install power wiring from the power panel to the fire alarm control panel and other system devices requiring 120 volt power or low voltage power.

C. Location and Mounting:
   1. Control panels shall be surface mounted unless otherwise indicated.
   2. Identify device boxes with device designation as indicated on the contract drawings.
   3. Install devices at heights indicated or where not indicated, at the following heights:
      a. 48 inches: Pull station (center).
      b. 72 inches: FACP (top).
      c. 10’ - 6”: Audible/Visible Signal Station (center).

D. Signal Initiating and Alarm Signaling Circuit Wiring:
   1. Provide wiring in accordance with Section 28 05 13.
   2. Install wiring in accordance with the NEC, NFPA 72, and wiring and termination diagrams provided by the Site Electronics contractor.
   3. Make fire alarm wiring continuous from terminal to terminal or from terminal to device pigtail lead.
   4. Circuit splices are not permitted.
   5. T-tapping is not permitted.
   6. Wiring joints, only when required at device pigtail leads shall utilize spring wire connectors under provisions of Section 26 05 19.
   7. Ground shielded cable at one end only.
   8. Unless otherwise approved, splices, including terminal boards, terminal blocks or terminal strips, will not be allowed.

E. Make wiring connections to all duct units with flex conduit to standard 4 inch octagonal outlet box mounted on base of detector. Provide conduit and wiring from each duct smoke detector auxiliary contact or programmable remote relay to the mechanical control panel at the mechanical unit for unit shutdown.

F. Furnish and install a weather-proof enclosure for devices which are exposed to weather. Furnish and install solar shield for devices, such as duct detectors, mounted in the direct sun when shield is required for proper operation. Unless mounting is not possible in any other way, mount duct detectors so they are not exposed to direct sunlight.

G. Furnish 6” x 6” surface metal raceway with screw cover in accordance with Section 26 05 35 above and below the FACP. Minimum width shall be 24” and raceways shall be separated a minimum of 60” from the bottom of the top raceway to the top of the bottom raceway. No power wiring shall be installed in the raceway. Properly sized conduits shall be installed from the surface raceway to the FACP. Where fire alarm panels are flush mounted to wall, provide flush mount 6” x 6” metal raceway with screw cover.

H. Make wiring connections to specified systems being installed by other building contractors to fire alarm system. Provide conduit and wiring as required.

3.2 QUALITY CONTROL AND TESTING

A. Testing shall be performed in accordance with the Schedules in the NFPA 72, Table 7-2-2.

B. Conduct Initial Building Contractor Testing in accordance with the approved testing procedures. Submit test results.

C. After completion of Initial Building Contractor Testing, schedule Final Building Performance Testing.

D. Deliver the final redline as-built box and conduit drawings and conduct Final Building Performance Testing of the entire building fire alarm system in accordance with the approved testing procedures. Submit test results for approval. Demonstrate the building fire alarm system to the satisfaction of the Owner’s Representative and the AHJ.

E. Maintain the cleanliness of the smoke and heat sensing fire detectors from the time that the devices are installed to the time that each building system is tested. The sensitivity listing of

all detectors shall not exceed 35% of the total environmental compensation as determined by reviewing the maintenance report at the local building FACP. If any detector exceeds the specified 35% level, then that detector shall be removed, cleaned, replaced and re-tested until the specified level is met.

F. Replace the protective dust covers on the smoke and heat detectors after all building system tests (Initial and Final) has been completed and accepted by the Owner's Representative and the AHJ.

G. Provide all qualified technicians and support equipment necessary for the completion of all testing and retesting requirements.

3.3 DETECTOR PROTECTION DURING CONSTRUCTION

A. Protect all ceiling-mounted fire system detectors during construction by providing disposable red plastic covers or bags for each detector.

END OF SECTION

SECTION 311100

CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Site clearing and grubbing.

B. Related Sections
   1. Section 02 41 00 - Demolition.
   2. Section 31 20 00 - Earth Moving.

C. References
   1. 2010 CBC (Chapter 11, California Green Code).

1.2 DEFINITIONS

A. Clearing: Removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines and any other items which will interfere with construction operations or are designated for removal.

B. Grubbing: The removal and disposal of wood or root matter below the ground surface remaining after clearing including stumps, trunks, roots, or root systems greater than one inch in diameter or thickness to a depth of six inches below the ground surface.

C. Stripping: The removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped

1.3 ENVIRONMENTAL REQUIREMENTS

A. Burning is not permitted.

B. Clearing or grubbing:
   1. Do not perform during weather conditions which may produce runoff from the site.
   2. Resumption of clearing and grubbing will be determined by the Owner's Representative.

C. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

1.4 SUBMITTALS

A. Submit plan for debris removal or disposal.

B. Submit plan for debris recycling.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Verify field measurements are as shown on Drawings.

B. Protect existing improvements and elements surrounding the site from damage.

C. Review erosion control plan and implement Best Management Practices (BMPs) prior to beginning work.

3.2 CLEARING

A. Clear the area within the limit of work of all objectionable plant material, to include roots, snags, brush, grass, weeds, and similar undesirable vegetation and any other debris found at the site not specified as improvements to be included as part of this project. All such materials shall be removed from the site and disposed of in an acceptable manner. Clearing limits shall extend 5-feet beyond the development limits unless otherwise noted.

B. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.

3.3 GRUBBING

A. Grub stumps, roots, and other obstructions greater than two (2) inches in diameter or thickness to a depth of not less than 18 inches below the ground surface.

3.4 STRIPPING

A. Remove soil material containing sod, grass, or other vegetation to a depth of six inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.

B. Deposit stripped material to be reused at locations as accepted. Use accepted material in top 6 inches of areas to be used for planting.

C. Replace topsoil where indicated on the Drawings.

3.5 DEBRIS DISPOSAL

A. Cleared and grubbed materials, including all tree removal materials, shall become the property of the Contractor. All cleared/grubbed materials, including all debris resulting from tree removal work, including broken branches, fallen leaves, wood chips, and sawdust produced from stump and root removal, shall be removed from the site and either disposed of or recycled in accordance with CalGreen.

B. Dispose of trash, unchipped material, and debris off site.

END OF SECTION

SECTION 312000

EARTH MOVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Site Grading.
2. Excavation, filling, and compacting.
3. Scarifying and recompaction.

B. Related Documents and Sections
1. Geotechnical Engineering Services Report for the Proposed San Lucas Library, prepared by PSI, dated March 27, 2012.
2. Section 02 41 00 - Demolition.
3. Section 31 23 33 - Trenching and Backfill.

1.2 REFERENCES

A. ASTM References:
1. ASTM D422 - Test Method for Particle-Size Analysis of Soils.
2. ASTM D751 - Test Methods for Coated Fabrics.
3. ASTM D1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
5. ASTM D2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
6. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
7. ASTM D2974 - Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
8. ASTM D4318 -Test Method for Liquid Limit, and Plasticity Index of Soils.
9. ASTM D6938 - Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. Caltrans Testing Methods:
1. #206 - Specific Gravity and Absorption of Coarse Aggregate.
2. #229 - Durability Index.
3. #301 - Test for Resistance “R” Value.

C. Caltrans Standard Specifications, Latest Edition.

1.3 DEFINITIONS

A. Structural Fill - Area within vertical planes located five feet outside the perimeter of each building; or one foot outside the outermost edge of the surface of roadways, parking areas,

sidewalks, concrete traffic slabs, or their shoulders unless specifically indicated otherwise on the drawings.

B. Nonstructural Areas - Graded areas for landscaping, including concrete walkways less than four feet wide, berms, and all other areas not defined as a structural fill or as storm water detention basin.

C. Influence Area - Area within planes sloped downward and outward at an angle of 45 degrees from the horizontal from (a) One foot outside the outermost edge of structural fill; or (b) One foot outside the outermost edge at the surface of roadways or shoulder; or (c) one foot outside the exterior edge at the spring line of pipes and culverts. An influence angle of 45 shall be used unless otherwise noted/required by the Geotechnical Engineer.

D. Unclassified Excavation - Nature of materials to be encountered is not identified or described.

E. Free from organic material - no visible wood or roots larger than two inches in diameter and all representative samples one cubic foot or larger shall contain no more than five percent by weight organic material when tested in accordance with ASTM D2974.

1.4 DESCRIPTION

A. Provide materials, services and equipment required for rough and finish grading of the site; preparing building, structure and road earthen foundation pads to include excavating and recompacting or replacing existing soils to requirements shown on the Contract Documents; and densification/stabilization of site soils.
   1. Contractor will verify shrinkage characteristics of imported soils and existing soils to be reused.
   2. Owner will not be responsible for additional costs associated with variations in shrinkage factors and related earthwork quantities.
   3. Owner makes no representation regarding the balance of cut and fill earthwork on the site. The Contractor is responsible for the calculation of cut and fill required and available, for the cost of obtaining fill required, and for the cost of disposal of surplus.

B. Excavations, filling, and fill and backfill material shall have the approval of Owner's Representative. Work shall be performed only under the general observation and, where required, the detailed inspection and testing by the Owner's Representative and the Geotechnical Engineer.

1.5 SUBMITTALS

A. Submit product data and certificates of compliance for all products and materials proposed to be used under this section

B. Independent Testing and Laboratory Reports: Submit results of specified tests performed by the Contractor.

C. Survey Data for Completed Grading: Submit supporting survey data indicating that completed grading conforms to Contract requirements. Submit drawings showing "as-built" elevations marked on the grading plans; include coordinates of each shot.

D. Construction staging plan detailing means, materials, and staging of the work.

E. Samples, product data, and certification for imported materials.

F. Fill Samples: Submit, in air-tight containers, 50 lb sample of each type of fill to Owner's testing laboratory.

G. Dewatering Plan: Submit dewatering plan for deep excavations.

H. Excess Soils Disposal Plan. Submit drawings showing a proposed grading plan for the disposal of material at the on-site soils disposal area. Plans shall include dimensions, elevations, slopes, drainage patterns, erosion control methods and materials, and drainage facilities.

I. Submit "Shoring and Bracing Drawings" prior to beginning any trench or structure excavation 5 feet deep or over in accordance with Section 6705, California Labor Code. If such plan varies from the shoring system standards established in the construction Safety Orders of the State of California, such alternative system plans shall be prepared, stamped and signed by a civil or structural engineer licensed in the State of California at the Contractor's expense.

J. Submit a construction drainage plan showing the collection and disposal of surface and subsurface water that may be encountered in the course of construction.

1.6 QUALITY ASSURANCE

A. The Owner will employ and pay for the services of an independent testing laboratory to perform specified testing per CCR Title 24, and any other testing specifically indicated in the Contract Documents to verify compliance with the Contract Documents.

B. Relative compaction, moisture, and permeability tests will be made at locations determined by the Owner's Representative. When tests indicate that the specified requirements have not been achieved, that portion of the Work shall be reworked until the required density, moisture, and permeability has been attained. Re-testing to show compliance shall be at the Contractor's expense.

C. Daily testing of materials and the work of the Contractor will be made during construction.

D. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with ASTM D 1557. Where cohesionless, free draining soil material is required to be densified to a percentage of relative density the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254. Field density in-place tests will be performed in accordance with ASTM D 2922, or by such other means acceptable to the Engineer.

1.7 STORAGE AND HANDLING

A. Cover and protect earth materials stockpiled for use from erosion and contamination.

1.8 ENVIRONMENTAL CONDITIONS

A. Weather: Protect bearing surfaces under foundations. Should bearing surfaces become softened, excavate to solid bearing and fill with concrete, mix and strength as approved by the Owner's Representative, to elevations indicated.

B. No fill material shall be placed, spread, or rolled if weather conditions increase the moisture content above permissible limits. When work is interrupted by rain, the earthwork operations shall stop and not be resumed until directed by the Owner's Representative.

PART 2 PRODUCTS

2.1 MATERIALS

A. Structural Fill
   1. Fill material for structural pad areas or structural fill material may be native material obtained from onsite excavations, free from organic and inorganic debris, with the approval of the Geotechnical Engineer. Particle size shall not exceed 3 inches in any dimension.
   2. Imported soil shall consist of silts and sands that have a Plasticity Index not greater than 20, a Liquid Limit less than 35, and Expansion Index not exceeding 20, a particle size not greater than 3 inches, and, when used in pavement areas, an R-value of 25 or greater.
   3. Representative samples of material to be used for structural fill and earth fill shall be tested to determine the maximum density, optimum moisture content, and classification of the soil.
   4. During earthwork operations, soil types other than those identified and/or analyzed in the Geotechnical Report may be encountered. Owner's Representative will determine the use or disposal of these soils.

B. Engineered Fill Material for Influence Areas
   1. Shall be non-expansive material, with a plasticity index of less than 15, a liquid limit of less than 35, between 5 and 45 percent passing the No. 200 sieve, and shall not contain aggregates larger than 3 inches. Material may be obtained and used from on-site excavation with the approval of the Geotechnical Engineer.

C. Sand
   1. Material with 100 percent passing a 3/8 inch sieve, at least 90 percent passing a No. 4 sieve, and a sand equivalent value of not less than 30.

D. Aggregate Base
   1. Aggregate base shall be crushed rock aggregate base material meeting the requirements of Section 26, "Aggregate Bases", for ¾ inch maximum grading of the Caltrans Standard Specifications.

E. Topsoil
   1. Topsoil material may be selected excavated, crushed material, graded, free of roots, rocks larger than 2 inches, subsoil, debris, and large weeds. Excavated soil from on-site grading operations may be used for topsoil with the approval of the Owner's Representative.

F. Steel Plate

1. When steel plate bridging is provided in-lieu of backfill and temporary asphalt, it shall conform to Section 602.1 of the Caltrans Encroachment Permit Manual, with the following minimum thicknesses:

Trench Width	Minimum Plate Thickness
10”	1/2”
1’-11”	3/4”
2’-7”	7/8”
3’-5”	1-1/4”
5’-3”	[ ]

2. For spans greater than 5 feet 3 inches, a structural design shall be prepared by a civil engineer registered with the State of California.

PART 3 EXECUTION

3.1 PREPARATION

A. Should indicated conditions conflict with actual conditions and contours, notify the Owner’s Representative and await directions before proceeding. Commencement of work indicates acceptance of existing conditions.

B. Contractor shall protect adjacent property and existing improvements and structures as necessary to prevent undermining, caving of cuts, and miscellaneous damage. Protect structures, utilities, sidewalk, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

C. Excavate as required to accomplish the demolition/construction. Perform all excavation regardless of the type, nature, or condition of the material encountered. The method of excavation used is optional; however, no heavy equipment shall be operated within 5 feet of existing structures or newly completed construction, except as approved. Excavation that cannot be accomplished without endangering the present or new structures shall be performed with hand tools. The bottom of all excavations shall be proof rolled to observe the presence of any potentially soft, yielding subgrade conditions. Notify the Owner’s Representative prior to commencement of proof rolling.

D. Excavations and trenches shall be properly sheeted, shored, braced and/or sloped to support adjacent earth banks, structures, construction materials, and equipment and to provide safe working conditions. No trench, pit, or other excavation shall remain open longer than is necessary to expeditiously carry out the work.

3.2 SITE PREPARATION

A. Refer to Section 31 20 00.

3.3 REMOVAL OF WATER

A. At all times, provide and maintain means and devices to remove and dispose of water entering excavations until backfill is complete.

B. Verify groundwater elevations in areas where its presence is likely to impact construction activities.

C. Determine means and methods and perform dewatering as needed to establish a stable structure base. Additional dewatering and/or other measures may be necessary to prevent flotation or disturbance of underground structures.

D. Dewatering facilities shall be installed and functioning prior to excavation below groundwater levels in order to avoid heave of the excavation bottom and/or wall instability. Sufficient time shall be planned between dewatering and excavation to allow for drawdown of groundwater surfaces to below the lowest adjacent excavation. Dewatering may consist of closely spaced well points, sheet piling, parallel subdrains, cutoff trenches, and/or other means and methods proved suitable by the Contractor.

E. Water disposal shall meet applicable Federal, State, and local requirements.

3.4 EXCAVATION

A. Comply with CAL-OSHA and the Project Geotechnical Report for maintaining stable excavations.

B. Excavation method shall be approved by the Owner's Representative prior to commencement of the Work. Explosives may not be used unless specifically authorized.

C. Extend excavations a minimum lateral distance of 8 feet beyond the building perimeters or a distance equal to the depth of the excavation, which ever is greater. Unless shown or specified, excavate a minimum of 3 feet below the bottom of the building footing or slab, whichever is deeper.

D. Pavement areas shall be excavated to a minimum depth of 1.5 feet below finish ground surface.

E. Areas to receive fill outside of building and pavement areas shall be excavated to a minimum of 1.0 feet below existing grade. (Note: this requirement may be waived if areas are located in open areas where settlement or the presence of loose subgrade soils will not be detrimental, as determined by the Owner's Representative.)

F. Excavate to solid bearing based on depths or elevations indicated on the Contract Documents. Do not carry excavations deeper than the elevation shown or established by the Owner's Representative. Excavations carried below the grade lines shall be replaced with approved compacted structural fill material at the Contractor's expense. Over-excavations under footings shall be filled with structural fill. Cuts below grade shall be corrected by similarly cutting adjoining areas and creating a smooth transition. The Contractor shall bear all costs for correcting over-excavated areas.

G. If solid bearing is not achieved at indicated elevations because of naturally occurring conditions, over-excavate per Owner's direction. Costs for over-excavation shall be paid by contract change order at the unit cost provided in Contractor's bid.

H. In excavating for footings and slabs on grade, do not disturb the bottom of excavation. Trim bottoms to required lines and grades and provide a solid base to receive concrete. Bottom of excavated areas shall be free of loose materials, debris, and water before concrete is placed.

3.5 PLACING STRUCTURAL FILL

A. Following excavation, exposed soil surfaces under all buildings, structural concrete pads, pavement areas, and horizontal areas beyond the structure footprint including at-grade or cut portions, shall be scarified to a depth of 12 inches, moisture conditioned to within 1-3 percent of the optimum moisture content, and recompacted to a minimum of 90 percent dry density based on ASTM D1557.

B. Backfilling shall consist of placing and compacting structural fill material in excavations to the finish grades indicated in the Contract documents. Do no backfilling until each specific location is approved by Owner's Representative. Perform subgrade stabilization by removing unsuitable material and backfilling with approved material as directed by the Owner's Representative.

C. Fill composed of native or import soil shall be brought to grade in level lifts which do not exceed 8 inches when compacted. After each layer has been placed, mixed, and spread evenly, fill shall be moisture conditioned to within 1-3 percent of the optimum moisture content, and compacted to a minimum of 90 percent dry density based on ASTM D1557 (95 percent dry density in new pavement areas).

D. If material is too dry, add water to raise moisture content to or above optimum. If material is too wet, disc as required to dry to optimum moisture content. "Puddling" or "soaking" will not be permitted.

E. Spread each layer evenly and thoroughly mix each layer during the spreading to insure uniformity of material and moisture in each layer.

F. Cut/Fill slopes shall be graded to the slopes shown on the Drawings. Track-walking is not an acceptable method of slope compaction. Slopes shall be overbuilt and cut back to finished grade.

G. Work that has been suspended by weather, scheduling or for any other reason, shall be protected against the effects of such weather or other conditions. Grading which has been considered acceptable, but which has been subsequently damaged shall be re-worked to meet the requirements of the Contract Documents.

H. Slopes shall be re-dressed as required to mitigate any erosion that may occur prior to establishment of the erosion control mitigation measures. Exterior slopes shall be roughened by track walking or with a serrated slope bar.

3.6 COMPACTION

A. Compact areas not accessible to heavy equipment with pneumatic hand tampers.

B. Compact areas within 5 feet of footings, foundations, and walls with hand-held vibratory and/or impact type compaction equipment.

C. Comply with all recommendations of the Owner's Representative and the requirements of the CBC.

D. Contractor shall allow for and accommodate the Owner's Representative to perform compaction testing.

3.7 GRADE TOLERANCES

A. The subgrade below base and subbase of the various pavement structural section types indicated in the Contract Documents shall not vary by more than 0.10 foot above or below the grade determined from the Contract Documents. The subgrade below asphalt shall not vary by more than 0.05 foot above or below the grade determined from the Contract Documents.

B. The elevation of building pads shall not vary by more than 0.05 foot above or below the grade determined from the Contract Documents.

C. The average plane of excavation and embankment slopes equal to or steeper than six horizontal to one vertical (6H:1V) shall conform to the slopes indicated in the Contract Documents. No point on the completed slopes shall vary from the designated slopes by more than 0.5 foot measured at right angles to the slope.

D. The average plane of excavation and embankment slopes flatter than six horizontal to one vertical (6H:1V) shall conform to the slopes indicated in the Contract Documents. No point on the completed slopes shall vary from the designated slopes by more than 0.1 foot measured at right angles to the slope.

E. The average flow line grade of ditches and swales shall conform to the grades determined from the Contract Documents, shall be free draining, and shall not vary from the designated grade by more than 0.10 foot above or below.

F. Finished grades in all other areas shall not vary from the grades indicated in the Contract Documents by more than 0.1 foot above or below. Rough interim grades established prior to finish site grading operations shall not vary from the grades indicated in the Contract Documents by more than 0.2 foot above or below.

3.8 DISPOSAL OF EXCESS EXCAVATION

A. Dispose of excess excavated materials to the on-site locations designated for excess fill disposal indicated in the Contract Documents or as directed by the Owner's Representative. Leave the disposal areas in a neat, uniformly graded, free draining condition or as indicated on the plans. Provide erosion control measures as required to prevent silt runoff.

3.9 SETTLEMENT

A. Any settlement in backfill, fill, or in structures built over the backfill or fill, which may occur within the guarantee period will be considered to be caused by improper compaction methods and shall be corrected at the Contractor's expense. Any structures damaged by settlement shall be restored to their original condition by the Contractor at no cost to the Owner.

3.10 FIELD QUALITY CONTROL

A. Owner will retain the services of an independent testing agency to perform field quality control tests.

B. In general, frequency of testing shall be as follows. Additional testing may be performed as determined by the Owner's Representative.

Test Method	Cubic Yards Placed
1. Laboratory Testing	
a. Grain Size Analysis - ASTM D422	20,000[a]
b. Moisture-Density Relationships (Compaction) - ASTM D1557	20,000[a]
c. Atterberg Limits - ASTM D4318	35,000[a]
d. Moisture Content - ASTM D2216	35,000[a]
e. Classification of Soils - ASTM D2487	20,000[a]
2. Field Testing	
a. Nuclear Gauge Density Testing - ASTM 6938	2,000[b]
b. Sand Cone Density Testing - ASTM D1556	25,000

[a] Testing will be performed more frequently if soils vary, i.e., at least one test per soil type.

[b] One or more test per day will be performed when the rate of fill placement is between 1 and 2,000 cubic yards per day. One test per lift per each 1,500 square feet in structural pad areas will be performed.

C. If tests indicate Work does not meet specified requirements, Owner's Representative will notify Contractor who shall proceed to correct the deficient work and request a retest. Costs for retesting shall be paid for by the Contractor.

3.11 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to depth directed by the County's Representative; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where settling occurs during the Project warranty period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

END OF SECTION

SECTION 312333

TRENCHING AND BACKFILL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Trenching and Backfill.

B. Related Documents and Sections:
   1. Project Geotechnical Investigation Report.
   2. Section 31 20 00 - Earth Moving.

1.2 REFERENCES

A. ASTM References:
   1. ASTM C33 - Concrete Aggregate.
   2. ASTM C94 - Ready-Mixed Concrete.
   3. ASTM C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. ASTM D422 - Test Method for Particle-Size Analysis of Soils.
   5. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   6. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   7. ASTM D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   8. ASTM D6938 - Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. Caltrans Testing Methods:
   1. #205 - Determining Percentages of Crushed Particles
   2. #217 - Sand Equivalent
   3. #229 - Durability Index

C. Caltrans Standard Specifications, Latest Edition.

1.3 DEFINITIONS

A. Pipe Base: The trench area between the bottom of the trench and the bottom of the pipe. Extend full width and length of trench.

B. Pipe Zone: Area of trench between the top of the pipe base and six inches above the pipe, unless otherwise indicated. Extend full width and length of trench.

C. Backfill Zone: Area above Pipe Zone to finish grade.

D. Relative Compaction: Field-measured dry weight expressed as a percent of maximum dry density of same soil determined in accordance with ASTM D1557.

E. Unclassified Excavation: Nature of materials to be encountered is not identified or described.

1.4 DESCRIPTION

A. Provide materials, services, and equipment required for trenching, backfilling, and compacting.

B. Trenching, backfilling, and compacting shall have the approval of Owner's Representative. Work shall be done only under the general observation and, where required, the detailed inspection of the Owner's Representative. Do not backfill until each specific location is approved. Water lines shall be pressure tested and approved by the CSFM before pipe zone and backfill zone materials are installed.

1.5 SUBMITTALS

A. Submit product data and certificates of compliance for all materials proposed to be used under this Section

B. Independent Testing and Laboratory Reports: Submit results of specified tests performed by the Contractor.

C. Submit methods and procedures for excavation, backfilling, compaction, and moisture addition or drying of all materials.

D. Dewatering Plan: Submit dewatering plan for trench construction below anticipated groundwater levels.

E. Submit "Shoring and Bracing Drawings" prior to beginning any trench or structure excavation 5 feet deep or over, in accordance with Section 6705, California Labor Code. If such plan varies from the shoring system standards established in the construction Safety Orders of the State of California, such alternative system plans shall be prepared, stamped and signed by a civil or structural engineer licensed in the State of California at the Contractor's expense.

F. Submit a construction drainage plan showing the collection and disposal of surface and subsurface water that may be encountered in the course of construction.

1.6 QUALITY ASSURANCE

A. The Owner will employ and pay for services of an independent testing laboratory to perform specified testing per CCR Title 24, and any other testing specifically indicated in the Contract Documents to verify compliance with the Contract Documents.

PART 2 PRODUCTS

2.1 PIPE BASE AND PIPE ZONE

A. Use sand conforming to ASTM C33 for conduit of any material less than 3-inch diameter and PVC pipe of any size.

B. Use crushed, partially crushed, or naturally occurring granular material, free from organic and inorganic debris, liquid limit less than 50, and plasticity index less than 20, that meets the following requirements for underground piping three inch or larger diameter, unless otherwise indicated:

Sand Equivalent	30 (minimum)
Passing 3/4-inch square sieve	100%
Passing 3/8-inch square sieve	50% - 75%
Passing No. 8 square sieve	5% - 15%
Passing No. 200 square sieve	0% - 3%

2.2 BACKFILL MATERIAL

A. Native material: Free from organic and inorganic debris and containing materials no larger than 3-inches maximum size.

B. Sand Slurry Mixture: One sack cement mix with sand aggregate; maximum slump of four inches.

2.3 STABILIZATION MATERIAL

A. Shall consist of uniformly graded, 2-inch minus coarse aggregate with percent by weight conforming to 100 percent passing the 3-inch sieve and 0 to 10 percent passing the No. 200 sieve.

2.4 STRUCTURAL FILL UNDER AND AROUND VAULTS, MANHOLES, AND STRUCTURES

A. Shall be 3/4 inch class 2 aggregate base or equivalent. Aggregate Base shall be crushed rock aggregate base material meeting the requirements of Section 26 of the Caltrans Standard Specifications.

2.5 STEEL PLATE

A. Shall be per Section 31 20 00.

2.6 CONCRETE FOR TRENCH BACKFILL

A. Conform to ASTM C94, Alternate 3. Proportion to obtain a 28 day compressive strength of 2,500 pounds per square inch. Use a minimum of five sacks of cement per cubic yard of concrete.

PART 3 EXECUTION

3.1 GENERAL

A. Verify that native excavated material to be reused as backfill meets specified requirements and is acceptable to Owner's Representative.

B. Verify lines and grades of proposed trench/utilities.

3.2 REMOVAL OF WATER

A. Refer to section 31 20 00, "Removal of Water."

3.3 TRENCH EXCAVATION

A. Trench excavation is unclassified. Excavate depth and width as shown or as directed. Allow for cover and pipe base under pipe. Remove loose matter.

B. Comply with CAL-OSHA requirements regarding trench bracing and shoring.

C. If Contractor elects to slope top of trench in lieu of trench bracing, the trench width shall be maintained at least 2 feet above top of pipe before sloping begins. Sloping, unless otherwise approved by the Owner's Representative, shall not be steeper than 1(H):1(V).

D. The Contractor shall furnish and install all shoring, sheeting and bracing required to support adjacent earth banks and structures for the protection and safety of all personnel working in the trench. All shoring, sheeting and bracing shall conform to the requirements of the State or local agencies having jurisdiction over such matters. Remove shoring, sheeting and bracing in a manner that will protect the workman and prevent caving of banks and damage to the pipe, excavation, backfill or adjacent property.

E. Contractor shall construct the trench to the line and grades as shown on the Contract Documents. Proper allowance shall be made for pipe thickness, bedding material and stabilization material.

F. Any part of the trench excavated below grade shall be backfilled with stabilization or pipe base/zone material as approved by Owner's Representative and compacted to a density equal to the undisturbed trench bottom at Contractor's expense.

G. No dead flat or reverse grades will be accepted.

H. Where pipelines are to be installed in embankments, embankment shall be placed and compacted to a minimum of 2 feet above the top of the pipe before trench excavation will be allowed.

I. On all roadways, except with specific approval of the Owner's Representative (and the County of Monterey for off-site roadway areas), no more than 150 feet of open trench shall be excavated in advance of laying the pipe. No excavated trench shall remain open at the end of each day's work without trench plates. All operations shall be carried out in an orderly fashion. Backfilling, compacting, base and cleanup shall be accomplished as sections of the pipe are installed.

J. Where it is necessary to cross or parallel drainage ditches and swales or channels, the backfill on the bottom and banks of such shall be carefully placed and compacted to 95 percent

relative compaction with impervious material so as to avoid settlement or erosion. The shape of the banks and bottom shall be restored and left in good condition.

3.4 PIPE BASE

A. Provide pipe base for supporting pipe for full width of trench. Unless shown otherwise, minimum depth of pipe base below pipe shall be four inches and not less than three inches under pipe bell.

B. Hand-grade ahead of pipe laying. Provide a firm, unyielding base.

C. If trench is excavated below required depth for pipe base, fill the excess depth with stabilization or pipe base/zone material to proper subgrade. Place pipe material for full width of trench in layers not exceeding six inches deep and compact until material does not yield or move.

D. Authorized overexcavation and backfill for subgrade stabilization will be paid for by contract change order when the exposed subgrade is unstable and subgrade stabilization is required, as determined by the Owner's Representative. Stabilization required as a result of the Contractor's operations or inadequate dewatering shall be performed by the Contractor at no additional cost to the Owner.

3.5 PIPE ZONE

A. Do not proceed with placing pipe zone material until pipe base stability has been approved by the Owner's Representative. Perform pipe base stabilization including dewatering and drying of the subgrade, removal of yielding soils as directed by the Owner's Representative and replacement with additional pipe base material, gravel or crushed rock (3-inch minus).

B. Use pipe zone material within the pipe zone except where concrete encased. Place material simultaneously on both sides of pipe in a manner approved by the Owner's Representative. Lifts shall not exceed six inches.

C. "Walk-in" each lift of backfill. Slice with a shovel or tamp with J-bars or similar devices so that all voids around pipe are filled.

D. Give particular attention to zone from bottom of pipe to pipe springline. Ensure firm support to prevent lateral movement or pipe deflection during final backfilling.

3.6 BACKFILL ZONE

A. Place moisture-conditioned backfill material in lifts not exceeding six inches for hand operated mechanical compactors and not exceeding eight inches for heavy equipment compactors.

B. Compact backfill to at least 90 percent relative compaction to within 2 feet of subgrade.

C. Compact the upper 24 inches of backfill to a minimum of 95 percent relative compaction when the trench is beneath pavement areas or where trench is beneath structures. Compact to 90 percent relative compaction in all other locations.

D. Flooding will not be permitted.

3.7 SETTLEMENT OF PAVED AND UNPAVED AREAS

A. The Contractor shall repair all damage caused by settlement deemed to have occurred if the following conditions exist:
   1. In paved areas, the depression of 3/8-inch below the average of the sides of the uncut portion shall be deemed a settlement.
   2. Along shoulder areas and unpaved portions of the roadways, a depression of 3/4-inch below the average of the sides of the uncut portion shall be deemed a settlement.
   3. Across all unpaved areas, or areas untravelled by automotive equipment, a depression of 1-1/2-inches below the average of the sides of the uncut portion shall be deemed a settlement. In this regard, any settlement that causes drainage problems or concentration causing water to run along the depression shall be subject to correction immediately during the entire guaranty period.

3.8 PAVING REMOVAL

A. Refer to Section 02 41 00.

3.9 FIELD QUALITY CONTROL

A. The Owner's Representative will conduct nuclear gauge moisture and density testing in accordance with ASTM D6938 procedures on each lift of trench materials placed every 100 feet of trench or every 100 cubic yards, whichever occurs sooner.

3.10 COMPLETION REQUIREMENTS

A. Dispose of suitable excess excavated material in fill area. Dispose of unsuitable excavated material in disposal area. Leave disposal area in a neat, free-draining condition.

END OF SECTION

SECTION 321123

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Aggregate Base (AB).

B. Related Sections
   1. Section 31 20 00 - Earth Moving.

1.2 REFERENCES

A. Caltrans Testing Methods:
   1. #216 - Relative Compaction of Untreated and Treated Soils and Aggregates.
   2. #217 - Sand Equivalent.
   3. #229 - Durability Index.
   4. #301 - Resistance "R" Value of Treated and Untreated Bases, Sub-bases and Basement Soils (Stabilometer).

B. Caltrans Standard Specifications, Latest Edition.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. Submit independent Testing Laboratory Reports that indicate material compliance with specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Base: Free from organic matter and other deleterious substances, capable of being compacted to form a firm and stable base conforming to the following grading and quality requirements:

Aggregate Grading Requirements

Sieve Sizes	Percentage Passing by Weight
1 inch	100
3/4 inch	90 to 100
No. 4	35 to 60
No. 30	10 to 30
No. 200	2 to 9

Quality Requirements

Tests	Requirement
Resistance (R-value) (CTM 301)	78 min.
Sand Equivalent (CTM 217)	22 min.
Durability Index (CTM 229)	35 min.

PART 3 EXECUTION

3.1 GENERAL

A. Verify that subgrade is to the correct line, grade, and required compaction immediately prior to placing base material. Subgrade shall conform to specified compaction requirements and elevation tolerances and shall be free of loose or extraneous materials.

B. Obtain approval from the Owner's Representative prior to placing aggregate base.

C. Schedule work during favorable weather conditions.

3.2 PLACING AGGREGATE BASE

A. Aggregate Base shall be delivered as uniform mixture and spread free from pockets of coarse or fine material.

B. When Aggregate Base is placed, moisture content shall be sufficient to obtain the required compaction. Supplement with sprayed water as required to achieve compaction. Moisture shall be uniformly distributed throughout the material.

C. Maximum compacted thickness of any one layer shall not exceed 6 inches. Begin compaction of each layer as soon after spreading as practicable. Continue compaction to a minimum 95 percent relative compaction per CTM 216.

D. Each layer shall be placed and compacted to the specified density before a succeeding layer is placed.

E. The finished surface shall be trimmed and shaped to produce a smooth, uniform surface. The entire work area shall be left in a neat condition and ready for placement of paving in locations shown on the Contract Documents.

3.3 FIELD QUALITY CONTROL

A. The Owner will conduct compaction testing on each lift in accordance with CTM 216.

END OF SECTION

SECTION 321216

ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt concrete (AC) paving and overlay work.
   2. Paving maintenance for existing AC paving during construction.

B. Related Sections:
   1. Section 31 20 00 - Earth Moving.
   2. Section 32 11 23 - Aggregate Base Course.

1.2 REFERENCES

A. ASTM References:
   1. ASTM C29 - Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
   2. ASTM C88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   3. ASTM C131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   4. ASTM C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   5. ASTM D1075 - Standard Test Method for Effect of Water on Compressive Strength of Compacted Bituminous Mixtures.
   6. ASTM D1188 - Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
   7. ASTM D2041 - Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   8. ASTM D2172 - Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.
   9. ASTM D2726 - Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
   10. ASTM D2950 - Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
   11. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

B. AASHTO T30 - Test Method for Mechanical Analysis of Extracted Aggregate.

C. Marshall Method of Mix Design, Chapter III, Asphalt Institutes Manual Series No. 2 (MS-2).

D. Pacific Coast Conference on Asphalt Specifications, Latest Edition.

E. Asphalt Institute Specification Series No. 1 (SS-1), Fifth Edition.

F. Caltrans Standard Specifications, Latest Edition.

1.3 SUBMITTALS

A. Prior to producing any mixture for use in paving, submit mix design and source of mix. Indicate the following in mix design:
   1. Gradation of each aggregate constituent to be used in mixture.
   2. Proportion of each constituent to be used to produce combined gradation of aggregate within limits specified.
   3. ASTM bulk specific gravity of each aggregate constituent.
   4. Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
   5. Properties of mix for at least four different asphalt contents other than optimum, two of which will be below optimum and two of which will be above optimum.
   6. Percent of asphalt lost due to absorption by aggregate.
   7. Temperature of water when discharged from mixer.
   8. Bitumen percentage based on the total weight of mix.
   9. Other information pertinent to design of mix.

B. Submit Testing Laboratory Reports for all tests used to develop each job mix formula to the Owner's Representative. Mix formula shall be developed for the Contractor by an independent testing laboratory retained by the Contractor.

C. Submit Certificate of Compliance from testing laboratory for aggregates.

D. Submit Certificate of Compliance for each carload (or equivalent) of bitumen shipped to the mixing plant for use on the project.

1.4 DESCRIPTION

A. Provide materials, services, and equipment required for asphalt paving and overlay work.

B. Asphalt concrete paving materials and methods of construction shall have the approval of the Owner's Representative. The Work shall be done only under the general observation and, where required, under the detailed inspection of the Owner's Representative.

C. Asphalt concrete shall be mixed in a central mixing plant and placed on a prepared course in accordance with these Specifications. Conform to lines, grades, thicknesses, and typical cross sections shown on the Drawings.

D. Each course shall be constructed to the depth, typical section, or elevation required by the Contract Documents, and shall be rolled, finished, and reviewed before the placement of the next course. Unless otherwise indicated, uppermost 1-inch of asphalt shall not be placed until scheduled or when authorized by the Owner's Representative.

1.5 QUALITY ASSURANCE

A. The Owner will employ and pay for the services of an independent testing laboratory to perform specified testing per CCR Title 24, and any other testing specifically indicated in the Contract Documents to verify compliance with the Contract Documents.

B. Contractor shall retain a testing laboratory certified by the State of California, Office of the State Architect, to perform tests required by this section and other sections of these Specifications.

1.6 STORAGE AND HANDLING

A. Store materials in a bermed area away from drainage courses.
   1. Cover materials and equipment when not in use.
   2. Place drip pans or absorbent materials under paving equipment when not in use.

1.7 ENVIRONMENTAL CONDITIONS

A. Do not place asphalt concrete when atmospheric temperature is lower than 50 degrees F, when substrate is wet and/or when precipitation is imminent.

PART 2 PRODUCTS

2.1 GENERAL

A. Asphalt concrete, prepared in a central plant, shall be a mixture of aggregate, filler if required, and bituminous material.

B. Aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of job-mix formula.

2.2 PRODUCTS

A. Aggregate
   1. As specified in Section 39 of the Caltrans Standard Specifications for hot plant mix bituminous pavement.

B. Prime Coat
   1. Liquid asphalt, Grade SC-250 or (Grade XXX) conforming to Section 93 of the Caltrans Standard Specifications.
   2. Emulsified asphalt, conforming to Section 94 of the Caltrans Standard Specifications.

C. Tack Coat
   1. Emulsified steamed-refined paving asphalt, Type SS-1, conforming to Section 94 of the Caltrans Standard Specifications.

D. Asphalt Concrete Mixture
   1. Asphalt Concrete: Type A, AR 4000, 1/2-inch maximum, medium grading, as specified in Section 39 of the Caltrans Standard Specifications.

E. Asphalt Cement
   1. Cement used for the asphalt concrete mixture shall be Grade AR-4000 as specified in Section 92 of the Caltrans Standard Specifications.

PART 3 EXECUTION

3.1 MINING AND PLACEMENT

A. As specified in Section 39 of the Caltrans Standard Specifications, and as indicated on the approved Submittals.

3.2 TRANSPORTATION AND SPREADING

A. Schedule so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight, unless otherwise approved by the Owner's Representative and adequate artificial lighting is provided. Hauling over freshly placed material is not permitted until material has been compacted and cooled to atmospheric temperature.

B. Immediately before placing, underlying course shall be cleared off all loose of deleterious material with power blowers, power brooms, or hand brooms.

C. Mix shall be placed at a temperature of not less than 225 degrees F. (107 degrees C.). Moisture content of mix shall not exceed 1 percent.

D. Upon arrival, spread mixture by approved paving machine. Strike off in uniform layer such that, when the Work is completed, it shall have required thickness and shall conform to the grades indicated on the Drawings. Speed of paver shall be controlled to eliminate pulling and tearing of the bituminous material.

E. In areas where irregularities or unavoidable obstacles make use of mechanical spreading and finishing equipment impractical, mixture may be spread, raked, and luted by hand tools.

3.3 COMPACTION

A. Rolling shall continue until all roller marks are eliminated and a density of at least 92 percent of the measured maximum density determined in accordance with ASTM D2041 has been obtained.

B. Sufficient rollers shall be furnished to handle output of mixing plant. Speed of rollers shall be sufficiently slow to avoid displacement of hot mixture. Any displacement occurring as a result of reversing roller direction, or from any other cause, shall be corrected at once by rakes and fresh mixture.

C. Roller wheels shall be kept properly moistened to prevent adhesion of the mixture, but excessive water will not be permitted. In areas not accessible to the roller, asphalt mixture shall be compacted with hot hand tampers.

D. Any mixture which becomes loose and broken or in any way defective, shall be removed and replaced with fresh hot mixture and immediately compacted to conform to surrounding area. Skin patching shall not be allowed.

3.4 JOINTS

A. Joints shall be made in such a manner as to ensure a continuous bond between old and new sections. Joints shall present same texture, density, and smoothness as other sections of the course.

B. All joint contact surfaces shall be cut vertically and uniform for full course depth, then given a tack coat of liquid bituminous material or emulsified asphalt before placing any fresh mixture against joint in order to provide a watertight seam.

C. Roller shall not pass over the unprotected end of freshly laid mixture except when necessary to form transverse joint. When necessary to form transverse joint, it shall be made by means

of placing a bulkhead or by tapering the course, in which case the edge shall be cut back on a straight line to its full depth.

3.5 EDGES

A. While surface is being compacted and finished, the Contractor shall carefully trim outside edges of pavement to proper alignment. Edges shall be beveled while still hot with the back of a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

3.6 TOLERANCES

A. Production Mix:
   1. Average of all mix tests shall fall within requirements specified for job mix formula.
   2. Individual field quality assurance tests may fall outside job-mix formula per the following, provided job mix average does not fall outside master grading band:

Material	Tolerance (plus or minus)
Aggregate passing No. 4 sieve or larger	7 percent
Aggregate passing No. 8, 16, 30, and 40 sieves	4 percent
Aggregate passing No. 100 and 200 sieves	2 percent
Bitumen	0.40 percent
Temperature of mix	20 degrees F. (7 degrees C.)

3.7 FINISH SURFACE:

A. Tests for conformity with indicated crown and grade shall be made by the Contractor immediately after initial compression. Variations shall be corrected by removal or addition of materials and by rolling.

B. Finished surface shall not vary more than 1/4 inch for the surface course when tested with a ten foot straightedge applied parallel with, or at right angles to surface.

C. After completion of final rolling, smoothness of top course shall again be tested; humps or depressions exceeding specified tolerances shall be corrected by removing defective work and replacing with new material.

D. Finished surfaces shall not vary from gradeline, elevations, and cross sections shown by more than 1/2-inch (0.04-foot). Contractor shall correct pavement areas varying in excess of this amount by removing and replacing defective work. Skin patching not permitted.

3.8 FIELD QUALITY CONTROL

A. Contractor shall retain the services of an independent Testing Laboratory approved by the Owner's Representative to perform field testing specified in this section.

B. Each day when asphalt concrete is placed at the project site, Owner's Representative will perform the following tests at least twice daily on production mix:
   1. Bitumen content in accordance with ASTM D2172.
   2. Aggregate gradation in accordance with AASHTO T30.
   3. Index of retained strength in accordance with ASTM D1075.

4. Index of retained strength shall not be less than 75.
5. Marshall specimens in accordance with Marshall Method procedures.

C. During each day when asphalt concrete is being placed, Owner's Representative will perform at least four in-place field compacted density tests for each 1,000 tons of asphalt concrete placed (or per day's total placement when less than 1,000 total tons per day is placed). In-place density tests will be performed on 2-1/2-inch or larger diameter cores of placed material in accordance with ASTM D2726 or D1188, as applicable, or with a nuclear device in accordance with ASTM D2950. If the nuclear device is used, Owner will select an area between 2,500 square feet and 10,000 square feet and perform at least 4 core density tests and 10 nuclear density tests within the area. Compliance with these specifications requires that the average density of the four core samples equals or exceeds the average density of the 10 nuclear device measurements. Location of sampling sites for density measurements shall be random in accordance with Appendix C of the Asphalt Institute Specification Series No. 1 (SS-1), Fifth Edition.

D. Upon completion of asphalt concrete placement for each project milestone, the Owner's Representative will select up to 25 random locations to be cored by the Contractor for pavement thickness verification. The Contractor shall provide tools, equipment, and labor to obtain two-inch and larger diameter cores and to patch cored holes to match adjacent pavement. If cored thicknesses are less than indicated design thicknesses, the Owner's Representative may reject all or part of paving and the Contractor shall take corrective measures as directed to provide acceptable paving.

E. If any of the quality control tests performed by the Owner's Representative indicates the Work does not meet specified requirements, the Contractor shall be advised and, upon approval of the Owner's Representative, proceed to remove and replace the defective work. All work will be retested by Owner at Contractor's expense.

3.9 CLEANING

A. Remove broken asphalt concrete from the site.

3.10 MAINTENANCE

A. Except where damaged by trenching by other Contractors, this Work includes maintenance of all asphalt concrete surfaces installed by the Contractor throughout the project. Maintain surfaces in driveable condition throughout project duration and repair areas of settlement and cracked surfaces prior to placement of the final lift of asphalt concrete.

3.11 FINAL LIFT

A. In general, final lift of pavement shall not be constructed until heavy construction traffic has ceased. Perform final lift paving operations following approval by the Owner's Representative to proceed. Apply tack coat to existing asphalt concrete surface prior to placing final lift.

END OF SECTION

SECTION 321713

PARKING BUMPERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Parking bumpers.
   2. Adhesive.
   3. Steel bars for installation.

B. Related Documents and Sections:
   1. Section 03 30 00 – Cast in Place Concrete.

1.2 REFERENCES

A. State of California, Department of Transportation
   1. Section 95: Epoxy.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. Shop Drawings: Submit shop drawings of bumpers, including bumper dimensions, plan layout, and installation details.

C. Product data: Submit manufacturer's product data of precast bumpers and epoxy adhesive for approval.

1.4 QUALITY ASSURANCE

A. Precast parking bumpers shall be manufactured by a company or firm specializing in the manufacture of precast concrete parking appurtenances.

PART 2 PRODUCTS

2.1 PRODUCTS

A. Precast Parking Bumpers:
   1. Half octagonal configuration.
   2. Nominal size: 4 feet long, 6 inches high.
   3. Color: Standard cement grey, or painted blue when installed in disabled access stalls. Blue paint, where required, shall be per Section 32 17 23
   4. Concrete: Per Section 03 30 00.
   5. Reinforcement: Two No. 4 deformed steel reinforcing bars, minimum.

B. Adhesive:
   1. Epoxy per Section 95 of the Caltrans Standard Specifications.

C. Steel Bars:
   1. Epoxy-coated rebar, No. 5 size, minimum 24 inches long.

PART 3 EXECUTION

3.1 INSTALLATION

A. Do not install parking bumpers until pavement are thoroughly cured.

B. Clean substrates free from dirt, dust, and other foreign matter.

C. Install units without damage to shape or finish, in locations as shown on the Drawings. Each bumper shall be uniformly spaced, accurately aligned, and securely adhered. Repair or replace damaged units.

D. Steel bars for installation shall be placed on either side of the parking bumper, 6 inches clearance from each end. Bars shall be sunk ½ inch below the top of the concrete bumper, and the gap filled with grout. Bars shall be embedded into the pavement a minimum of 18 inches.

END OF SECTION

SECTION 321723

PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Painted pavement markings.

1.2 REFERENCES

A. State of California, Standard Specifications, 2010 Version, Section 84.

B. California Administrative Code, Title 24, Part 2, Handicap Accessibility Regulations.

C. Federal Standard 595B - Colors Used in Government Procurement.

1.3 SUBMITTALS

A. Submit certification that products meet or exceed specified requirements.

B. Submit manufacturer's installation instructions.

C. Submit pavement marking plan including lane line restoration (if required) and defined parking spaces.

D. Submit curb marking plan including Fire lane and no-parking zones.

1.4 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not perform painting if atmospheric temperature is below 40 degrees F, or when atmospheric temperature is expected to drop below 40 degrees F during the paint drying period.
   2. Do not perform painting when freshly painted surfaces may be damaged by rain, fog, snow, ice, or condensation.

B. Do not place markings until layout lines and pavement symbols have been approved by the Owner's Representative.

1.5 COORDINATION

A. Do not apply pavement markings until pavement, including seal coats where required, have cured for at least 30-days or longer if necessary to ensure that substrate materials and conditions will not adversely affect pavement markings.

PART 2 PRODUCTS

2.1 PAINT

A. Paint schedule: Alkyd-resin type, ready-mixed complying with AASHTO M248 Type I. Apply 2-coat pavement and curb markings as scheduled below and as indicated on the drawings:
   1. Parking Stripes and Lane Lines – Color: White.
   2. Roadway Centerline Striping – Color: Yellow.
   3. ADA Markings and Stripes – Color: Blue; shall match Color 15090 of Federal Standard 595B.

B. Thinning of paint is not permitted.

2.2 EQUIPMENT

A. Striping Machine Used for Paint Application:
   1. Commercial type designed for the application specified; with oil extractors, pressure regulators.
   2. Spray-gun assemblies and orifices sized as required for specified application.
   3. Rubber-tired; minimum 100-inch wheelbase.
   4. Maneuverable as required to follow straight lines and true arcs.

PART 3 EXECUTION

3.1 PREPARATION

A. Thoroughly clean all surfaces to be marked before application of paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by the County's Representative.

B. Provide measured layouts, temporary markings, templates, and other means necessary to provide required marking.

3.2 APPLICATION

A. Apply markings only on dry surfaces during periods of favorable weather in accordance with manufacturer's instructions.

B. Apply paint at the rate of not more than 80 square feet per gallon (approximately 20-mil wet thickness).

C. Lines and symbols shall be accurately formed and true to line and form; lines shall be straight and uniform in width.

D. Painted edges shall be clean cut and free from raggedness, and corners shall be cut shark and square

E. Provide cones, barricades, and other devices as required to protect paint until it is sufficiently dry to withstand traffic loading.

F. Tolerances:
   1. Stripe Width: Plus or minus 1/4 inch.
   2. Stripe Length: Plus or minus 1 inch per 40 feet of lane line, noncumulative.

G. When complete, pavement markings shall be clean and free from stains, discoloration, and other defects and damage. Adjacent surfaces shall be free from marking paint spills, splatters, and overruns.

H. Protect the newly painted markings so that, as much as possible, the tires of passing vehicles will not pick up paint. Place warning signs to alert approaching traffic.

3.3 CLEANING

A. Immediately remove drips, overspray, and improper markings from pavement surface by blast cleaning or other method approved by the Owner's Representative.

END OF SECTION

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SECTION 329000

PLANTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Planting guidelines, including soil amendments and landscaping materials.

B. Related Sections
   1. Section 31 20 00 – Earth Moving.
   2. Section 32 92 00 – Turf and Grasses

C. Warranty: Sample of special warranty.

1.2 REFERENCES

A. American Association of Nurserymen: Horticultural Standards, [Date] edition.

1.3 SUBMITTALS

A. Submit in accordance with Division 1.

B. Samples: Soil amendment with laboratory fertility analysis.

C. Manufacturer's Certificates of Quantity: Description of such mix; soil amendments; fertilizers; and plant materials as delivered.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

B. Do not prune trees or shrubs prior to delivery. Do not bend or bind-tie trees in such a manner as to damage bark, break branches, or destroy natural shape. Provide protecting covering during delivery.

1.5 MAINTENANCE

A. Upon acceptance by the Owner's Representative, commence landscape Maintenance Period. It shall last for a period of not less than 90 days. During the Maintenance Period:
   1. Weed, mow, edge, feed and maintain in a healthy state, all lawn areas.
   2. Prune, trim, shape, feed, stake, tie, guy, spray for pests, and maintain in a healthy state, all trees, with replacement as required.
   3. Repair, adjust, clean, and generally maintain irrigation system in optimum operating mode.
   4. Hose down, remove litter, debris and clippings, rake, vacuum, to leave area in neat, clean appearance.

5. Lawns shall be fully germinated and established with no bare spots after at least one mowing before Contractor can be released from Maintenance Period.

1.6 WARRANTY

A. Special Warranty: Contractor's standard or custom warranty in which Contractor and Installer jointly agree to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's/Installer's control.
      b. Structural failures including plantings falling or blowing over.
      c. Faulty performance of tree stabilization.
   2. Repair or replace within 30 days following receipt of notification.
   3. Warranty Period: Two years from Date of Project completion.

PART 2 PRODUCTS

2.1 SOIL PRODUCTS AND AMENDMENT

A. Topsoil, imported or otherwise, shall be reasonably free of debris or rocks, and shall not contain any noxious weeds, seeds, or stolons.

B. NPK fertilizer shall be 18-18-6 commercial fertilizer with micronutrients.

C. Fertilizer tablets shall be 21 gram 20-10-5 planting tablets.

D. Soil amendment shall be nitrolized shredded redwood, fir bark or cedar particles, graded from 0 to1/4 inch.

2.2 PLANT MATERIALS

A. Plant materials shall be furnished in quantities required to complete the Work as indicated in the Contract Documents and as specified. Quality and size of plant material shall be in accordance with the current edition of "Horticultural Standards" for #1 Grade Nursery Stock as adopted by American Association of Nurserymen. In all cases, botanical names shall take preference over common names.

B. Plants shall be nursery grown under climatic conditions similar to those at the site.

C. If documentation is submitted that any plant specified is not obtainable, substituting of nearest variety will be considered.

D. Plants shall be symmetrical, typical for variety and species; sound, healthy, vigorous and free from plant disease, insects and their eggs, and shall have healthy normal root systems, filling their containers, but not root bound.

E. Container stock shall be grown for at least six months in containers in which they are to be delivered, but shall not be root bound. Stock shall be acceptable size for container specified.

F. At least one tree and shrub of each variety shall have a securely attached waterproof tag from the nursery, bearing legible designation of botanical and common name.

2.3 MISCELLANEOUS LANDSCAPE MATERIALS

A. Tree stakes shall be treated lodgepole pine (or equal), 2-inch diameter.

B. Tree ties shall be as detailed on Drawings.

C. Weed control shall be Round Up, Eptam applied per manufacturer's instructions.

D. Pre-emergent herbicide shall be Treflan EC.

E. Hydroseed Materials shall be as specified in Section 32 92 00.

PART 3 EXECUTION

3.1 GENERAL

A. Prior to the work of this section, carefully inspect the existing grades and the installed Work of other trades and verify that the planting may be completed in accordance with the Contract Documents.

B. Irrigation system shall be in full working order prior to installation of planting.

C. Proceed with landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

D. Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

E. Do not continue planting when conditions detrimental to plant growth are encountered such as rubble fill, adverse drainage conditions, or obstructions. Consult with the Owner's Representative, regarding what, if any, planting adjustments may be made.

3.2 PREPARATION OF PLANTING AREAS

A. Planting areas shall be completely free of trash and debris. Rocks larger than 2 inches shall be removed. Finish grading shall be completed before planting begins. Unless shown otherwise, finish grade at edge of planting shall be 1 inch below surface of curbs and paved areas. Surfaces shall be sloped with due regard for drainage.

B. Prior to placing soil amendment in areas to receive seeding, disc or scarify the subgrade to a depth of at least 8 inches. Irregularities in the surface shall be corrected to prevent depressions where water would pond.

C. Apply soil amendment to landscape areas to receive groundcover or lawn at the rate of five cubic yards per 1,000 square feet and lawn fertilizer 18-18-6 at the rate of 10 pounds per 1,000 square feet. Uniformly blend amendment and fertilizer into top 6 inches of soil.

3.3 PLANTING TREES AND SHRUBS

A. Deliver trees and shrubs after preparations for planting have been completed. Plant immediately. If planting is delayed more than six hours after delivery, set trees or shrubs in shade, protect from weather and mechanical damage, and keep roots moist.

B. Do not remove container-grown stock from containers until planting time.

C. Plants shall be planted in holes twice the diameter and twice the depth of their nursery containers. Plant holes shall have a layer of tamped topsoil placed with the crown 2 inches higher than adjacent finish grade. Slope backfill upwards to the center.

D. Place fertilizer tablets. Backfill around the roots shall be firmly tamped to prevent settling before watering. Provide bermed watering basins for trees in shrub areas, water thoroughly after planting, and stake as shown.

3.4 MISCELLANEOUS

A. Planting areas except hydroseeded lawn areas shall be saturated with water immediately after planting.

B. Treat planting areas with a pre-emergent herbicide. Follow application procedures recommended by the manufacturer.

C. Prune, thin out, and shape trees in accordance with standard horticultural practice. Do not cut tree leaders. Remove only injured or dead branches from trees. Remove and replace misformed stock resulting from improper pruning.

3.5 CLEANUP AND PROTECTION

A. During landscape Work, keep pavements clean and work area in orderly condition.

B. Protect landscape Work and materials from damage. Maintain protection until planting becomes fully established. Treat, repair, or replace damaged landscape work as required.

3.6 INSPECTION

A. Planting Work shall be completed prior to final inspection by the Owner's Representative. When all punch list items from this inspection are completed to the satisfaction of the Owner's Representative, acceptance shall be given to begin the Maintenance Period.

END OF SECTION

SECTION 329200

TURF AND GRASSES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydroseeding.

B. Related Sections:
   1. Section 32 90 00 - Planting.

1.2 SUBMITTALS

A. Submit under provisions of Division 1.

B. Submit a minimum of two (2) seed mixes for review.

C. Submit fertilizer certificates of compliance including seed inspection certificates by State or Federal Authorities.

D. Submit stabilization measures required for seed mix selected.

1.3 PROJECT CONDITIONS

A. Do not place hydroseed materials prior to October 1, nor later than May 31, unless otherwise approved by the Owner's Representative.

PART 2 PRODUCTS

2.1 HYDROSEEDING MATERIALS

A. Hydroseed:
   1. Seed mix shall be native or adaptive, and selected to be compatible with the regional climate.
   2. Seed germination rate shall be 90 percent minimum.

B. Fungicide: As recommended by the seed distributor.

C. Hydroseed Binder:
   1. Binder for hydroseeding shall be concentrated liquid chemical that forms a plastic film upon drying and allows water and air to penetrate.
   2. Binder film shall be nonflammable, shall have an effective life of at least one year, shall be miscible with water at the time of mixing application, shall be nontoxic to plant or animal life, and shall be nonstaining to concrete or painted surfaces.
   3. In cured state, binder shall not be re-emulsifiable.
   4. Binder Material shall be registered with and licensed by the State of California, Department of Food and Agriculture, as an "auxiliary soil chemical."

5. Submit a Certificate of Compliance for binder.

2.2 OTHER LANDSCAPE MATERIALS

A. Pre-emergent herbicide: Shall be “Treflan EC,” “Tupersan,” or approved equal.

B. NPK Fertlizer: Shall be 18-18-6 commercial fertilizer with micronutrients.

PART 3 EXECUTION

3.1 HYDROSEED

A. Hydroseed Installation
1. Soil in all seeding areas shall be cultivated with soil amendment and fertilizer prior to hydroseeding as specified in Section 32 90 00. Rocks and debris larger than 1 inch in diameter which are brought to the surface during cultivation shall be removed from the site.
2. The finish grade of hydroseeded areas shall be as shown on the grading plans (per the Contract Documents) and smooth, with no abrupt change in surface appearance unless otherwise noted on the Contract Documents. Finished grade shall allow for positive drainage without ponding.
3. Hydroseeding shall not commence until all other planting has been completed, and finish grades have been approved by the Owner’s Representative.
4. Hydromulch slurry preparation shall take place at the site. Begin with adding water to the tank with engine at half throttle. When water level has reached the height of the agitator shaft, and good recirculation is established, add seed mixture, chemical additives, then fertilizer. Pulp shall be added after the tank is at least one third full, and engine shall be opened to full throttle when tank is half full. Spraying shall commence only after all materials are thoroughly mixed.
5. Hydromulch slurry: As specified below, or in accordance with the seed distributor.
    a. Seed Mixture 0.50 lbs/1000 SF (Turf) / 0.25 lbs/1000 SF (Wildflower and Dryland Grass)
    b. Fiber 46 lbs/1000 SF
    c. Fungicide 2 oz /1000 SF
    d. NPK Fertilizer 7 lbs/1000 SF
    e. Binder 5 lbs/1000 SF
6. Mix to homogenous slurry.
7. Moisten areas to be hydroseeded to 2-inch depth just prior to application of slurry.
8. Slurry shall be evenly applied under high pressure in a uniform coating. Exercise care around plants and structures. Immediately remove any oversprayed slurry from walks or buildings that are inadvertently sprayed.
9. Irrigation during the germination period shall keep the hydromulch sufficiently moist at all times to promote dense uniform establishment of grass, without creating washouts. Irrigation system shall be tested for proper coverage prior to hydroseeding.
10. Re-seed bare spots until an even stand of grass results and is approved by the Owner’s Representative.

END OF SECTION

SECTION 331100

WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
1. Potable water system piping and fittings.
2. Water meters and boxes.
3. Backflow preventers and accessories.

B. Related Sections
1. Section 03 30 00 - Cast-In-Place Concrete.
2. Section 22 05 10 - Basic Piping Installation Requirements.
3. Section 22 05 23 - General-Duty Valves for Plumbing Piping.
4. Section 31 20 00 - Earth Moving.
5. Section 31 23 33 - Trenching and Backfill.

1.2 REFERENCES

A. ANSI Standards:
1. ANSI A21.15 - Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
2. ANSI A21.11 - Rubber-Gasket Joints for Cast-Iron Pressure Pipe and Ductile-Iron Pressure Pipe and Fittings.
3. ANSI B18.2 - Square and Hex Bolts and Nuts.
4. ANSI B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
5. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
6. ANSI B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
7. ANSI B16.9 - Factory Made Wrought Steel Buttwelding Fittings.
8. ANSI B16.11 - Forged Fittings, Socket-Welding and Threaded.
9. ANSI B31.1 - Power Piping.
10. ANSI B36.10 - Welded and Seamless Wrought Steel Pipe.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

C. ASTM References:
1. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Compounds.
3. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
4. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.
5. ASTM D2464 - Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
6. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D246 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
8. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

9. ASTM F439 - Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
10. ASTM F441 - Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
11. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic pipe.
12. ASTM F493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

D. AWWA References:
1. Manual M-11 - Steel Water Pipe: A Guide to Design and Installation.
2. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
3. AWWA C110 - Ductile Iron and Gray-Iron Fittings.
4. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 - Flanged Ductile Iron Pipe with Ductile-Iron or Gray Iron Threaded Flanges.
6. AWWA C153 - Ductile-Iron Compact Fittings for Water Service.
7. AWWA C200 - Steel Water Pipe, 6 inches (150 mm) and larger.
8. AWWA C205 - Cement Mortar Protective Lining and Coating for Steel Water Pipe, 4 Inch and Larger, Shop Applied.
9. AWWA C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 Inch Through 144 Inch (100 mm through 3600 mm).
10. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
11. AWWA C510 - Double Check Valve Backflow-Prevention Assembly
12. AWWA C606 - Grooved and Shouldered Joints.
13. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Transmission and Distribution.
14. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inches through 48 inches (350 mm through 1,200 mm), for Water Transmission and Distribution.

1.3 SYSTEM DESCRIPTION

A. Provide materials, services, and equipment required to install and make ready the potable water distribution system, complete in place. The potable water distribution system includes the fire water piping supply lines up to the indicated building connection points if not otherwise indicated.

B. The class of pipe shown in the Contract Documents is the minimum required static internal design pressure in pounds per square inch. When the class of pipe is not otherwise called out the minimum pressure rating shall be 200 psi. The pipe shall be designed for this internal pressure plus transient pressure or the specified test pressure, whichever pressure is greater, for earth loads, and for an AASHTO H-20 wheel load, all without exceeding the allowable design stresses. Pipe shall be designed for earth and wheel load both with and without internal pressure. The minimum design transient pressure shall be 50 percent of the static internal design pressure unless otherwise specified.

1.4 SUBMITTALS

A. Product Data, Drawing and Literature
   1. Product data on all pipe materials.
   2. Manufacturer's catalog information.
   3. Submittal data as required by referenced Specification sections.
   4. Shop drawings of all equipment and valve / meter boxes.
   5. Manufacturer's data and drawings for freeze protection pad/envelope.

B. Quality Control Submittals
   1. Manufacturer's Affidavit of Compliance as specified in AWWA C200, Section 1.12.
   2. Nondestructive weld test method and results on fabricated fittings.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Maintenance Data for inclusion in operating and maintenance manuals as specified in Division for the following:
   1. Backflow Preventers.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Comply with requirements of the San Lucas Water District. Include tapping of water mains and backflow prevention.
   2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing and disinfection.
   3. NSF Compliance:
      a. Comply with NSF 61, "Drinking Water System Components-Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.6 DELIVERY, SERVICE AND HANDLING

A. Preparation for Transport: Prepare valves and meters according to the following:
   1. Ensure that equipment is dry and internally protected against rust and corrosion.
   2. Protect equipment against damage to threaded ends and flange faces.
   3. Set equipment in best position for handling. Set valves closed to prevent rattling.

B. During storage: Use precautions according to the following:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
   2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

D. Protect flanges, fittings, and specialties from moisture and dirt.

E. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Coordinate connection to water main with San Lucas Water District.

PART 2 PRODUCTS

2.1 WATER METERS

A. Description:
   1. Standard: AWWA C700.
   2. Pressure rating: 150-psig working pressure.
   3. Body Design: Nutating disc; totalization meter.
   4. Size: 1-inch (irrigation) or 2-inch (building supply).
   5. Registration: In gallons or cubic feet as required by the San Lucas Water District.
   6. Case: Bronze.

B. Manufacturers:
   1. Carlon Meter, Mueller, Schlumberger Limited, or approved equal.

2.2 WATER METER BOXES:

A. Description: Polymer-concrete body and cover with lettering “WATER” in cover, and with slotted, open-bottom base section of length to fit over service piping. Lid shall be hinged cast-iron lid with a 1-3/4” pre-cast hole located opposite water label.
   1. Box size and type: Christy or approved equal, sized for 1-inch (irrigation) or 2-inch (domestic water).
   2. Lid manufacturer and type: Christy approved equal.
   3. Support: Set box on 4-inch by 16-inch (1-inch thick) concrete block, all sides of the meter box. Cover any openings or holes in the size of the utility box with concrete block.

2.3 BACKFLOW PREVENTERS:

A. Description:
   1. Standard: UL Classified, IAPMO and FM-approved, ASSE 1013.
   2. Operation: Continuous-pressure applications.
   3. Sizes: 2-inch (building supply) and 1-inch (irrigation).
   4. Pressure loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Body: Bronze.
   6. End connections: Threaded.
   7. Configuration: Designed for horizontal, straight-through flow.
   8. Accessories:
      a. OS&Y gate valves on inlet and outlet and strainer on inlet.
      b. Pressure differential relief valve having ASME A112.1.2 air-gap fitting located between two positive-seating check valves for continuous pressure application.
      c. Freeze protection bag: Insulated pad or envelope type, waterproof, color Green. Insulation shall have a minimum R-value of 13 and be sewn as an integral part of the pad/jacket to prevent shifting, with a double sewn lock stich (minimum 4 to 6 inches per stich.) Pad/jacket assembly shall be equipped with a minimum of one lock (with grommets) at the base.

B. Manufacturers:
   1. Zurn, FEBCO, Watts, Ames Fire & Waterworks, or approved equal.
   2. Freeze protection: BASECO or approved equal.

2.4 DOUBLE DETECTOR CHECK VALVE ASSEMBLY

A. Description:
   1. Standards: UL Classified, IAPMO and FM-Approved, AWWA C510, ASSE 1048
   2. Operation: Continuous-pressure applications.
   3. Size: 6-inch.
   4. Pressure loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Body: 300-Series Stainless Steel (lead-free through the waterway).
   6. End connections: Threaded.
   7. Configuration: Designed for horizontal, straight-through flow.
   8. Accessories:
      a. OS&Y gate valves on inlet and outlet and strainer on inlet.
      b. Fire department connection: FM-Approved and UL listed siamese fire hose connection, 6-inch outlet, two way (2.5-inch inlets), labeled "AUTO-SPKR", with individual drop clappers.
      c. Fire department caps: Threaded brass plugs, 2.5-inch MNST.
      d. Freeze protection bag: Insulated pad or envelope type, waterproof, color Green. Insulation shall have a minimum R-value of 13 and be sewn as an integral part of the pad/jacket to prevent shifting, with a double sewn lock stich (minimum 4 to 6 inches per stich.) Pad/jacket assembly shall be equipped with a minimum of two locks (with grommets) at the base. Provide openings for OS&Y valves at top of pad/envelope.
      e. Concrete pad: Rectangular, 4-inch thickness, extending 12 inches past each side of the assembly. See Section 03 30 00 for concrete requirements.

B. Manufacturers:
   1. Zurn, FEBCO, Watts, Ames Fire & Waterworks, American Fire Protection Inc., or approved equal.
   2. Fire department connection and caps: Ames Fire & Waterworks, American Fire Protection Inc., or approved equal.
   3. Freeze protection: BASECO or approved equal.

2.5 POLYVINYL CHLORIDE PIPE AND FITTINGS (PVC)

A. Smaller than 4 inches: PVC pressure pipe Schedule 80, iron pipe size PVC, Type 1, Grade 1, or Class 12454-B in accordance with ASTM D1784 and ASTM D1785.
   1. Fittings shall be in accordance with ASTM D2467 for socket-type and ASTM D2464 for threaded type.
   2. Joints shall be socket-type, solvent welded, except that threaded connections shall be used to connect to unions and valves that may require future disassembly.

B. Pipe joints shall be rubber gasketed bell and spigot or rubber gasketed couplings except where otherwise called for on the Contract Documents. Gaskets shall conform to ASTM F477. Furnish sufficient feeler gages of the proper size, type, and shape for use by the installation contractor to check the rubber gaskets.
   1. Where solvent welded type joints are specifically called for in the Contract Documents, provide solvent-cement type bell-ended pipe. Primer and solvent shall be provided by the pipe manufacturer.

C. Lubricants intended for use with PVC pipe and couplings shall be made from materials that are compatible with the plastic material and gasket material. The lubricant shall not support

the growth of bacteria nor adversely affect the potable quality of the water that is to be transported.

D. Fittings, unless otherwise shown on the Contract Documents, shall be ductile iron, conforming to the same class and rating as the pipe. Fitting joints shall be as required for the pipe being connected. Transition fittings necessary for proper connection shall be the standard of, and provided by, the manufacturer of the fittings.
   1. Ductile iron fittings shall be mechanical flanged or push-on joint in conformance with AWWA C110, and shall be mortar-lined in accordance with AWWA C104. Joints shall be rubber gasketed in accordance with AWWA C111. Ductile iron fittings shall be coal tar epoxy coated.

2.6 DUCTILE IRON PIPE AND FITTINGS (DIP)

A. Pipe
   1. Centrifugally cast, Grade 60-42-10 iron, ANSI A21.51, AWWA C151.
   2. Cement-lined and coal-tar pitch varnish coated.
   3. 250 psi minimum working pressure.
   4. Grooved end pipe and threaded flanged pipe shall be Class 53 minimum.

B. Joints
   1. Grooved end, flanged, mechanical joint, push-on, or proprietary restrained as specified herein and as shown on the Contract Documents.
   2. Grooved end joints shall conform to AWWA C606.
   3. Flanged joint pipe shall conform to ANSI/AWWA C115 and shall use ductile iron flanges.

C. Fittings
   1. Gray or ductile iron, 250 psi working pressure. Where taps are shown on fittings, tapping bosses shall be provided.
   2. Grooved End: ANSI/AWWA C110, AWWA C606 and ANSI B16.1, radius cut grooved rigid joint, as manufactured by Victaulic Company of America, Gustin-Bacon, or equal.
   3. Flanged: ANSI/AWWA C110 and ANSI B16.1, faced and drilled 125-pound ANSI standard.
   4. Mechanical Joint: ANSI/AWWA C110, ANSI/AWWA C111, and ANSI/AWWA C153.
   5. Push-On: ANSI/AWWA C110 and ANSI/AWWA C111, American Cast Iron Pipe Company, Fastite Joint; U.S. Pipe and Foundry, Tyton joint; or equal.
   6. Proprietary Restrained: Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring Joint or Lok-Ring Joint; U.S. Pipe, TR Flex; or approved equal. Any joint employing setscrews, anchor pins, or field welded retainers is unacceptable.

D. Flanges: Ductile iron, ANSI A21.15/AWWA C115, threaded, 250 psi working pressure, 125-pound ANSI drilling.

E. Bolts: For Class 125 FF Flanges: Carbon Steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.

F. Gaskets
   1. Gaskets for grooved end joints shall be manufacturer's flush-seal type specifically designed for cast surfaces. Properties shall be as designated in ASTM D2000 for the required service. Dimensions shall conform to AWWA C606.

2. Gaskets for mechanical, push-on, and proprietary restrained joints shall be rubber conforming to ANSI A21.11, AWWA C111.
3. Gaskets for flanged joints shall be 1/8-inch thick, full-face cloth-inserted rubber conforming to applicable parts of ANSI B16.1 and AWWA C207, unless otherwise specified. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in sewage or potable waterlines.

PART 3 EXECUTION

3.1 INSTALLATION

A. Refer to Section 31 23 33 for trenching and backfill.

B. Wrap all steel pipe, coat all iron, and heat shrink wrap pipe joints after assembly where buried or concrete encased.

C. Cathodically protect steel and DIP pipe but not concrete-encased pipe.

D. Install continuous underground (detectable) warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.

3.2 WATER METER AND BOX

A. Install water meters, piping, and specialties according to the manufacturer's instructions and in accordance with San Lucas Water District requirements.

B. Install water meters in meter box with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

C. Water meter top elevation:
1. In paved areas: Set top flush with paved surface.
2. In grass or landscaped areas: Set top 2 inches above grade.

3.3 ROUGHING-IN FOR WATER METER

A. Rough-in piping and specialties for water meter installation in accordance with San Lucas Water District requirements.

3.4 BACKFLOW PREVENTERS

A. Install backflow preventers of type, size, and capacity indicated in the Drawings and in this Specification. Include valves and test cocks. Install according to the requirements of the plumbing and health department, and the San Lucas Water District.

B. Install freeze protection per manufacturer's instructions. Provide two (2) sets of keys for each lock to the Owner.

C. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

D. Do not install bypass piping around backflow preventers.

3.5 DOUBLE DETECTOR CHECK ASSEMBLIES

A. Install double detector check assembly at location specified in the Drawings and according to the requirements of this Specification and the manufacturer. Lowest point of the assembly shall be set a minimum of 18 inches above grade and a maximum of 36 inches above concrete pad.

B. Install concrete pad beneath assembly. Top of pad shall be set 1 inch above grade. Pad shall have a 2-inch clearance space between the assembly pipe risers and concrete.

C. Install freeze protection per manufacturer's instructions. Provide two (2) sets of keys for each lock to the Owner.

D. Provide positive grading around the concrete pad to direct runoff away from the pad and piping.

3.6 FIRE DEPARTMENT CONNECTION

A. Install fire department connection with threaded plugs per the manufacturer's instructions. FDC shall be located on the building side of the double detector check valve assembly and at the same elevation above grade as the assembly. Provide tees and elbows as required to orient the FDC in the direction specified on the Drawings.

3.7 WATER MAIN CONNECTION

A. Tap water main according to the San Lucas Water District requirements (including use of thrust restraints as required) and of size and in location indicated on the Drawings.

3.8 PVC PIPE

A. All rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation.

B. Schedule 40 pipe shall not be threaded. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

C. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to overtighten these fittings. Pipe shall not be laid when the temperature is below 40 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.

D. Provide adequate ventilation when working with pipe joint solvent cement.

3.9 DUCTILE IRON PIPE

A. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

B. Dressing Cut Ends
   1. Dress cut ends of pipe in accordance with the type of joint to be made.

2. Dress cut ends of buried pipe joints to remove sharp edges or projections which may damage the rubber gasket.
3. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
4. Dress cut ends of pipe for flexible couplings, flanged coupling adapters, and grooved end pipe couplings as recommended by the coupling or adapter manufacturer.

C. Fabrication of Flanged Pipe
1. Fabricate flanged pipe in the shop, not in the field, and deliver to the jobsite with flanges in place and properly faced.
2. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.
3. Face flanges after fabrication in accordance with ANSI A21.15/AWWA C115.
4. Hydrostatically shop test a sufficient number of selected flange-to-pipe threaded joints to ensure joint integrity.

D. Jointing Pipe
1. Grooved End: Install in accordance with the manufacturer's printed instructions.
2. Flanged
a. Prior to connecting flanged pipe, thoroughly clean the faces of the flanges of all oil, grease, and foreign material.
b. Check the rubber gaskets for proper fit and thoroughly clean.
c. Take care to assure proper seating of the flange gasket.
d. Tighten bolts so that the pressure on the gasket is uniform. Use torque-limiting wrenches to ensure uniform bearing insofar as possible.
e. If joints leak when the hydrostatic test is applied, remove and reset gaskets and retighten bolts.
3. Mechanical, Proprietary Restrained, and Push-On Joint
a. Join pipe with mechanical, proprietary restrained, and push-on type joints in accordance with the manufacturer's recommendations.
b. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation.
c. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes will be permitted under any circumstances.

E. Encapsulate all buried ductile iron pipe and/or fittings in polyethylene bagging in accordance with AWWA C105.

3.10 THRUST RESTRAINT

A. Anchor all pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

B. Determine dimensions of thrust blocks based upon the pipeline maximum design pressure.

C. Pipe anchorage and expansion provisions are not completely detailed. The absence of these details on any Contract Document shall not relieve the Contractor of the responsibility for providing them where required, and at his sole expense.

D. Place thrust blocking between undisturbed ground and the fitting to be anchored. Place blocking so that pipe and fitting joints will be accessible for repairs. Place concrete in accordance with Section 03 30 00.

3.11 SYSTEM TESTING

A. Conform to requirements of Section 22 05 10 for piping systems testing.

B. Potable water distribution system shall be hydrostatic leak tested per the City of San Lucas testing requirements for water systems.

C. Water pipes shall be tested prior to back filling per NFPA requirements.

D. Refer to manufacturer's instructions for testing of backflow preventers and double detector check valve assembly.

3.12 DISINFECTION

A. Disinfect system under provisions of Section 22 05 10.

END OF SECTION

SECTION 333100

SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Sanitary sewer piping.

B. Related Sections
   1. Section 22 05 10 - Basic Piping Installation Requirements.
   2. Section 31 23 33 - Trenching and Backfill.

1.2 REFERENCES

A. ASTM D2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

B. ASTM D3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

C. ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

D. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

E. ASTM F481 - Practice for Installation of Thermoplastic Pipe and Corrugated Pipe in Septic Tank Leach Fields.

F. ASTM F679 - Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

G. ASTM F891 - Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core.

1.3 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, and accessories, and certificates of tests.

PART 2 PRODUCTS

2.1 SANITARY SEWER GRAVITY PIPE

A. Sanitary Sewer Pipe and Fittings: PVC 4 inches through 15 inches in diameter, conforming to either modulus indicator wall thickness T-1 of ASTM F789 or SDR 35 of ASTM D3034.

B. PVC Pipe Joints: Rubber gasketed conforming to ASTM D3212. Joints may be push-on joint or mechanical joint.

C. Gaskets: Conform to ASTM F477.

D. Fitting Bends: Long-radius unless otherwise approved by the Owner's Representative.

E. Pipe-to-Pipe connections: Make with 45-degree wyes and long radius bends. Tees are not permitted.

F. Caps may be used on temporary pipe closures.

G. Pipe adaptors: As recommended by pipe manufacturer, for connecting PVC pipe to manholes, and end enclosures.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine the Contract Documents and determine that the sanitary sewer collection system will not interfere with other utilities, including the storm drain system, potable water distribution system, electric and communication conduit systems, and return systems.

B. Criteria for the sanitary sewer collection system:
   1. Sanitary sewers shall have minimum pipe slopes as shown on the Contract Documents.
   2. All sanitary sewer laterals shall be stubbed up, capped and tagged to the indicated building utility point of connection, except that sanitary sewer laterals shall be connected to the building or facility sewers that are constructed by the Contractor of this Contract. The Contractor shall confirm the location and elevation of each building or facility sewer connection point, with the applicable building or facility contractor who will be responsible for connecting the building or facility sewer to the stubbed-up sanitary sewer lateral.

C. Sanitary sewers adjacent to or crossing potable water distribution mains shall conform to the following requirements:
   1. Sanitary sewers crossing above water mains will not be permitted.
   2. Sanitary sewers shall be installed at least ten feet horizontally from and 1 foot vertically below any water main located parallel to the sanitary sewer, and at least 1 foot vertically below any water main crossing the sanitary sewer either perpendicularly or at an askew angle.

D. Propose field adjustments in sanitary sewer routing or grade changes to achieve non-interference with other utility systems.

E. Discuss proposed field adjustments with Owner's Representative prior to implementation.

3.2 EXECUTION

A. Installation of sanitary sewers shall comply with ASTM D2321.

B. Place pipe and fittings to accommodate sanitary sewer laterals.

C. Place sanitary sewer pipe and fittings to line and grade.

D. Provide stub ups and plugs at building sewer connection points.

E. Construct cleanouts in accordance with the details shown on the Drawings. Sewer cleanout box and lid shall be traffic-rated, and manufactured by Christy or approved equal.

F. Mandrel test after backfilling pipe. The mandrel shall be commercially manufactured with a circular cross section of diameter equal to at least 95 percent of the specified average inside diameter of the pipe, and a length equal to at least the nominal diameter of the pipe. The mandrel shall be rigid with an odd number of legs, nine leg minimum.
   1. Notify Owner's Representative of pending mandrel test.
   2. Pull mandrel through sanitary sewer by hand.
   3. Obstructions encountered by the mandrel shall be corrected by the Contractor.
   4. Sanitary sewer pipe that does not meet the mandrel test shall be reinstalled.
   5. Rerounding will not be allowed.

G. Perform air tests on all sections of the sanitary sewer piping system, including all sanitary sewer laterals to the points of building sewer connection in accordance with Section 22 05 10.

H. Perform interim cleaning and flushing in accordance with Section 22 05 10, prior to final acceptance.

3.3 SYSTEM TESTING

A. In accordance with Section 22 05 10 for piping systems testing.

B. Sanitary sewer collection system shall be air tested to five psi.

END OF SECTION

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LEED 2009 for New Construction and Major Renovation

Project Checklist

San Lucas Library

Sustainable Sites — Possible Points: 26

Y	N	?			
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
	5		Credit 2	Development Density and Community Connectivity	5
1			Credit 3	Brownfield Redevelopment	1
	6		Credit 4.1	Alternative Transportation—Public Transportation Access	6
	1		Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
3			Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
2			Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
		1	Credit 6.1	Stormwater Design—Quantity Control	1
	1		Credit 6.2	Stormwater Design—Quality Control	1
		1	Credit 7.1	Heat Island Effect—Non-roof	1
1			Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	N	?			
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
	2		Credit 2	Innovative Wastewater Technologies	2
	4		Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	N	?			
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
7	12		Credit 1	Optimize Energy Performance	1 to 19
7			Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
	2		Credit 4	Enhanced Refrigerant Management	2
		3	Credit 5	Measurement and Verification	3
	2		Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	N	?			
Y			Prereq 1	Storage and Collection of Recyclables	
	3		Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
	1		Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
	2		Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	N	?			
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
	1		Credit 6	Rapidly Renewable Materials	1
	1		Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	N	?			
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
	1		Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
	1		Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
	1		Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
		1	Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	N	?			
1			Credit 1.1	Green Cleaning	1
		1	Credit 1.2	Green Education	1
		1	Credit 1.3	Intergrated Pest Management	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	N	?			
1			Credit 1.1	SSc1	1
1			Credit 1.2	SSc4.3	1
1			Credit 1.3	WEc1	1
1			Credit 1.4	EAc2	1

Total — Possible Points: 110

54	46	10	Total

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110