

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes domestic water piping inside the building.

1.3 DEFINITIONS

- A. PEX: Crosslinked polyethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- C. PEX pipe and associated fittings are to be warranted for a complete distribution system by PEX pipe manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Types L and M, 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 ends. 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.
 - 4. Copper Press-Seal Fittings: Shall conform to the material requirements of ASME B16.18 bronze and ASME B16.22 copper, and the performance requirements of IAPMO PS117.
 - 5. Copper Press Seal Fittings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation.
 - 2) NIBCO, Inc.
 - 3) Tyco GRINNELL.
 - 4) Viega.
 - b. Fittings for NPS 2 and Smaller: Wrought-copper or lead-free bronze fitting with EPDM sealing element in each end.
 - c. Fittings for NPS 2-1/2 to NPS 4: Lead-free bronze or wrought-copper fitting with EPDM sealing element in each end, 420 stainless grip ring, PBT separator ring and un-pressed fitting, leak identification feature.

2.4 PEX PIPE AND FITTINGS

- A. PEX Distribution System: 3/8-inch thru 2-inch shall conform to, ASTM F876, F877, CSA B 137.5, NSF 61 (NSF@us-pw), and ASTM E84. PEX tubing shall have a Standard Dimensional Ratio designation (SDR 9), with a 100 psi at 180 deg F / 160 psi at 73 deg F pressure, temperature rating, and "PEX5006" chlorine resistance rating. PEX tubing shall have a 60 day minimum UV rating.
 - 1. Fittings for PEX Tube: ASTM F 1807, or ASTM F 2159 and ASTM F877 lead-free metal-insert type with copper crimp rings or metal-insert type with attached 304 stainless steel press sleeve, or plastic-insert type with attached 304 stainless steel press sleeve for use with SDR 9 PEX tube.

2. Manifold: Multiple-outlet, or "Homerun" system shall conform to ASTM 877, CSA 137.5 shall be a copper assembly with brass valves for each outlet or polysulfone with preformed valves attached.
3. All manifolds, PEX tube, fittings and accessories for PEX distribution systems are to be by same manufacturer.
4. All manifolds, PEX tube, fittings and accessories for PEX distribution system are to comply with the manufacturer's warranty and installation requirements.
5. Manufacturers:
 - a. IPEX.
 - b. Uponor WIRSBO.
 - c. Watts Radiant Inc.
 - d. Zurn Plumbing Products Group.

B. PEX Pre-insulated Piping System:

1. Service Tubing: 3/8-inch thru 2-inch shall conform to, ASTM F876, F877, CSA B 137.5, NSF 61 (NSF@us-pw), and ASTM E84. PEX tubing shall have a Standard Dimensional Ratio designation (SDR 9), with a 100 psi at 180 deg F / 160 psi at 73 deg F pressure, temperature rating, and "PEX5006" chlorine resistance rating. PEX tubing shall have a 60 day minimum UV rating.
2. Outer Jacket: Corrugated seamless high density polyethylene (HDPE). The jacket completely encompasses and protects the insulation from moisture and damage. The outer jacket shall be extruded directly over the insulation and is flexible.
3. Insulation: Layered expanded cross-linked water resistant polyethylene closed cell foam.
4. Fittings for PEX Tube: ASTM F 1807, or ASTM F 2159 and ASTM F877 lead-free metal-insert type with copper crimp rings or metal-insert type with attached 304 stainless steel press sleeve, or plastic-insert type with attached 304 stainless steel press sleeve for use with SDR 9 PEX tube.
5. Manufacturers:
 - a. Uponor Ecoflex for Potable Water.

PART 3 - EXECUTION

3.1 PIPE AND FITTING 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. Aboveground Domestic Water Piping: Use the following piping materials:
 1. NPS 6 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. NPS 2 and Smaller: PEX distribution system, insert fittings, and crimped joints or press joints.

3. NPS 1/2 to NPS 4: Hard copper tube, Type L; copper or lead-free bronze press-seal-fittings.
- C. Belowground and Exterior Domestic Water Piping: Use the following piping materials:
1. NPS 2 and Smaller: PEX pre-insulated piping system.

3.2 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 bronze ball valves for piping NPS 2 and smaller.
 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.
- C. Shutoff Duty: Use bronze press-seal ball valves for NPS 2 and smaller type L copper tube.

3.3 PIPING INSTALLATION

- A. Install domestic water piping level and plumb.

3.4 JOINT CONSTRUCTION

- A. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- B. Press Seal Joints: Shall be installed using the most current edition of the manufactures installation guidelines. A factory trained field representative shall provide on-site training for the Contractor's field personnel engaged in the operation and installation of pressure-sealed-joints. Upon completion of this training the installing Contractor must submit documentation, which includes those in attendance, from the grooved products manufacturer to CTA. The factory trained representative shall periodically visit the jobsite, review the product installation and provide additional training if new manpower has been assigned to pressure-sealed-joint piping installation. Contractor shall remove and replace any improperly installed products.

3.5 Below-Grade Installation

- A. Potable pre-insulated piping will be installed in accordance with manufacturer's recommendations.
- B. The system will be installed with the fewest number of underground joints as possible.

- C. The system does not require expansion loops, expansion joints or compensators of any type.
- D. An EPDM rubber end cap will be applied at all terminations of the pre-insulated potable piping system, including all fitting locations, to form a watertight seal.
- E. All buried fittings will be installed, insulated and sealed in accordance with the instructions of the piping manufacturer.
- F. Connection Vaults or Insulation Kits are required for all below-grade installations.
- G. Backfill
 - 1. The pre-insulated potable piping system will be backfilled with clean sand material.
 - 2. Minimum vertical distance from the bottom of the tubing to the trench floor is 4 inches.
 - 3. Minimum lateral distance from the side of the tubing to the trench wall is 6 inches.
 - 4. Install a minimum of 12 inches of clean fill over the top of the pre-insulated potable piping.
- H. The balance of the trench can be backfilled with native soil void of stone greater than 2 inches in diameter.
- I. Pressure testing: Pressure test tubing before and during backfill. Test to 1.5 times operating pressure for a minimum of 1 hour prior to system burial.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
- B. Install supports for vertical copper tubing every 10 feet.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

3.8 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

- a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. 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.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. 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.
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.
7. After press-seal fittings have been installed a "step test" shall be followed. Utilizing air, water, or dry nitrogen, pressurize the system not to exceed 85 psi. Walk the system and check for leaks. If you do not locate any leaks proceed to pressurize the system to the recommended pressures, not to exceed 600 psi. Should you locate a leaking joint that has not been pressed, relieve the pressure from the system, insure the tube is fully inserted into the fitting and proceed to press the fitting. Should you locate a fitting that is leaking that has been previously pressed, you can press the fitting a second time. Resume test procedure, after the necessary repairs have been made.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
4. Check plumbing specialties and verify proper settings, adjustments, and operation.

END OF SECTION 221116

SECTION 230500 - COMMON WORK RESULTS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Record Documents, Maintenance Manuals, and General Provisions for mechanical work.
 - 2. Piping materials and installation instructions common to most piping systems.
 - 3. Dielectric fittings.
 - 4. Mechanical demolition.
 - 5. Equipment installation requirements common to equipment sections.
 - 6. Painting.
 - 7. Concrete bases.
 - 8. Supports and anchorages.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
- B. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing by the engineer and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified without added cost to Project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.6 FEES AND PERMITS

- A. Contractor shall apply and pay for all permits, inspections, reviews, etc. required by the authorities having jurisdiction.
 - 1. This shall include the cost of extending the natural gas service from the utility company main line to the building meter, setting the meter and regulator and all related utility company costs.
 - 2. The Contractor shall include in his/her Bid all system development or similarly named fee imposed by the serving utility company or governing entity (City, County, etc.).

1.7 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with the requirements in Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - 1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
 - 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (ie. traps, strainers, tanks, etc.). Refer to Section 230553 "Identification for HVAC Piping and Equipment". Indicate actual inverts and horizontal locations of underground piping.
 - 3. Equipment locations (exposed and concealed) dimensioned from prominent building lines.
 - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed. Revise equipment schedules.
 - 5. Contract Modifications, actual equipment and materials installed.

1.8 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01. Assemble O & M Manuals as follows:
 - 1. Compile two copies of Operating and Maintenance Manuals for the mechanical systems and equipment. The manuals shall be provided to the Architect for approval complete

and at one time, prior to requesting final payment. Partial or separate data will be returned for completion.

2. Manuals shall be assembled in three-ring binders. Binders shall be 3 inches thick or less and more than one binder shall be used for each set of data if required to prevent overfilling of one binder. Binders shall have plastic coating with correct name of the Project permanently attached to the spine. Binders shall be Sparco, #68031. All information shall be arranged in sections and each section shall have a blank buff colored, heavy paper divider with a protruding tab clearly labeled. Sections shall be arranged in the same order that the equipment is listed in the Specification and each Specification Section shall have a separate tab. Shop Drawings which are larger than 8-1/2 inches x 11 inches shall be individually folded so they are 8-1/2 inches x 11 inches or less and inserted behind the appropriate tab.
3. Tabs shall be labeled and arranged as follows:
 - a. Index: Furnish under the first tab an index of sections listing name of Section and Specification numbers.
 - b. Equipment Manufacturers: Furnish under the second tab a complete typed list of equipment suppliers and manufacturers representative including type of equipment, name, address and phone number. The company listed here should be the one which could furnish replacement parts and offer technical information about the equipment.
 - c. Valve Directory: Furnish under this tab a typed copy of the valve chart required.
 - d. Product Literature: Each tab, starting with the fourth shall contain the name of a Specification Section. Behind each tab shall be the previously submitted and approved Shop Drawing, factory published operation and maintenance instructions and parts lists.
4. Upon completion and approval of the booklets, one copy shall be given to the Architect, and two to the Owner.
5. Electronic Format: Provide all O&M information in a searchable electronic PDF format on CD for submission to the Owner with the hard copies.

1.9 MECHANICAL EQUIPMENT TRAINING

- A. The mechanical contractor shall schedule training with the Owner. Using the O & M Manuals, the mechanical contractor shall explain in detail and instruct the Owner's maintenance personnel in the correct operation and maintenance of the equipment.
 1. The mechanical contractor shall develop and create an agenda to be used during Training.
 2. The mechanical contractor shall provide a sign in sheet to verify dates and types of training and who attended.
- B. Refer to Division 01, section "Demonstration and Training."
- C. Refer to specific training and demonstration requirements in the individual specifications.

1.10 GENERAL PROVISIONS FOR MECHANICAL WORK

- A. Interferences: Project design took into account potential interferences between trades (e.g. mechanical ductwork with piping or with electrical light fixtures), however, not every interference has been eliminated. It shall be the responsibility of the Bidder and potential

Contractor to field verify all mechanical piping and duct routing, making allowances for existing beams, pipes, ducts, hangers, and other obstructions. Provide HVAC duct offsets and transitions as required maintaining duct aspect ratios within 10 percent of design. The cost associated with interferences shall be included in the Base Bid.

B. Examination of Project Drawings:

1. The Drawings (Plans, elevations, flow schematics, etc.) for the mechanical work are intended to convey Scope of Work and to indicate the general arrangements and locations of end-use equipment, systems, etc., and the approximate sizes thereof.
2. The Contractor shall determine the exact location and mounting heights of equipment, rough-ins, and the exact routing and positioning of piping/ductwork equipment so as to best fit the layout of the job. Scaling of the Drawings will not be sufficient for determining these locations. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made, by the Contractor, at no additional cost to the Client.
3. Because of the scale of the Drawings, certain basic items/materials and quantities thereof, (e.g. fittings, connectors, flanges, unions, pipe wells, couplings, hangers, sleeves, clamps, screws, hooks, inserts, pipe/duct mounted - meters, gauges, sensors, etc.) may not be shown, but where such items are required by other sections of the Specifications or where they are required for proper installation of the Work, such items shall be furnished and installed and the cost thereof, reflected in the Base Bid.
4. The determination of quantities of HVAC and plumbing end-use systems and equipment required shall be made by the Contractor from the Drawings. Interferences and quantities and locations of basic items/materials may not be indicated on the Drawings and will require field verification and determination by the Contractor.
5. The Contractor shall coordinate the location and method of support of the piping/duct systems with that of all installations under other Divisions and Sections of the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8-inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Central Plastics Company.
 - b. Epcos Sales, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
- D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150 or 300 psig minimum working pressure where required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225 deg F.

1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Refer to Division 01 Sections for general demolition requirements and procedures.

- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- 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 Coordination Drawings.

- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: Split plate, cast-brass or stamped steel type with polished chrome-plated finish.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000 psi, 28 day compressive-strength concrete and reinforcement as specified.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 - 1. Thermometers.
 - 2. Gages.
 - 3. Test plugs.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves, Shop Drawings, product certification, operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SOLAR DIGITAL THERMOMETERS

- A. Manufacturers:
 - 1. Ashcroft.
 - 2. Terice, H. O. Co.
 - 3. MILJOCO Corporation
 - 4. Weiss Instruments, Inc.
 - 5. Weksler Instruments.
- B. Case: High Impact ABS Plastic.

- C. Resolution: 0.10 deg F between -50 deg F to 199.9 deg F.
- D. Recalibration: Internal potentiometer.
- E. Display: LCD, black.
- F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- G. Stem: Aluminum.
- H. Sensor: Glass passivated thermistor.
- I. Accuracy: Greater value of 1 deg F, or 1 percent of reading.
- J. Range: -58 deg F to 302 deg F, field switchable to deg C.

2.3 THERMOWELLS

- A. Manufacturers: Same as manufacturer of thermometer being used.
- B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

- A. Manufacturers:
 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 2. Ernst Gage Co.
 3. Eugene Ernst Products Co.
 4. Marsh Bellofram.
 5. MILJOCO Corporation
 6. Palmer - Wahl Instruments Inc.
 7. Trerice, H. O. Co.
 8. Weiss Instruments, Inc.
 9. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2 inch diameter.
 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 6. Pointer: Red or other dark-color metal.
 7. Window: Glass.
 8. Ring: Metal.

9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball valve with teflon seat equal to Trerice Model #866.
2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Sisco Manufacturing Co.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install meters and gages as indicated.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

3.2 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

- B. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install ball-valve and snubber fitting in piping for each pressure gage for fluids (except steam).
- E. Install test plugs in tees in piping.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR PLUMBING AND HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general duty valves common to several mechanical piping systems.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- 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.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Comply with the requirements specified in Division 01 Section "Materials and Equipment," under "Source Limitations" Paragraph.
- B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Division.
 - b. Milwaukee Valve Company, Inc.
 - c. Hammond Valve.

- d. Kitz Corporation of America.
 - e. Victaulic Company of America.
 - f. NIBCO, Inc.
 - g. Watts Industries, Inc.
2. Globe Valves:
- a. Crane Company; Valves and Fitting Division.
 - b. Hammond Valve.
 - c. Kitz Corporation of America.
 - d. Milwaukee Valve Company, Inc.
 - e. NIBCO Inc.
 - f. Powell: Wm. Powell Company (The).
3. Butterfly Valves:
- a. Crane Company; Valves and Fitting Division.
 - b. General Signal; DeZurik Unit.
 - c. Grinnell Corp.
 - d. Hammond Valve.
 - e. Keystone Valve USA, Inc.
 - f. Kitz Corporation of America.
 - g. Line, Mark Controls Corporation.
 - h. Milwaukee Valve Company, Inc.
 - i. NIBCO Inc.
 - j. Victaulic Company of America.
4. Swing Check Valves:
- a. Crane Company; Valves and Fitting Division.
 - b. Hammond Valve.
 - c. Kitz Corporation of America.
 - d. Milwaukee Valve Company, Inc.
 - e. NIBCO, Inc.
 - f. Powell: Wm. Powell Company (The).
 - g. Victaulic Company of America.
 - h. Watts Industries, Inc.
5. Silent Check Valves:
- a. Conbraco Industries, Inc.; Apollo Division.
 - b. Hammond Valve.
 - c. Keystone Valve USA, Inc.
 - d. Metraflex Company.
 - e. Milwaukee Valve Company, Inc.
 - f. NIBCO Inc.
 - g. Victaulic Company of America.

2.2 BASIC, COMMON FEATURES

- A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.
- 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: 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.
- 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 B1.20.1.
- H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

2.3 BALL VALVES

- A. Ball Valves, 2 Inches and Smaller: MSS SP-110, Class 150, 600 psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch valves and smaller and conventional port for 3/4-inch valves and larger; blowout proof; bronze or brass stem; Teflon seats and seals. Ball valves shall be full-port type for steam condensate applications as indicated.
 1. Operator: Vinyl-covered steel lever handle.
 2. Stem Extension: For valves installed in insulated piping.
- B. End Connection: Threaded.

2.4 GLOBE VALVES

- A. Globe Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200 psi CWP, or Class 150, 300 psi CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or Teflon disc, silicon bronze-alloy stem, Teflon-impregnated packing with bronze nut, and with aluminum or malleable-iron handwheel.
- B. End Connection: Threaded.
- C. Globe Valves, 3 Inches and Larger: MSS SP-85, Class 125, 200 psi CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy

stem, outside screw and yoke, Teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.5 BUTTERFLY VALVES

- A. Butterfly Valves: MSS SP-67, 200 psi CWP, 150 psi maximum pressure differential, ASTM A 126 cast-iron body and bonnet, extended neck, stainless-steel stem, EPDM sleeve and stem seals, wafer, lug, or grooved style:
 - 1. Disc Type: Nickel-plated ductile iron for HVAC and plumbing.
 - 2. Operator for Sizes 2 Inches to 6 Inches: Lever handle with latch lock.
 - 3. Operator for Sizes 8 Inches to 24 Inches: Gear operator with position indicator.
- B. Valves shall be capable of bubble-tight dead-end shut-off at full rated pressure without the need of a downstream blind flange.

2.6 CHECK VALVES

- A. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200 psi CWP, or Class 150, 300 psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat.
- B. End Connection: Threaded.
- C. Swing Check Valves, 2-1/2 Inches and Larger: MSS SP-71, Class 125, 200 psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.
- D. Silent Check Valves: Class 125, 200 psi CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless steel pins and springs, Buna N seals, wafer or flanged style.

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 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above the center of the pipe.
- E. Install valves in a position to allow full stem movement.
- F. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
 - 2. Silent Check Valves: Horizontal or vertical position.

3.3 VALVE END SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size, 2 Inches and Smaller: Threaded ends.
 - 2. Steel Pipe Sizes, 2 Inches and Smaller: Threaded or grooved end.
 - 3. Steel Pipe Sizes, 2-1/2 Inches and Larger: Grooved end or flanged.

3.4 APPLICATION SCHEDULE

- A. General Application: Use ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements. Select trim to suit piping systems:
- B. Domestic Water Systems: Use the following valve types.
 - 1. Ball Valves: Class 150, 600 psi CWP, with stem extension.
 - 2. Bronze Swing Check: Class 125, with rubber seat.
- C. Heating Water Systems: Use the following valve types.
 - 1. Ball Valves: Class 150, 600 psi CWP, with stem extension and memory stop.
 - 2. Globe Valves: Class 150, bronze or cast-iron body to suit piping system, and bronze disc.
 - 3. Butterfly Valves: Nickel-plated ductile iron or aluminum bronze EPDM or Buna N sleeve and stem seals.

4. Bronze Swing Check: Class 150, with composition seat.
5. Check Valves: Iron swing, wafer, or lift type, as indicated. Swing check shall be Class 150 with bronze seat ring.

3.5 ADJUSTING

- A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

- A. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- B. Thermal-Hanger shield inserts shall be installed at the time of hanger installation.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. ERICO International Corporation.
3. Mechanical Pipe Shields "SNAP-ITZ."
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. TOLCO a brand of Nibco.
10. Value Engineered Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig or water-repellent treated, ASTM C 533, Type I calcium silicate, minimum compressive strength and vapor barrier.

- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Installed by Mechanical Contractor at time of hanger installation. Inserts are required on all cold piping 2 inch and larger.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators

- that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert for pipes 2 inches and larger. Run insulation continuously through hanger and install a galvanized Type 40 insulation shield between hanger and insulation for pipes smaller than 2 inches.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Where indicated, install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier smaller than 2 inches. Shields shall span an arc of 180 degrees.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods.

3.5 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for cold insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Pipe Size	Pipe Material	MSS Hanger Type	Manufacturer/Model	Notes
1/2" - 4"	Bare Steel	Type 1	ANVIL Fig. 65	
1/2" - 4"	Bare Copper	Type 9	ANVIL Fig. CT-99 or CT-65	
1/2" - 4"	Insulated Copper (Hot)	Type 9	ANVIL Fig. CT-99 or CT-65	
1/2" - 12"	Insulated Steel (Hot)	Type 1	ANVIL Fig. 300	Hanger may contact pipe.
1/2" - 1-1-2"	Insulated Copper and Steel (Cold)	Type 1	ANVIL Fig. 300 with shield	No pipe contact allowed.
2" - 12"	Insulated Copper and Steel (Cold)	Type 1	ANVIL Fig. 300 with shield and insert	No pipe contact allowed.

- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230549 - SEISMIC CONTROLS FOR PLUMBING AND HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Seismic snubbers.
 - 2. Restraining braces and cables.
 - 3. Restrained isolators.
- B. It is the intent of this section to have the seismic bracing requirements designed by the approved seismic equipment manufacturer and installed by the mechanical contractor. The seismic manufacturer shall be responsible for the structural design of attachment hardware as required to attach snubbers to both the equipment and supporting structure. The manufacturer shall submit seismic shop drawings showing type and location of restraint devices as required to meet the code and performance requirements specified herein. The work under this section shall include all materials and labor necessary for complete execution of installation of seismic restraint assemblies as required per IBC code requirements.
- C. The requirements of this seismic restraint section are in addition to other requirements as specified for support and attachment of equipment and mechanical services.

1.3 DEFINITIONS

- A. IBC: International Building Code.

1.4 PERFORMANCE REQUIREMENT

- A. Seismic-Restraint Loading:
 - 1. Seismic Design Category as Defined in the IBC: See Structural Drawings.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: See Structural Drawings.
 - a. Component Importance Factor: (1.0) for all ductwork, equipment and piping, except propane piping which shall be (1.5).
 - b. Component Response Modification Factor: As required by IBC 2021 and ASCE 7-10 for specific component.

- c. Component Amplification Factor: As required by IBC 2021 and ASCE 7-10 for specific component.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): $S_{ds} = 0.571$.
4. Design Spectral Response Acceleration at 1-Second Period: $S_{d1} = 0.268$.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting seismic restraints. Certification documents to be signed and sealed by a qualified Professional Engineer with at least 5 years experience in the design of seismic restraints.
2. Seismic Restraint Details: Detail submittal drawings of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration anchors.
3. Seismic Shop Drawings: Floor Plans indicating seismic bracing locations and spacing for HVAC piping, ductwork and equipment.

1.6 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic restraint products shall be of the same manufacturer.
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

- E. All piping and ductwork is to be restrained to meet code requirements. The seismic restraint manufacturer will provide documentation on maximum restraint spacing for various cable sizes and anchors. In addition, the seismic restraint manufacturer will provide support documentation containing adequate information to allow the installation contractor to make reasonable field modifications to suit special case conditions.
- F. Seismic Restraint Designers/Manufacturers: Subject to compliance with requirements provide seismic design services and products by one of the following:
 - 1. Amber/Booth Co. Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
 - 4. Vibro Acoustics

PART 2 - PRODUCTS

2.1 RESTRAINED ISOLATORS

- A. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized steel cables pre-stretched with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on shop drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Installation of all seismic restraint materials shall be installed according to the manufacturer's installation instructions and project shop drawings.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Snubbers are not needed if restrained isolators are used.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports and longitudinal supports as required for the site spectral response.
 - 3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.

- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

END OF SECTION 230549

SECTION 230553 - IDENTIFICATION FOR PLUMBING AND HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment markers.
 - 2. Pipe markers.
 - 3. Valve tags.
 - 4. Valve schedules.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme.
- C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a. Name and plan number.
 - 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.2 PIPING IDENTIFICATION DEVICES

- A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 - 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 - 3. Pipes with OD, Including Insulation, Less Than 6 inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 - 4. Pipes with OD, Including Insulation, 6 inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 - 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Engineer. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch thick brass or aluminum.
 - 2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other related Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment.
 - 1. Letter Size: Minimum 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.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Boilers.
 - b. Pumps and similar motor-driven units.
 - c. Tanks and pressure vessels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4-inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 2. Pipes with OD, Including Insulation, 6 inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; exterior nonconcealed locations and concealed ceiling spaces as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings at intervals of 50 feet.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 1. Valve-Tag Size and Shape: 1-1/2 inches
 2. Valve-Tag Color: Natural Brass or Aluminum.

3.5 CLEANING

- A. Clean faces of mechanical identification devices.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for all air and water systems.

1.3 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3.
- C. Sample Report Forms: Submit two sets of sample TAB report forms.

1.4 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. The Test and Balance Contractor shall be an independent consultant. The firm shall be independent of all Contractors including the Mechanical and Temperature Controls Contractor.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." Or from SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing."
- E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Used)

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.
 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- D. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- E. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- F. Examine strainers for clean screens and proper perforations.
- G. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

- H. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- I. Examine system pumps to ensure absence of entrained air in the suction piping.
- J. Examine equipment for installation and for properly operating safety interlocks and controls.
- K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Complete system readiness checks and submit a system readiness report to the Project Engineer. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Hydronic systems specified to contain antifreeze have the correct percentage.
 - 4. Automatic temperature-control systems are operational.
 - 5. Equipment and duct access doors are securely closed.
 - 6. Isolating and balancing valves are open and control valves are operational.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check expansion tank liquid level and system pressurization.
 - 3. Check flow-control valves for specified sequence of operation and set at indicated flow.

4. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
5. For hydronic systems containing antifreeze, note the product used and measure the actual concentration. Record final results on the TAB report.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 1. Heating-Water Flow Rate: 0 to minus 10 percent.

3.6 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed by the testing and balancing engineer.
 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.
 5. Architect's/Engineer's name and address.
 6. Contractor's name and address.
 7. Report date.
 8. Signature of TAB firm who certifies the report.
 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 10. 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.
 11. Notes to explain why certain final data in the body of reports varies from indicated values.
 12. Test conditions for pump performance.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe, duct, and equipment insulation.

1.2 SUBMITTALS

- A. Product data for each type of mechanical insulation identifying k-value, thickness, jackets (factory and field applied) and accessories.

1.3 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct installation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation.

1.4 SEQUENCING AND SCHEDULING

- A. Schedule insulation application after pressure testing of piping and duct systems.
- B. Schedule insulation application after installation and testing of heat trace tape.
- C. Thermal-hanger shield inserts are specified in "Hangers and Supports." Inserts shall be installed at the time of hanger installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Glass Fiber:
 - a. CertainTeed Corporation.
 - b. Knauf Fiberglass.
 - c. Manville/Schuller.

- d. Owens-Corning Fiberglas Corporation.
 - e. E-Insulation.
2. Flexible Elastomeric Cellular:
- a. Armacell LLC.
 - b. IMCOA Corporation.
 - c. Rubatex Corporation.

2.2 GLASS FIBER

- A. Material: Inorganic glass fibers, bonded with a thermosetting resin.
- B. Jacket: All-service, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil skim backing having pressure sensitive self-sealing lap.
- C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.
 - 1. Thermal Conductivity: 0.23 average maximum, at 75 deg F mean temperature.
 - 2. Density: 3.0 pcf average maximum.
- D. Blanket: ASTM C 553, Type I, Class B-2, jacketed flexible blankets.
 - 1. Thermal Conductivity: 0.27 at compressed thickness, at 75 deg F mean temperature.
 - 2. Density: 0.75lb/cu. ft.
- E. Preformed Pipe Insulation: ASTM C 547, Class 1, rigid pipe insulation, factory applied all-service jacket with self seal lap.
 - 1. Thermal Conductivity: 0.26 average maximum at 75 deg F mean temperature.
 - 2. Density: 5 lb/cu. ft average maximum.
- F. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.3 FLEXIBLE ELASTOMERIC CELLULAR

- A. Material: Flexible expanded closed-cell structure with smooth skin on both sides.
 - 1. Tubular Materials: ASTM C 534, Type I.
 - 2. Sheet Materials: ASTM C 534, Type II.
- B. Thermal Conductivity: 0.25 average maximum at 75 deg F.
- C. Coating: Water based latex enamel coating recommended by insulation manufacturer.

2.4 ADHESIVES

- A. Flexible Elastomeric Cellular Insulation Adhesive: Solvent-based, contact adhesive recommended by insulation manufacturer. Comply with MIL-A-24179A, Type II, Class 1.

2.5 FIELD APPLIED JACKETS

- A. PVC Jacketing: High-impact, ultra-violet-resistant PVC, 30-mils thick, roll stock ready for shop or field cutting and forming to indicated sizes.
 - 1. Mastic/Adhesive: As recommended by insulation manufacturer.
- B. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil-thick, high-impact, ultra-violet-resistant PVC.
 - 1. Mastic around fitting to pipe insulation.

2.6 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4-inch wide, in one of the following materials compatible with jacket:
 - 1. Aluminum: 0.007-inch thick.
 - 2. 1/8-inch by 1/8-inch Rapid Penetrating point screws for non vapor barrier application.
- B. Wire: 14 gauge nickel copper alloy, 16 gauge, soft-annealed stainless steel, or 160 gauge, soft-annealed galvanized steel.
- C. Cupped Head Weld Pins- 1-1/2 inch diameter cupped head, mild, annealed steel with zinc plating.
- D. Corner Angles: 28 gauge, 1 inch by 1 inch aluminum, adhered to 2 inch by 2 inch kraft paper.
- E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.
- F. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- G. Foil/Skrim/Kraft Tape: Vapor barrier tape with rubber adhesive and UL listed and 25/20 rated.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 85 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 45 lbf/inch in width.

2.7 SEALING COMPOUNDS-MASTIC

- A. Vapor Barrier Compound: Water-based, fire-resistive composition.
 - 1. Water Vapor Permeance: 0.08 perm maximum.
 - 2. Temperature Range: Minus 20 to 180 deg F.
- B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.
 - 1. Water Vapor Permeance: 0.02 perm maximum.
 - 2. Temperature Range: Minus 50 to 250 deg F.
 - 3. Color: Aluminum.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

3.2 INSTALLATION, GENERAL

- A. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each mechanical system.
- B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.
- C. Install vapor barriers on insulated pipes, ducts, and equipment where indicated and defined in insulation service chart.
- D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.
- E. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.
- F. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.
- G. Keep insulation materials dry during application and finishing.
- H. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:
 - 1. Metal ducts with duct liner.
 - 2. Flexible connectors for ducts and pipes.
 - 3. Testing laboratory labels and stamps.
 - 4. Nameplates and data plates.
 - 5. Access panels and doors in air distribution systems.

6. Chrome-plated pipes and fittings, except for plumbing fixtures for the disabled.
7. Backflow prevention device.

3.3 PIPE INSULATION INSTALLATION, GENERAL

- A. Tightly butt longitudinal seams and end joints.
- B. Apply insulation continuously over fittings, valves, and specialties.
- C. Apply insulation with a minimum number of joints.
- D. Apply insulation with all service jackets as follows:
 1. Pull jacket tight and smooth.
 2. Cover circumferential joints with butt strips, at least 3 inches wide, and of same material as insulation jacket.
 3. Longitudinal Seams: Overlap 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.
 4. At penetrations in jackets for thermometers and pressure gauges, fill and seal voids with mastic.
 5. Repair damaged insulation jackets, except metal jackets, by applying jacket material around damaged jacket. Extend patch at least 2 inches in both directions beyond damaged insulation jacket and around the entire circumference of the pipe.
- E. Roof Penetrations: Apply insulation for interior applications to a point even with the top of the roof flashing. Seal with vapor barrier coating. Apply insulation for exterior applications butted tightly to interior insulation ends. Extend metal jacket for exterior insulation outside roof flashing at least 2 inches below top of roof flashing. Seal metal jacket to roof flashing with vapor barrier coating.
- F. Exterior Wall Penetrations: For penetrations of below grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.
- G. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.
- H. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with mastic. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight.
 1. Use same material and thickness as adjacent pipe insulation.
 2. Overlap nesting insulation by 2 inches or 1-pipe diameter, which ever is greater.
 3. Insulate elbows with blanket insulation inserts.
 4. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.
- I. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. For vapor barrier application piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

1. Install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer. Refer to "Hangers and Supports" for thermal-hanger shield inserts.
2. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

3.4 GLASS FIBER PIPE INSULATION INSTALLATION

- A. Seal exposed seams and joint ends, with mastic.

3.5 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

- A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, use longitudinally precut insulation and apply to the pipe. Seal seams and joints with adhesive.
- B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive. Use prefabricated fittings if available.
 1. Miter cut materials to cover soldered elbows and tees.
 2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.6 EQUIPMENT INSULATION INSTALLATION, GENERAL

- A. Install board materials with a minimum number of joints.
- B. Ensure insulation materials to fit as closely as possible to the equipment and to fit contours of equipment. Stagger end joints.
- C. Insulation Thicknesses Greater than 2 inches: Install insulation in multiple layers with staggered joints.
- D. Secure sections of insulation in place with bands spaced at 12 inch centers, except for flexible elastomeric cellular insulation.
- E. Protect exposed corners with corner angles under bands.
- F. Manholes, Handholes, and Information Plates: Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- G. Removable Insulation: Install insulation on components that require periodic inspecting, cleaning, and repairing for easy removal and replacement without damage to adjacent insulation.
- H. Finishing: Except for flexible elastomeric cellular insulation, see Insulation schedule for jacketing.

3.7 GLASS FIBER EQUIPMENT INSULATION INSTALLATION

- A. Secure insulation with anchor pins and speed washers.
- B. Space anchors at maximum intervals of 18 inches in both directions and not more than 3 inches from edges and joints.

3.8 FLEXIBLE ELASTOMERIC EQUIPMENT INSULATION INSTALLATION

- A. Install sheets of the largest manageable size.
- B. Apply full coverage of adhesive to the surfaces of the equipment and to the insulation.
- C. Butt insulation joints firmly together and apply adhesive to insulation edges at joints.
- D. Coat exterior installations with manufacturer's coating and install by manufacturer's installation instructions.

3.9 DUCT INSULATION

- A. Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:
 - 1. 24 Inches and Larger: Anchor pins spaced 12 inches apart each way.
 - 2. Overlap joints 3 inches.
 - 3. Seal joints, breaks, and punctures with vapor barrier tape, matching jacket material.

3.10 FIELD APPLIED JACKETS

- A. Install the PVC jacket with 1 inch overlap at longitudinal and butt joints and seal with adhesive.

3.11 FINISHES

- A. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of manufacturer's recommended protective coating to exposed insulation.

3.12 INSULATION SCHEDULES

- A. General: Abbreviations used in the following schedules include:
 - 1. Field-Applied Jackets: PVC - PVC, A - Aluminum, SS - Stainless Steel, Glass Cloth.
 - 2. Pipe Sizes: NPS - Nominal Pipe Size.
 - 3. Materials: GF - Glass Fiber, FE - Flexible Elastomeric, CG - Cellular Glass, CS - Calcium Silicate, FPS - Fire Protection System.
- B. Pipe Insulation:

APPLICATION	TEMP (°F)	NOM. PIPE SIZE (IN.)	INSUL. MAT.	THICKNESS (IN.)	INSERTS OR SHIELDS NOTE 1	VAPOR BARR.	FIELD APP. JKT.
DOMESTIC COLD WATER	ALL	ALL	GF or FE	1	NO	YES	NONE
HEATING WATER SUPPLY AND RETURN GLYCOL SUPPLY AND RETURN	141 - 200	1/2 TO 1-1/4 1-1/2 AND UP	GF GF	1-1/2 2	YES	NO	NONE

NOTE 1: INSERTS AND SHIELDS ARE IN SECTION 230529 - HANGERS AND SUPPORTS FOR PLUMBING AND HVAC PIPING AND EQUIPMENT AND SHALL BE PROVIDED BY THE INSULATION CONTRACTOR.

C. Equipment Insulation:

APPLICATION	TYPE	INSUL. MAT.	THICKNESS (IN.)	VAPOR BARRIER	FIELD APPLIED JACKET
HOT EQUIPMENT, TANKS, BUFFER TANK, AIR SEPARATORS, HEAT EXCHANGERS	BOARD	GF	2	NO	GC

D. Duct Systems:

APPLICATION	TYPE	INSUL. MAT.	THICKNESS (IN.)	VAPOR BARRIER	FIELD APPLIED JACKET
COMBUSTION AIR DUCTS FROM LOUVER TO OUTLET AND FROM TERMINATION CAP TO RADIANT HEATER	BLANKET	GF	1-1/2	NO	NONE

BOILER COMBUSTION AIR DUCT BEHIND LOUVER	BOARD	GF	1-1/2	NO	NONE
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END OF SECTION 230700

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating systems; makeup water for these systems; and blowdown drain lines.

1.3 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support and anchor assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 01.
- E. Chemical Treatment: Product Data on Glycol, Glycol Feeders, Bypass Feeders and proposed system inhibitors.
- F. Press Seal Joint Installation Training Certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.5 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.6 WARRANTY

- A. Manufacturer's Warranty for Hydronic Piping: Manufacturer's standard 25 year warranty for PEX-a piping and ASTM F 1960 fittings.
- B. Manufacturer's Warranty for Pre-Insulated Pipe Distribution Systems: Submit, for owner's acceptance, USA manufacturer's standard 5-year warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights owner may have under contract documents.
- C. Warranty covers the repair or replacement of any piping or fittings proven defective.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Copper or Bronze Pressure-Seal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Products Corporation.
 - b. NIBCO, Inc.
 - c. Tyco GRINNELL.
 - d. Viega.
 2. Housing: Copper.
 3. O-Rings and Pipe Stops: EPDM.
 4. Tools: Manufacturer's special tools.
 5. Minimum 200 psig working-pressure rating at 250 deg F.
- C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PLASTIC PIPE AND FITTINGS

- A. Polypropylene Pipe: Pipe shall be manufactured from a PP-R or PP-RCT resin meeting requirements of ASTM F 2389. The pipe shall contain no recycled materials. All pipe shall be made in a three layer extrusion process. Heating piping shall contain a fiber layer (Faser) to restrict thermal expansion. Pipe shall be certified by NSF International complying with NSF 14. Piping shall contain an oxygen barrier. Pipe shall have a minimum SDR rating of 11 or heavier and conform with maximum pressure rating of connected system.
 - 1. Manufacturers: Subject to compliance with requirements, polypropylene pipe shall be manufactured by one of the following:
 - a. Aquatherm.
 - b. Nupi Americas of Houston, TX.
 - 2. Fittings: Manufactured of polypropylene resin in conformance with ASTM F2389 and NSF 14. Fittings and joints shall be socket fusion, electrofusion or butt-fusion type, made in accordance with manufacturer's installation requirements.
 - 3. Smoke and Fire Ratings: Where indicated on the Drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of

- CAN/ULC-S102.2-03 or ASTM E 84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.
4. UV Protection: Where indicated on the Drawings and as scheduled by the Contractor that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a factory-applied, UV-resistant coating or alternative UV protection.
 5. Manufacturers Standard Colors: Polypropylene piping may be pigmented in different colors identifying the pipe application.
 6. Polypropylene piping shall warranty pipe and fittings for 10 years to be free of defects in materials. Warranty shall cover all labor and material costs of repairing and replacing defective materials.
- B. PEX-a (Engle-method Crosslinked Polyethylene) Piping: ASTM 876 with oxygen-diffusion barrier that meets DIN 4726.
1. Manufacturers: Subject to compliance with requirements, PEX-a pipe shall be manufactured by one of the following:
 - a. Uponor.
 2. PEX-a piping and fittings shall meet the following pressure and temperature ratings:
 - a. 200 degrees F (93 degrees C) at 80 psi (551 kPa).
 - b. 180 degrees F (82 degrees C) at 100 psi (689 kPa).
 - c. 73.4 degrees F (23 degrees C) at 160 psi (1,102 kPa).
 3. PEX-a Fittings, Elbows and Tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - a. UNS No. C69300 Lead-free (LF) Brass.
 - b. 20 percent glass-filled polysulfone as specified in ASTM D6394.
 - c. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394.
 - d. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - e. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394.
 - f. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".
 4. PEX-a Fittings (1 inch through 4 inch nominal pipe size): SDR9 compression type fitting consisting of a double O-ring insert with a compression sleeve tightened around the pipe and insert.
 5. Plastic-to-Metal Transition Fittings:
 - a. Manufacturer: Provide fittings from the same manufacturer of the piping.
 - b. Threaded Brass to PEX-a Transition: One-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
 - c. Brass Sweat to PEX-a Transition: One-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
 - d. Dezincification-resistant (DZR) Brass to PEX-a Transition: Male NPT thread and PEX compression fitting. Editor: Typically used for PEX sizes 1 inch through 4 inch.
 6. Plastic-to-Metal Transition Unions:
 - a. Manufacturer: Provide unions from the same manufacturer of the piping.
 - b. Threaded Brass to PEX-a Union: One-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.

- c. Brass Sweat to PEX-a Union: One-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
- C. Pre-insulated PEX Thermal Distribution System: PEX-a service tubing is USA manufactured and tested in accordance with ASTM F876, ASTM F877, ASTM F1960, CSA B137.5 and NSF-rfh.
1. Manufacturers: Subject to compliance with requirements, Pre-insulated PEX Thermal Distribution System shall be manufactured by one of the following:
 - a. Uponor.
 2. The PEX service tubing has hydrostatic ratings in accordance with the temperatures and pressures listed in the ASTM standard. The hydrostatic ratings are:
 - a. 200 degrees F (93 degrees C) at 80 PSI (551 kPa).
 - b. 180 degrees F (82 degrees C) at 100 PSI (689 kPa).
 - c. 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa).
 3. Service Tubing:
 - a. Material: Crosslinked polyethylene (PEX) manufactured to PEX-a or Engel-method standard
 - b. Material Standard: Manufactured in accordance with ASTM F876 and F877
 - c. Pressure Ratings: Hydrostatic design and pressure ratings are in accordance with the ASTM standard. Operating limits are as follows.
 - d. -58 degrees F to 203 degrees F at 80 psi (-50 degrees C to 95 degrees C at 551 kPa).
 - e. The PEX service tubing pipe has an oxygen diffusion barrier that does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.
 - f. Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated. Note: Numbers in brackets are the metric equivalent pipe size.
 - 1) 1 inch (25mm).
 - 2) 1-1/4 inch (32mm).
 - 3) 1-1/2 inch (40mm).
 - 4) 2 inch (50mm).
 - 5) 2-1/2 inch (63mm).
 - 6) 3 inch (75mm).
 - 7) 3-1/2 inch (90mm).
 - 8) 4 inch (110mm).
 4. Outer Jacket:
 - a. Material: Corrugated seamless high-density polyethylene (HDPE)
 - b. The HDPE jacket completely encompasses and protects the insulation from moisture and damage.
 - c. Outer jacket shall be extruded directly over the insulation and is flexible.
 - d. The outer jacket shall contain 2 percent carbon black, finely divided and thoroughly dispersed to provide protection from UV degradation.
 - e. Minimum Bend Radius:
 - 1) 1 inch pre-insulated tubing with 5.5-inch (140mm) jacket has a bend radius of 10 inches (254mm).
 - 2) 1-1/4 inch pre-insulated tubing with 5.5-inch (140mm) jacket has a bend radius of 12 inches (304mm).
 - 3) 1-1/2 inch pre-insulated tubing with 6.9-inch (175mm) jacket has a bend radius of 16 inches (406mm).

- 4) 2 inch pre-insulated tubing with 6.9-inch (175mm) jacket has a bend radius of 18 inches (457mm).
 - 5) 2-1/2 inch pre-insulated tubing with 6.9-inch (175mm) jacket has a bend radius of 30 inches (762mm).
 - 6) 3 inch pre-insulated tubing with 7.9-inch (200mm) jacket has a bend radius of 32 inches (812mm).
 - 7) 3-1/2 inch pre-insulated tubing with 7.9-inch (200mm) jacket has a bend radius of 44 inches (1117mm).
 - 8) 4 inch pre-insulated tubing with 7.9-inch (200mm) jacket has a bend radius of 48 inches (1219mm).
5. Insulation:
 - a. The insulation shall be layered expanded crosslinked water-resistant polyethylene closed-cell foam.
 - b. All seams of the insulation shall be sealed.
 - c. Insulation shall not be bonded to the service tubing.
 6. End Seals:
 - a. The piping manufacturer will supply all EPDM rubber end caps with water-stop seal.
 - b. EPDM rubber end caps are to be installed on each end prior to connecting the service pipes and insulating the field joints.
 - c. The EPDM end caps will seal onto the tubing and outer jacket forming a watertight seal.
 7. Cold Expansion Fittings for PEX-a Service Tubing:
 - a. For system compatibility, use fittings offered by the tubing manufacturer.
 - b. Fittings must comply with the performance requirements of ASTM F877.
 - c. Fittings are to be manufactured in accordance with ASTM F1960.
 - d. The fitting assembly consists of a barbed adapter and an applicable-sized PEX ring.
 - e. All buried fittings will be installed, insulated, and sealed in accordance with the instructions of the piping manufacturer.
 8. Compression Fittings for PEX-a Service Tubing:
 - a. For system compatibility, use fittings offered by the tubing manufacturer.
 - b. Fittings are to be manufactured from dezincification-resistant brass and lead-free brass.
 - c. The fitting assembly must comply with performance requirements of ASTM F877.
 - d. Fittings will consist of a compression fitting with a coupling sleeve, a fitting body insert with o-ring(s) and a bolt and nut.
 - e. All buried fittings will be installed, insulated, and sealed in accordance with the piping manufacturer's instructions.
 9. Male NPT thread for each compression fitting is shown below.
 - a. 1 inch PEX compression fitting has 1-inch male NPT thread.
 - b. 1-1/4 inch PEX compression fitting has 1-1/4 inch male NPT thread.
 - c. 1-1/2 inch PEX compression fitting has 1-1/2 inch male NPT thread.
 - d. 2 inch PEX compression fitting has 2 inch male NPT thread.
 - e. 2-1/2 inch PEX compression fitting has 2 inch male NPT thread.
 - f. 3 inch PEX compression fitting has 2-1/2 inch male NPT thread.
 - g. 3-1/2 inch PEX compression fitting has 3 inch male NPT thread.
 - h. 4 inch PEX compression fitting has 4 inch male NPT thread.
 10. All transition fittings connecting to the compression fittings will be manufactured of dezincification-resistant brass.

11. Pipe and Fitting Identification: The pipe shall be marked in accordance with the standards to which it is manufactured.
 - a. Color identification by the use of stripes on pipe to identify pipe service shall be optional. If used, stripes or colored exterior pipe product shall be blue for potable water, green for wastewater/sewage, or purple for reclaimed water.
 - b. Tracing wire shall be placed parallel and 18 inches above, but separate from, the pipe and shall be 10 AWG.
 - c. Marking tape shall be approved by the engineer and placed between 12 and 18 inches above the crown of the pipe.
12. Accessories: Use accessories associated with the installation of the piping system as recommended by or available from the manufacturer.
13. Insulation Kits: Insulation kits will be manufactured of ABS shells or HDPE sleeves, will feature equal thickness of closed-cell PEX insulation as the pipe, and sealed watertight.
14. Connection Vaults:
 - a. The piping manufacturer will provide the connection vaults when required by the project construction.
 - b. Connection vaults shall be constructed of rotationally molded composite polyethylene and PE foam, providing a structurally sound and thermally insulated chamber.
 - c. Heat shrink seals as provided by the tubing manufacturer shall be installed to prevent introduction of water into the vault.
15. Anchors: The project engineer will determine the use of anchors, if required, within the distribution system.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
 1. Manufacturers:
 - a. Date Y No. 10.
 - b. Dutton Nokorode No. 290.
 - c. Dutton Nokorode No. 292.
 - d. Kester No. 720.
 - e. LA-CO Flux-Rite 90.
 - f. Superior No. 142.
 - g. Superior No. 146.

- D. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

2.6 VALVES

- A. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Bronze, Calibrated-Orifice, Balancing Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Nexus Valves.
 - g. Taco.
- 2. Body: Bronze, ball, globe or plug type with calibrated orifice or venturi.
- 3. Ball: Brass or stainless steel.
- 4. Plug: Resin.
- 5. Seat: PTFE.
- 6. End Connections: Threaded or socket.
- 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
- 8. Handle Style: Lever, with memory stop to retain set position.
- 9. CWP Rating: Minimum 125 psig.
- 10. Maximum Operating Temperature: 250 deg F.

- C. Diaphragm-Operated Safety Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.

- e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
 3. Disc: Glass and carbon-filled PTFE.
 4. Seat: Brass.
 5. Stem Seals: EPDM O-rings.
 6. Diaphragm: EPT.
 7. Wetted, Internal Work Parts: Brass and rubber.
 8. Valve Seat and Stem: Noncorrosive.
 9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.7 AIR CONTROL DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amtrol, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
 4. Spirotherm.
 5. Taco.
- B. High Capacity Air Vent: Cast iron body with stainless steel, brass and EPDM interval components. Float actuated air vent designed to purge air from hydronic systems. Provide shutoff at pressures up to 150 psig at a maximum temperature of 250 deg F.
- C. Manual Air Vents:
 1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Screwdriver or thumbscrew.
 4. Inlet Connection: NPS 1/2.
 5. Discharge Connection: NPS 1/8.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.
- D. Bladder-Type Expansion Tanks:
 1. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
 2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
 3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg F.

2.8 CHEMICAL TREATMENT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. By-Pass Chemical Feeders:
 - a. Culligan USA.
 - b. J.L. Wingert.
 - c. John Wood.
 - d. Vulcan Laboratories, Subsidiary of Clow Corp.
 - e. Vector Industries.
 - f. Claypool Pump and Machinery.
2. Inhibited Glycol-Based Heat Transfer Fluids:
 - a. Dow Chemical Co. (systems without cast aluminum heat exchangers)
 - b. Huntsman. (systems without cast aluminum heat exchangers)
3. Industrial Grade Glycol:
 - a. Chemical Specialties.
 - b. Dow Chemical.
 - c. Huntsman.
 - d. Hubbard-Hall.
 - e. Hydrite Chemical Co.
 - f. Kost-USA.
 - g. MIL-SPEC Industries.
4. Glycol Feeder Assembly:
 - a. Advantage Controls.
 - b. Armstrong Pumps.
 - c. Axiom.
 - d. ExpanFlex.
 - e. Sage Industries, Inc.
 - f. Wessels.

B. Inhibited Propylene Glycol-Based Heat Transfer Fluids: Heat transfer fluid specifically designed for closed-loop HVAC systems, low toxicity, dyed to facilitate leak detection, and industrially inhibited. The inhibitor system shall be designed to protect brass, copper, solder, steel, cast iron and other metals commonly found in industrial cooling and heating systems. The fluid shall include phosphate and tolyltriazole inhibitors. Product shall be JEFFCOOL P150; DOWFROST-HD or approved equal.

1. Provide heat transfer fluid with propylene glycol concentration for burst protection to -40 deg F.
 2. When make-up water hardness is greater than 100 PPM the concentrate shall be mixed with distilled or deionized water to achieve proper burst protection.
 3. When levels of chlorides, sulfates, calcium, magnesium in make-up water are greater than 25 PPM each, the concentrate shall be mixed with distilled or deionized water to achieve proper burst protection.
- C. Industrial Grade Propylene or Ethylene Glycol: Industrial Propylene glycol mixed with water to obtain the specified burst protection. The approved chemical treatment supplier shall perform a chemical analysis to determine the make-up water characteristics and add proper inhibitors to protect brass, copper, solder, steel, cast iron, and other metals in the piping system. When levels of chlorides, sulfates, calcium, magnesium in make-up water are greater than 25 ppm each or the hardness of the water is greater than 100 ppm the industrial glycol solution and inhibitors shall be mixed with distilled or deionized water.
- D. Glycol Feeder Assembly: Provide a complete factory packaged automatically controlled antifreeze feeder assembly. Package shall be factory assembled and tested including 50 gal clear polyethylene tank, 115 volt, 1 phase positive displacement pump, controls, pressure switch, pressure relief valve, pressure gauge, tank drain valve, interconnecting piping and supporting legs and pads. Controls shall include "pump run" and "low level" colored lights, "push to test" and "alarm silence" buttons and an audible alarm. Assembly shall require only one 115V, 1 phase plug in power cord. The pressure switch shall detect a drop in hydronic system pressure which will activate pump to refill system from premixed glycol/water solution in tank. Assembly shall be Sage Industries Model WC-0202 or equal.
- E. Bypass Chemical Feeder: Welded steel construction; 125 psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

2.9 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
1. Manufacturers:
 - a. Armstrong Machine Works.
 - b. Guston Bacon.
 - c. Hoffman Specialty.
 - d. Metraflex Co.
 - e. Nexus Valves.
 - f. Nibco.
 - g. Spirax Sarco.
 - h. Tyco GRINNELL.
 - i. Victaulic Co. of America.
 - j. Watts Regulator Co.
 - k. Wheatley.

2. Bronze 3 inches and smaller:
 - a. Body: ASTM B584 or B62 bronze.
 - b. End Connections: Threaded or soldered ends.
 - c. Strainer Screen: 20 mesh type, 304 stainless steel or 0.033 inch perforated type 304 stainless steel screen.
 - d. CWP Rating: 125 psig.
3. Iron 3 inches and smaller:
 - a. Body: ASTM A126, Class B, Cast iron with bottom drain connection.
 - b. End Connections: Threaded.
 - c. Strainer screen: Stainless steel.
 - d. CWP Rating: 125 psig.
4. Iron 2-1/2 and larger:
 - a. Body: ASTM A126, Class B cast iron with bolted cover and bottom drain connection.
 - b. End Connections: Flanged or grooved end.
 - c. Strainer Screen: Stainless steel.
 - d. CWP Rating: 125 psig.
5. End Connections: Threaded ends for NPS 2 and smaller; flanged or grooved ends for NPS 2-1/2 and larger.
6. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
7. CWP Rating: 125 psig.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping and glycol piping, aboveground, NPS 2 and smaller, shall be one of the following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 3. Polypropylene pipe, "PP-R" or "PP-RCT" with socket, butt, or electro-fusion joints and fittings.
 4. PEX-a (Engle-method Crosslinked Polyethylene) piping with cold expansion or compression fittings.
- B. Hot-water heating piping and glycol piping, aboveground, NPS 2-1/2 and larger, shall be one of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 2. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints.
 3. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 4. Polypropylene pipe, "PP-R" or "PP-RCT" with socket, butt, or electro-fusion joints and fittings.
 5. PEX-a (Engle-method Crosslinked Polyethylene) piping with cold expansion or compression fittings.
- C. Hot-water heating piping and glycol piping, belowground, NPS 2-1/2 and larger, shall be the following:
1. Pre-insulated PEX Thermal Distribution System: PEX-a service tubing with insulation and HDPE jacket with cold expansion or compression fittings.
- D. Air-Vent Piping:
1. Inlet: Same as service where installed.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- E. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- C. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes and free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4ball valve, and short NPS 3/4threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. Install branch connections to mains with the branch connected to the bottom of the main pipe for down-feed risers and connect the branch to the top of the main pipe for up-feed risers.
- N. Install unions in piping, NPS 2and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- O. Install flanges in piping, NPS 2-1/2and larger, at final connections of equipment and elsewhere as indicated.
- P. Fire stopping shall be provided to both be compatible with the piping and meet the requirements of ASTM E 814 or ULC S115, "Fire Tests of Through-Penetration Firestops." Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
- Q. Below-grade Installation:
 - 1. Pre-insulated piping shall be installed in accordance with manufacturer's recommendations and the details as shown on the contract drawings.
 - 2. The system will be installed with the fewest number of underground joints as possible.
 - 3. The system does not require expansion loops, expansion joints or compensators of any type.
 - 4. An EPDM rubber end cap shall be applied at all terminations of the piping system, including all fitting locations, to form a watertight seal.
 - 5. All buried fittings will be installed, insulated and sealed in accordance with the piping manufacturer's instructions.
 - 6. Connection Vaults or Insulation Kits are required for all below-grade installations.

- R. Backfill:
1. The pre-insulated piping system will be backfilled with clean sand material.
 2. Minimum vertical distance from the bottom of the tubing to the trench floor is 4 inches (100 mm).
 3. Minimum lateral distance from the side of the tubing to the trench wall is 6 inches (150 mm).
 4. Install a minimum of 12 inches (300 mm) of clean fill over the top of the potable pre-insulated piping.
 5. The balance of the trench can be backfilled with native soil void of stone greater than 2 inches (50mm) in diameter.
- S. PEX-a Piping:
1. PEX-a Piping Hanger Spacing: Install hangers for PEX-a piping with the following maximum spacing:
 - a. 1 inch and below: Maximum span, 32 inches.
 - b. 1-1/2 inch and above: Maximum span, 48 inches.
 2. PEX-a Piping Hanger Spacing with PEX-a Support Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations, with the following maximum spacing:
 - a. Maximum span, 8 feet.
 3. PEX-a Riser Supports: Install CTS riser clamps at the base of each floor and at the top of every other floor. Install mid-story guides between each floor.
 4. Pipe Joint Connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for F1960 connections.

3.4 FIELD QUALITY CONTROL

- A. Site Tests: To ensure system integrity, pressure-test the tubing before and during backfilling of the piping. The service tubing will be air tested at 1 1/2 times the operating pressure for a minimum of 1 hour prior to system burial

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install the following pipe attachments:
1. Adjustable steel clevis hangers or adjustable band hangers for individual horizontal piping less than 20 feetlong.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feeter longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feeter longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.

5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10 foot intervals between floors.

3.6 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly. A factory trained field representative shall provide on-site training for the Contractor's field personnel engaged in the operation and installation of pressure-sealed-joints. Upon completion of this training the installing Contractor must submit documentation, which includes those in attendance, from the grooved products manufacturer to CTA. The factory trained representative shall periodically visit the jobsite, review the product installation and provide additional training if new manpower has been assigned to pressure-sealed-joint piping installation. Contractor shall remove and replace any improperly installed products.

3.7 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- D. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.8 CHEMICAL TREATMENT

- A. Utilize a water-treatment specialist with a minimum of 5 years of experience in water chemical treatment to perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
 - 1. pH: 9.0 to 10.5.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.

4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
 5. Corrosion Inhibitor as recommended by the chemical treatment supplier.
- B. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- C. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- D. Fill systems indicated to have antifreeze or glycol solutions to provide burst or freeze protection to following outdoor air temperatures.
1. Hot-Water Heating Piping: Freeze protection to -40 deg F.
- E. Freeze/burst protected piping systems filled with required percentage of glycol shall be mixed with distilled or deionized water as recommended by the approved glycol manufacturer.

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare type-written report of testing. Include report in O&M manuals.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Compact in-line circulators.
 - 2. Close-coupled, in-line centrifugal pumps.

1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. 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.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COMPACT IN-LINE CIRCULATORS

- A. Manufacturers:
1. Armstrong Pumps Inc.
 2. Bell & Gossett; Div. of ITT Industries.
 3. Grundfos Pumps.
 4. Taco, Inc.
 5. Wilo USA LLC.
- B. Description: Water cooled, horizontal, in-line, compact design, seal-less, centrifugal, and single stage. Include pump and motor assembled on a common shaft in hermetically sealed unit, without stuffing boxes or mechanical seals. Include lubrication of sleeve bearing and cooling of motor by circulating pumped liquid through motor section, and isolation of motor section from motor-stator windings by corrosion-resistant, nonmagnetic, alloy liner. Include design rated for 125 psig minimum working pressure and a continuous water temperature of 225 deg F.
1. Casing: Cast bronze or cast iron, with stainless-steel liner, static o-ring seal to separate motor section from motor stator, and flanged piping connections.
 2. Impeller: Overhung, single suction, closed or open, nonmetallic.
 3. Shaft and Sleeve: Stainless-steel shaft with carbon-steel sleeve.
 4. Motor: Single speed.
 5. Motor: Variable speed for use with load match hydronic systems.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
1. Armstrong Pumps Inc.
 2. Aurora Pump; Division of Pentair Pump Group.
 3. Bell & Gossett; Div. of ITT Industries.
 4. Grundfos Pumps.
 5. PACO Pumps.
 6. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 250 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

- F. Install electrical connections for power, controls, and devices.
- G. Ground equipment according to Division 26.
- H. Connect wiring according to Division 26.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232123

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Listed double-wall vents.

1.2 SUBMITTALS

A. Product Data: Manufacturers literature with material gages, product listing and furnished accessories.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cleaver-Brooks; Div. of Aqua-Chem Inc.
 - b. Hart & Cooley, Inc.
 - c. Heat-Fab, Inc.
 - d. Metal-Fab, Inc.
 - e. Schebler Co. (The).
 - f. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
 - g. Simpson Dura-Vent Co., Inc.; Subsidiary of Simpson Manufacturing Co.

2.2 LISTED TYPE B AND BW VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- C. Inner Shell: Aluminum alloy or stainless steel.
- D. Outer Jacket: Galvanized or aluminized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 2. Termination: Antibackdraft.

2.3 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

- A. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1 inch annular space filled with high-temperature, ceramic-fiber insulation.
- C. Inner Shell: ASTM A 666, Type 304 stainless steel.
- D. Inner Shell: ASTM A 666, Type 304 stainless steel.
- E. Outer Jacket: Galvanized or aluminized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Round chimney top designed to exclude 98 percent of rainfall.

2.4 GUYING AND BRACING MATERIALS

- A. Cable: Three galvanized, stranded wires of a size determined by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

3.2 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 235250 – WOOD BOILER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The owner has purchased a wood boiler system from Biomass Systems Supply, Chico, California. The contact person for the boiler system is:

Dave Schmucker
Biomass Systems Supply
P.O. Box 1835
Chico, CA 95927
Toll Free: 877.474.5521
O: 530.893.2444
F: 530.893.2244
C: 530.228.2442
E: dave@biomasssystemssupply.co
www.BiomassSystemsSupply.com

- B. The boiler is expected to be delivered to Craig, Alaska by March, 2023. The owner will coordinate receipt of and storage of the equipment when it arrives in Craig. The contractor shall coordinate with the owner delivery of the boiler system to the project site when the project begins. The owner will deliver the boiler system to the project site.
- C. The contractor shall install all the boiler system equipment and components per the manufacturer's installation instructions to provide a complete and operational system. Information on the boiler equipment and components are located in Part 2 and in layout drawings included in the construction documents.
- D. Biomass Systems Supply will be on site to coordinate final assembly of the boiler system components. Biomass Systems Supply will perform start up checks and will perform system start up and operation testing. Biomass Systems Supply will provide owner training of the system.
- E. The boiler system includes a packaged, factory-fabricated and assembled boiler, trim, and accessories for generating hot water from burning wood chips. Boiler includes heat exchanger and burner tube.
- F. The boiler system includes factory-fabricated walking floor scraper system, collection augers, lift auger, metering bin and stoker auger.

1.2 WARRANTY

- A. Biomass Systems Supply will provide the equipment warranty.
- B. The contractor shall warranty any components provided by the contractor as part of the assembly.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Twin Heat furnished by Biomass Systems Supply, Chico, CA

2.2 BOILER

- A. Description: Factory-fabricated, assembled, and tested, steel flame-tube boilers with heat exchanger sealed pressure tight, built on a steel base plate; including insulated jacket, flue-gas vent, water supply and return connections, and controls.
 - 1. Twin Heat Boiler System Model CS 150i
- B. Burner: Welded steel construction, with primary air plate ports and bottom screw conveyor feed for wood chip fuel. Mounted to boiler side, fastened with lugs and nuts.
- C. Combustion Blower: Variable speed centrifugal fan integral to burner, directly driven by motor, with fixed primary, secondary air ratio plenum.
- D. Fuel Supply: Direct mounted gear motor and auger, with modulated, on-off control sequence. Fed through air-tight fire valve.
- E. Flue Gas Fan: Variable speed centrifugal fan integral to smoke box, directly driven motor, controlled via PID, using feedback from manometer.
- F. Water cooled burner tube pump, pressure switch, and accessories.
- G. Emergency burner tube cooling back up connection with connection to domestic water.
- H. Stoker sprinkler head for burn back prevention.
- I. RTD Controllers.
- J. Operating controls.
 - 1. Electric factory-installed panel to control burner firing rate to maintain boiler set temperature.
- K. Drain Valve: 1/2-inch diameter.
- L. 100 Liter atmospheric expansion tank.

- M. Shunt 3-way boiler protection valve and valve controller.
- N. Brazed plate heat exchanger for use between open boiler system and glycol loop to school.
- O. Smoke box pipe and insulation.
- P. All fuel stack with support stand.

2.3 ASH HANDLING

- A. Flame Tube Cleaning Mechanism: Cam driven cleaning mechanism provides vertical oscillation of stainless steel spiral turbulators, twice daily.
- B. Burner Plate Cleaning Mechanism: Steel burner scraper plate oscillated with steel rod eccentrically driven with dedicated motor, ash removal system controlled.
- C. Ash Screw-Auger:
 - 1. Screw-auger and hardened steel ash wiper direct drive with shaded pole motor.
 - 2. Shaft rotation monitor invokes boiler shutdown when ash box full, after showing requirement to empty for 6 burner hours.
 - 3. Controlled by ash removal system logic.
- D. Ash Bin: Detachable external compressed ash storage, fed by screw conveyor.

2.4 WOOD HANDLING EQUIPMENT

- A. Hydraulic walking floor scraper system. Components shall be heavy duty to accommodate 15 feet of wood chips on top.
- B. Collection Auger. To lift wood chips to metering bin.
- C. Air-tight spring loaded valve between burner and day bin for burnback fire prevention controlled by boiler to automatically close before vacuum fills day bin or during power loss.

2.5 ELECTRICAL POWER

- A. Field Power Available to boiler: 208 VAC, 3 Phase, 16 Amps.
- B. Power connections at boiler and at hydraulic floor system. Each power connection is 380 VAC, 3 Phase.
- C. A step up transformer is provided to provide 380 VAC to the boiler and hydraulic floor system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation examine locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
- B. Determine exact locations before roughing-in for piping and electrical connections.
- C. Install boilers on a flat level base on a non-combustible floor or shielding. The floor must comply with NFPA 31.
- D. Examine mechanical spaces for suitable conditions where boilers will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Before wood fuel handling delivery system installation, examine boiler and storage location to verify actual lengths, locations, and orientations affecting connection of the wood chip delivery system.

3.2 BOILER INSTALLATION

- A. Consult all provided installation manuals and factory training programs prior to installation.
- B. Install boilers according to NFPA 31.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with the boiler but not specified to be factory mounted.

3.3 WOOD CHIP DELIVERY SYSTEM INSTALLATION AND ASSEMBLY

- A. Consult all installation manuals and factory training prior to install.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Allow for removable boiler casing do not attach non-removable connections to the sheet metal boiler jacket.
- C. Install piping adjacent to boiler to allow service and maintenance.
- D. Connect wood chip delivery system to burner.
- E. Connect hot-water piping to supply and return boiler tapings with shutoff valve and union and flange at each connection.

- F. Connect boiler flue gas to chimney.
- G. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- H. Install piping adjacent to machine to allow service and maintenance.
- I. Ground equipment according to Division 26.
- J. Connect wiring according to Division 26.

3.2 DEMONSTRATION

- A. Biomass Systems Supply will provide a factory trained technician to train Owner's maintenance personnel to adjust, operate, and maintain boilers and fuel handling system.

END OF SECTION 235250

SECTION 235700 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes plate heat exchangers.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, pressure drops, weights, furnished specialties, accessories, and installation instructions.
- B. Operation and Maintenance Data: For heat exchangers to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 BRAZED PLATE HEAT EXCHANGERS

- A. Manufacturers:
 - 1. Alfa Laval Thermal, Inc.
 - 2. Armstrong Pumps, Inc.

3. ITT Industries; Bell & Gossett.
 4. Kelvin, GEA.
 5. Taco, Inc.
-
- B. Configuration: Brazed assembly consisting of two end plates, one with threaded nozzles and pattern-embossed plates.
 - C. End-Plate Material: Type 316 stainless steel.
 - D. Threaded Nozzles: Type 316 stainless steel.
 - E. Plate Material: Type 316 stainless steel.
 - F. Brazing Material: Copper or nickel.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

- A. Install heat exchangers according to manufacturer's written instructions.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other related Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.
- C. Install shutoff valves at heat-exchanger inlet and outlet connections.

3.3 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

END OF SECTION 235700

SECTION 238239.16 – PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include details of anchorages and attachments to structure and to supported equipment.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek company.
 - 2. CCI Thermal Technologies, Inc.

3. Engineered Air.
4. Rosemex Products.
5. Trane.
6. Reznor.

2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.
- D. Comply with UL 823.

2.3 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.4 COILS

- A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- C. Hot-Water Coil: Steel tube, minimum 0.049-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 400 psig and a maximum entering-water temperature of 450 deg F, with manual air vent. Test for leaks to 600 psig underwater.

2.5 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, multispeed or 2-speed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Ground equipment according to Division 26.
- F. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

DIVISION 26 - ELECTRICAL

SCOPE

The provisions, terms and requirements of Division 1 and 2, the applicable Drawings and Technical Specifications herein shall apply to work under this Division.

This Work consists of, but is not necessarily limited to, the furnishing of all labor, equipment, appliances and materials and the performance of all operations in connection with the installation of all electrical work completed, in strict accordance with Specifications and/or Drawings, applicable codes, including incidental materials necessary and required for their completion.

"PROVIDE" = Furnished and installed complete. "OR EQUAL" = Or equal as approved to quote by Engineer, 10 days prior to Bid.

260000 - COMMON WORK RESULTS

- A. Intent of Drawings: Drawings are partly diagrammatic and do not show exact location of conduit unless specifically dimensioned.
- B. Workmanship:
 - 1. Work shall be accomplished by workmen skilled in particular trade, in conformance with best practices and accepted standards.
 - 2. Work shall contribute to efficiency of operation, accessibility, maintenance and appearance. No part of installation shall interfere with operation of any other system or part of building.
 - 3. Non-satisfactory work shall be corrected at no additional expense to Owner.
- C. Responsibility:
 - 1. The Electrical Contractor is responsible for installation of satisfactory and complete work in accordance with the intent of Drawings and Specifications. Provide, at no extra cost, incidental items required for completion of work even though not specifically mentioned or indicated in Specifications or on Drawings.
 - 2. If, at any time, and in any case, change in location of conduit, outlets, fixtures, switches, panels, electrical equipment or associated components, etc., becomes necessary due to obstacles or installation of other trades, such required changes shall be made by Contractor at no extra cost.
 - 3. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision. Do not proceed with installation in area of question until conflict has been fully resolved.
 - 4. Coordinate all electrical work with other trades to prevent unnecessary delays in the construction schedule.
 - 5. Excavation and backfill required by electrical installations shall be accomplished in accordance with Division 2 by this Contractor.
 - 6. Provide temporary electrical power and lighting for all trades that require service during the course of this Project. Provide temporary service and distribution as required. Comply with the NFPA 70 and OSHA requirements. (Energy costs by General Contractor.)

- D. Guarantee-Warranty: This Contractor shall and hereby does warrant and guarantee:
1. That all work executed under this Section will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of this work.
 2. The Contractor agrees to, at the Contractor's own expense, repair and replace all such defective materials and work and all other work damaged thereby which becomes defective during the term of warranty. Agreement does not include damages done by Owner.
- E. Permits, Tests, Codes and Standards:
1. Electrical Contractor to pay for all permits and fees in connection with this work.
 2. WORK SHALL BE IN ACCORDANCE WITH THE MOST RECENT EDITIONS OF ADOPTED LOCAL, STATE AND NATIONAL CODES AND ORDINANCES, THE STATE FIRE MARSHAL, AND UTILITY COMPANY REGULATIONS.
 3. Electrical work shall conform to National Electrical Codes, latest editions, as a minimum requirement.
 4. All material to conform with applicable standards.
- F. Discrepancies: Prior to submitting Bid, Contractor shall refer any apparent discrepancies or omissions to engineer for clarification.
- G. Prior Approvals: All proposed substitutions shall be received by the Engineer **10 days prior to Bid. Priors received after 3 p.m. of the 10th day will be rejected.** Supply technical data, photometrics and dimensional Drawings showing that substitutes are equal to product specified.
- H. Shop Drawing Submittals:
1. In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," submit Electronic Drawings in pdf format for final and official approval through the General Contractor as listed below.
- Additional copies may be required by individual Sections of these Specifications. Copies of price list sheets are not acceptable. Manufacturer's name and address must appear on each sheet. All copies shall be legible.
- Shop Drawings shall include a completed specification sheet of all equipment along with fabrication, installation drawings, setting diagrams, schedules, patterns, templates and similar Drawings.
- I. Project Close-Out Record Documents:
1. Provide three full size sets, unless more are called for under Division 1 (one for Engineer and one for Owner). In addition to requirements called for under Division 1, indicate the following installed conditions:
 - a. Actual location of all electrical service gear/feeders, panel/motor/special equipment feeders, all major underground or underslab conduits, all conduit stubs for future use, any change in branch circuitry from Drawings, key junction boxes and pull boxes not indicated on Drawings, any control locations or indicator lights not shown on Drawings.

- b. Addendum items, change order items and all changes made to Drawings from Bidding phase through to Project completion.
- c. Actual equipment and materials installed. Where manufacturer and catalog number are indicated on Drawings, generally or in fixture or equipment schedules, change to reflect actual products installed.
- d. Change service panel and branch panel breaker locations and schedules to reflect actual installed conditions.

J. Project Close-out Maintenance Manuals:

- 1. Prepare 3 copies, unless more are called for under Division 1 (one for Engineer, two for Owner). In addition to requirements under Division 1, provide heavy duty, durable 3-ring vinyl covered loose-leaf binder for each manual sized to receive 8.5 inch by 11 inch paper. Provide a clear plastic sleeve on the spine to hold labels and pockets in the cover to receive folded sheets. In manual, include all Shop Drawings, installation/operation/maintenance data furnished with electrical equipment, voice/data test reports, and letters from manufacturer's representatives that the fire alarm, has been completed and tested to satisfy requirements/codes. List project name, date, and Contractor's name, address and telephone number. Include index sheet for each Specification Section indicating equipment, with supplier and supplier's telephone number. Provide tabbed dividers indicating major groupings of equipment.
- 2. Turn over to Owner all spare equipment and devices specified and shown.

K. Supporting Equipment:

- 1. Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a power charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws. All device boxes in sheetrock walls will be tight before, during and after installation of sheetrock.
- 2. Provide supports for electrical items in accordance with NFPA 70 and all other applicable codes.
- 3. Contractor responsible for providing watertight conduit penetrations at all watertight walls, floors roofs and membranes. Contractor also responsible to maintain fire rating of walls, floors, roofs and membranes penetrated.
- 4. When applicable, center within insulation any electrical conduit routed in attic space. Provide sealing as per NFPA 70 300-7 for all conduits exposed to different temperatures.

L. Electrical Identification:

- 1. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor starters, panelboards and main control panel and similar systems.
- 2. Identify all 120 VAC and 208 VAC power receptacle cover plates with panel and circuit number utilizing a clear label with black designations. Designation example: L1-38.

3. Identify underground exterior electrical circuits by installation of continuous underground plastic marker, 6 - 8 inches below grade.

260300 - REMODEL WORK

- A. The Contractor shall carefully examine the Drawings and Specifications, visit the project site, and make note of all existing conditions, dimensions and limitations prior to Bid and make allowances thereto.
- B. No Change Orders will be issued for Contractor's failure to visit site, remodel work necessary for a complete installation of systems shown, and due to Contractor's lack of understanding of amount or difficulty of work involved.
- C. The Contractor shall also notify all corporations, companies, individuals or local authorities owning, or having jurisdiction over existing utilities and services which interfere in any manner with the execution of the work under this Contract, and shall remove, relocate or protect such utilities or equipment as required by the parties having jurisdiction over same.
- D. If existing active or nonactive services (which may not be shown on plans) are encountered that require relocation or disconnecting, the Electrical Contractor shall make written request for decision on proper handling of the services. The Electrical Contractor shall not proceed with the work until so authorized by the Architect.
- E. When areas of the existing buildings are adjacent to the area of construction in which work is going on and are occupied, then this Contractor shall arrange the work so as to reduce to a minimum the periods of interruption or outages in the various services.
- F. Not less than one week before any system is to be put out of service, the Contractor shall notify and coordinate with other trades and the Owner of such necessity including the extent of the work to be done during the outage, possible length of time required for that phase of the work, and the desired time at which the outage is to begin.
- G. Balance additional loads to existing circuitry between phases. Furnish a revised, typed panel directory on existing panelboards where loads have been added or changed on this project.
- H. Carefully lay out all work in advance to minimize cutting, channeling or drilling. Where necessary, all cutting and patching shall be done in a manner approved by the Architect. Do not endanger the stability of the structure. Restore any damaged surfaces to original conditions. Contractor at fault to assume all costs.
- I. Remove or relocate existing conduits, wires, equipment, devices or fixtures indicated on Drawings and as required by remodel operations. Where the reuse of existing conduits, wires, devices, or fixture is permitted, verify that wiring is continuous. Existing outlets or junction boxes shall not be rendered inaccessible by structural changes made to the building.
- J. Where existing walls are being furred out or refinished, extend existing outlets and devices to new surface as required.

- K. Existing equipment which is indicated as being removed and not indicated for re-use shall be disposed of unless stated otherwise. Light fixture ballasts may contain PCB's and shall be disposed of according to environmental regulations.

260519 - CONDUCTORS AND CABLES

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Feeders: Copper THHN-THWN. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper THHN-THWN. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Multiconductor Cable: Copper Type AC and Type MC with separate insulated ground wire.
- E. Aluminum conductors are not acceptable.
- F. Conductor Insulation: Comply with NEMA WC 70 for types THHN-THWN. Utilize other types of insulation only where specifically noted or required by code for the installed condition.
- G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening valves or as specified in UL Codes.
- H. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208y/120 Volts</u>	<u>Phase</u>
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground

260526 - GROUNDING AND BONDING

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Install separate insulated equipment grounding conductors for feeder and branch circuits in compliance with NFPA 70 Article 250.
- C. additional grounding requirements and comply with NFPA 70 and all other applicable codes/standards.

260533 - RACEWAYS AND BOXES

- A. Submit Shop Drawings in accordance with the "Common Work Results" section.
- B. Conduit Raceway:

1. Indoors, use the following, unless otherwise stated:
 - a. Concealed: EMT or MC cable.
 - b. Exposed: EMT, IMC or RMC.
 - c. Connection to vibrating equipment: Flexible metal conduit.
 2. Outdoors, use the following, unless otherwise stated:
 - a. Concealed: RMC or IMC.
 - b. Exposed: RMC or IMC.
 - c. Underground: Schedule 40 PVC with Schedule 80 PVC fittings.
 - d. Connection to Vibrating Equipment: Liquid tight flexible metal conduit.
 3. **ENT IS NOT ALLOWED.**
 4. Conceal conduit and cable, unless otherwise noted; conduit is permitted to be exposed in equipment rooms. All conduits shall have insulated ground wire installed. Do not install conduit embedded in slabs. EMT fittings shall be steel, compression or set screw type. All raceways shall be installed and supported in accordance with NFPA 70 and applicable codes.
- C. Outlet Boxes:
1. Conform to UL 514A, "Metallic Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Outlet boxes shall be metallic and installed flush in all areas, except mechanical rooms, above lay-in ceilings, or as otherwise indicated. Minimum size to be 4 inches square by 2-1/8 inches deep. Boxes shall be of type, shape, size and depth to suit each location and application. All fittings shall be steel.
- D. Pull and Junction Boxes:
1. Comply with UL 50, "Electrical Cabinets and Boxes," for boxes over 100 cubic inches volume. Boxes shall have screwed or bolt-on covers, shall be suitable for the intended application and shall be labeled.
- E. All materials shall be UL listed, appropriate for intended application. Entire raceway system shall be in accordance with NFPA 70, ANSI, NEMA, UL, and all other applicable codes.

262716 - SERVICE ENTRANCE

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Install service-entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NFPA 70, UL, ANSI, IEEE, and NEMA standards.
- C. Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A, and the NFPA 70.

262416 - PANELBOARDS

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Manufacturer: Siemens, Square-D, GE or Cutler Hammer.
- C. Load centers are not acceptable unless specifically noted.
- D. Branch Panelboards shall have aluminum bus including neutral and ground bars. Breakers shall be bolt on type. All 3-pole breakers 50 amp and larger shall have minimum feature of a thermal magnetic adjustment. Features: Provide hinged front cover and hinged door (door in door) and feed through lugs. If indicated on the Panel Schedule, provide internal SPD with a 120 kA per phase surge rating and protect L-N, L-G and N-G modes; include status indicator.
- E. Distribution Panelboards shall have aluminum bus including neutral and ground bars. Breakers shall be bolt on type for 125A and smaller. Breakers larger than 125A shall be bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal. All 3-pole breakers 50 amp and larger shall have minimum feature of a thermal magnetic adjustment. Breakers with 1200 amp frame or larger shall be equipment with an Arc Flash Energy-reducing maintenance switching with local status indicator. Provide hinged front cover and hinged door (door in door). If indicated on the Panel Schedule, provide internal SPD with a 120 kA per phase surge rating and protect L-N, L-G and N-G modes; include status indicator.
- F. Provide typed circuit schedules for existing panelboards where loads have changed and framed, typed circuit schedules for all new panelboards with identification of items controlled by each individual breaker. Indicate room numbers of items controlled or room name where appropriate for Owner's convenience.

262726 - WIRING DEVICES

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Acceptable Manufacturers: Pass & Seymore, Bryant, GE, Hubbell, Leviton.
- C. Devices:
 - 1. General light switches shall be 20 amp, 120/277 volt AC rated and **Industrial Grade**.
 - 2. General receptacles shall be self grounding 5-20R and **Industrial Grade**. GFCI receptacles shall be 20 amp feed through type with two utilization points. Do not connect downstream devices to load side of GFCI.
 - 3. General device color shall be **white**.
- D. Device Plates:
 - 1. Device plates shall have opening for device intended and shall be **Lexan**. General device color shall be **white**.
 - 2. All device plates shall have a clear label with the panel and circuit number designation in black.

3. Weatherproof receptacle covers shall be a corrosion resistant die cast metal, minimum 3 inch deep, flip cover with latch and with pad locking provisions.

262813 - OVER CURRENT PROTECTION DEVICES

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Fuses:
 1. Motor or combination motor/branch circuit: UL listed RK-5.
 2. Feeder Loads: UL listed RK-1.
 3. Plug fuses shall be dual element Type S with adapter.
 4. Manufacturer: Bussman, Gould, Littlefuse or Brush.

262816 - CIRCUIT AND MOTOR DISCONNECTS

- A. Submit Shop Drawings in accordance with the "Common Work Results for Electrical" Section.
- B. Manufacturer: Same as panelboard manufacturer.
- C. Disconnects shall be heavy duty type with Class R rejection feature when required to be fusible. Voltage rating shall be at or greater than the application voltage. Provide NEMA 3R enclosure for exterior locations. Service switches shall be UL listed for use as service equipment.

262913 - MOTOR CONTROLLERS

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.
- B. Manufacturer: Same as panelboard manufacturer.
- C. Unless scheduled otherwise, 3/4 horsepower or less single-phase motors shall have 1 HP rated manual toggle starters with thermal overload protection sized for the motor in accordance with NFPA 70. Provide pilot light for manual starters not in sight from motor. Units located at the exterior of the building shall be NEMA 3R rated.
- D. Starters shall be across-the-line magnetic type, combination starter/disconnect, FVNR, and HP rated, unless otherwise scheduled. Starter shall have solid state adjustable and resetable overload protection on all phases, constructed of one-piece Class 20 construction. Provide 120 volt control, H-O-A and interlocks where indicated on schedules. Provide two N/O auxiliary contacts. Units located at the building exterior shall be NEMA 3R rated.
- E. All motor controllers shall be UL listed and installed in accordance with NFPA 70, NEMA, and manufacturer's recommendations.

265100 - LIGHTING

- A. Submit Shop Drawings in accordance with the "Common Work Results" Section.

- B. Manufacturer, model, style, color, size, etc., as scheduled. If no color has been selected, provide fixture with the standard finish as published by the manufacturer. All fixtures to be supplied as complete, housing, sockets, lamp holders, internal working, wire guards, lens guards, diffusing materials or lenses, pendants, hangers, canopies, aligners, end caps, ballasts and emergency battery packs, plaster frames, recessing boxes, hold down clips, anchor bolts, etc. Install plumb and true, free of light leaks, warps, dents and other irregularities.
- C. Support for Suspended Fixtures: Brace pendants and rods over 48 inches long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
- D. Surface-mounted light fixtures attached to a ceiling grid shall be attached with positive clamping devices that completely surround the supporting members. Safety wires shall be attached between the clamping device and the adjacent ceiling hanger or to the structure above.
- E. LED Modules:
 - 1. Comply with ANSI C78.377, UL 8750, IES LM-79 and IES LM-80.
 - 2. CRI minimum of 80 or as scheduled.
 - 3. Efficiency: 100 Lumens per watt minimum for downlights and 90 lumens minimum per watt minimum for other fixture types or as schedule on the drawings.
 - 4. Rated life of minimum 50,000 hours minimum or as scheduled.
 - 5. Fully serviceable and upgradable Light Engine.
 - 6. Warranty: 3-year minimum for all fixture components.
- F. LED Drivers:
 - 1. LED Driver/Power Supply: Integral high efficiency driver with power supply of 120V-277v input 60HZ. Power factor greater than 0.9 at full load. Drive current at 1000ma maximum. Class 2 power supply. Dimming utilizing 0-10V dimming control. Provide continuous flicker free dimming from 100 percent to 10 percent. The driver shall be capable of being serviced through the aperature for downlight applications.
 - 2. Warranty: 3-year minimum for all fixture components.