

**SECTION 232113
HYDRONIC PIPING****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

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

1.02 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled-water piping.
 - 3. Makeup-water piping.
 - 4. Condensate-drain piping.
 - 5. Blowdown-drain piping.
 - 6. Air-vent piping.
 - 7. Safety valve inlet and outlet piping.
 - 8. Feed & Fill Equipment / Bypass Chemical Feeders
 - 9. Valves
 - 10. Air Control Devices and Equipment
 - 11. Hydronic Filtration Equipment
 - 12. Coil Kits / Koil-Kits & Components
- B. Related Sections include the following:
 - 1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.03 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air control devices.
 - 3. Hydronic specialties.
 - 4. Bypass Chemical Feeders
- B. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.04 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 1.

1.05 EXTRA MATERIALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.06 PERFORMANCE REQUIREMENTS

- A. Definitions:
 - 1. TDS: Total dissolved solids
 - 2. TSS: Total suspended solids
- B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- D. Closed hydronic systems, including heating, hot-water, chilled water, and glycol hot water heating, shall have the following water qualities:
 - 1. pH: Maintain a value within 9.0 to 10.5.
 - 2. ATP Total Biological Reading: Maintain a maximum value of 100RLUs
 - 3. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 4. Boron: Maintain a value within 100 to 200 ppm.
 - 5. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - 6. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - 7. Soluble Iron: Maintain a maximum value of 0.30 ppm
 - 8. TDS: Maintain a maximum value of 3500 ppm.
 - 9. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - 10. Initially, Nitrite levels need to be between 700-1200 ppm to develop a film on the seal, then the Nitrite level would be allowed to drop to 700-1000ppm for everyday use.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot water heating system routing through and serving connected equipment, coils, terminal devices, and heat exchangers in basement and floors 1-13.
 - a. Maximum Pressure: 125psi
 - b. Maximum Temperature 200°F
 - 2. Hot water heating system on load/cold/exchange side of Heat Exchangers, routing from basement up to and serving connected equipment, coils, and other terminal heating equipment and domestic hot water heat exchanger on floors 13-35 and the mechanical penthouse areas.
 - a. Maximum Pressure: 250psi
 - b. Maximum Temperature 200°F
 - 3. Glycol water heating systems in penthouse and basement.
 - a. Maximum Pressure: 125psi
 - b. Maximum Temperature 200°F
 - 4. Makeup-Water Piping: 150 psig 73 deg
 - 5. Air-Vent Piping: 180 deg F
 - 6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company, -
 - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube-or ASTM B 152 wrought copper, or ASTM B 584 cast bronze, with copper tubing sized grooved ends designed to accept

- Victaulic couplings. Flaring of tube and fitting ends to IPS dimensions is not permitted.
3. Grooved-End Copper Couplings: Two ASTM A536 ductile iron housings cast with offsetting, angle-pattern bolt pads, coated with copper-colored alkyd enamel. Gasket shall be pressure-responsive grade EHP, suitable for operating temperatures to +250 deg F, secured together with plated steel bolts and nuts. Couplings will be Installation-Ready, for direct stab installation without field disassembly, and manufactured to connect copper tubing sized tube and fittings. Victaulic Style 607.
 4. Grooved-End Copper Flange Adapters: ASTM A536 ductile iron casting coated with copper-colored enamel, flat faced, for engaging into roll grooved copper tube and fittings and bolting directly to flanges with ANSI Class 125 and 150 bolt hole patterns. Victaulic Style 641.
 5. Grooved-End Copper Mechanical-T®: (C83600 85-5-5-5) cast bronze upper housing with female threaded NPT outlet and locating collar, ductile iron (ASTM A536) lower housing coated with copper-colored enamel and synthetic rubber gasket. Victaulic Style 622.
- C. Wrought-Copper Unions: ASME B16.22.

2.03 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. Grooved Mechanical-Joint Fittings and Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company. -
 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron;-or ASTM A 53/A 53M, Type F, E, or S, Grade B forged or factory-fabricated steel fittings with grooves or shoulders constructed to accept Victaulic standard or AGS "W" series grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 3. Standard Couplings NPS 2 to NPS 12: Ductile-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9.
 - 1) 2" through 8" Sizes: Victaulic Style 107 (Quick-Vic™) installation ready rigid coupling designed for direct "stab" installation onto grooved end piping without prior disassembly of the coupling. Gasket shall be Grade "EHP" EPDM compound with red color code for water services from -30 deg F to 250 deg F.
 - 2) Victaulic Style 07 (Zero-Flex®) standard rigid coupling. Gasket shall be Grade "E" EPDM compound with green color code for water services from -30 deg F to 230 deg F.

- b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Installation-Ready Style 177, or Style 75 and 77.
 - c. Flange Adapters: Ductile iron casting, flat faced, for incorporating flanged components with ANSI Class 125, 150, and 300 bolt-hole patterns to a grooved piping system. Victaulic Style 741 or 743.
4. AGS Couplings NPS 14 to NPS 24: ASTM A536 ductile-iron housing segments cast with wedge-shaped AGS key profile, lead-in chamfer and flat bolt pads for metal-to-metal contact. Gaskets shall be wide-width, pressure-responsive synthetic rubber of a FlushSeal® design (Grade “E” EPDM for water systems to 230°F), and zinc-plated steel bolts and nuts.
- a. Rigid Type: Victaulic Style W07, provides system rigidity and support and hanging in accordance with ASME B31.1 and B31.9.
 - b. Flexible Type: Victaulic Style W77, allows for linear and angular movement, vibration attenuation and stress relief.
 - c. Flange Adapters: Ductile iron casting, flat faced, for incorporating flanged components with ANSI Class 150 bolt-hole pattern to a grooved piping system. Victaulic Style W741.
- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.04 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. Grooved Joint Lubricants: Lubricate gaskets in accordance with the manufacturer’s recommendations with lubricant supplied by the coupling manufacturer that is suitable for the gasket elastomer and system media. Victaulic ‘Vic-Lube’.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BA9-1, silver alloy for joining copper with bronze or steel.
- F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.05 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 Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

- D. Dielectric Nipples: Electroplated steel or ductile iron nipple with inert and noncorrosive, thermoplastic lining, plain, threaded, or grooved ends.
 1. Manufacturer: Perfection Corporation; a subsidiary of American Meter Company, or Victaulic Style 47
 2. MWP @ 230°F: 300psig

2.06 VALVES

- A. Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett
 - b. Flow Design Inc.
 - c. Pro Hydronics
 - d. Victaulic
 2. Body: Bronze, ball or plug type with calibrated venture or Ametal brass, y-pattern globe type.
 3. Ball: Brass or stainless steel.
 4. Plug: Resin.
 5. Seat: PTFE or Ametal.
 6. End Connections: Threaded, socket, or soldered.
 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 8. Handle Style: Lever or 4-turn digital readout handwheel type, with memory stop to retain set position.
 9. CWP Rating: Minimum as noted on plans or by system
 10. Maximum Operating Temperature: 250 deg F.
 11. Union: Integral
 12. Provide probe port extensions for balancing valves installed in insulated piping. Extension lengths shall allow threaded port cap to clear surface of insulation.
- D. Cast-Iron, Ductile Iron or Steel, Calibrated-Orifice, Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tour & Anderson Series 788 or 789; available through Victaulic Company of America.
 - b. Victaulic
 - c. Armstrong Pumps, Inc.
 - d. Bell & Gossett Domestic Pump; a division of ITT Industries.
 2. Body: Cast-iron, ductile iron, or steel body, globe type.
 3. Ball: Brass or stainless steel.
 4. Stem Seals: EPDM O-rings.
 5. Disc: Glass and carbon-filled PTFE.
 6. Seat: PTFE.
 7. End Connections: Flanged or grooved.
 8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 9. Handle Style: Lever, or 8-, 12-, or 16-turn digital readout handwheel with memory stop to retain set position.
 10. CWP Rating: matching system
 11. Maximum Operating Temperature: 250 deg F (flanged) or 230deg (grooved).
- E. 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. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. 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.

2.07 COIL KITS (KOIL-KIT)

- A. Manufactures: Subject to compliance with requirements, provide products by one of the following. All components shall be provided by one manufacturer.
 1. Victaulic Koil-Kit (Basis of Design)
 2. Bell & Gossett
 3. Pro Hydronics
- B. General Requirements: Applicable to all components
 1. Max Temp Rating: 230°F
- C. Coil Hoses: Not allowed. Use rigid pipe connections.
- D. Combination Strainer & Shut-off Valve: Bronze or Brass construction
 1. Connections: Solder, NPT, or Tool-Press
 2. Union: at one end of assembly
 3. Pressure Rating: 400psi
 4. Strainer: Y-pattern with integral blowdown
 5. Pressure & Temperature Port: Integral
 6. Ball Valve: Teflon Packing, Chrome Plated Ball
- E. Combination Union & Port fitting: Brass or Bronze Construction installed opposite side of automatic temperature control valve from balancing valve: Includes integral Union, Manual Air vent, & P&T Port.

2.08 AIR CONTROL DEVICES

- A. Manual Air Vents:
 1. Ball valve (see Section 230523) with threaded end fitting and cap. Secure cap to valve handle with chain.
- B. Automatic Air Vents:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Spirotherm
 - b. Amtrol, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Taco.
 - e. Grundfos
 2. Operation: Automatic venting of air, non-siphon type.
 3. Body: Cast Bronze.
 4. Internal Parts: Nonferrous.
 5. Operator: Noncorrosive metal float.
 6. Inlet Connection: NPS 1/2.

7. Discharge Connection: NPS 1/4.
 8. CWP Rating: as noted on drawings and by system
 9. Maximum Operating Temperature: 240 deg F.
- C. Coalescing-Type Air and Dirt Separators: High velocity type with integral automatic air vents
1. Basis of Design Manufacturer & Model: Taco 4900 Commercial
 2. Tank: Fabricated steel tank; ASME Section VIII, Div 1, constructed and stamped for 250-psig (862-kPa) working pressure and 270 deg F (130 deg C) maximum operating temperature.
 3. Coalescing Medium: Copper wire or pall ring type
 4. Air Vent: Cast Bronze, Threaded to the top of the separator.
 5. Inline Inlet and Outlet Connections: One each, Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 (DN 65) and larger.
 6. Blowdown Connection: Threaded to the bottom of the separator.
 7. Size: As noted/scheduled on the drawings, match system flow capacity.
- D. Coalescing-Type, Quad Air Eliminator, Dirt Separator & Hydraulic Separator/Decoupler, with integral automatic air vents.
1. Basis of Design Manufacturer & Model: As scheduled on the drawings
 2. Tank: Fabricated steel tank with removable head; ASME Section VIII, Div 1, constructed and stamped for 150-psig (862-kPa) working pressure and 270 deg F (130 deg C) maximum operating temperature.
 3. Coalescing Medium: Copper
 4. Air Vent: Threaded to the top of the separator.
 5. Inline Inlet and Outlet Connections: Two each designed for hydraulic system separation. Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 (DN 65) and larger.
 6. Blowdown Connection: Threaded to the bottom of the separator.
 7. Size: As noted/scheduled on the drawings, match system flow capacity.

2.09 EXPANSION TANKS

- A. Bladder Type ASME Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Taco, Inc.
 - e. Wessels
 - f. Grundfos
 2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
 4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- B. Diaphragm Type Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by the following
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Taco, Inc.
 - e. Wessels
 - f. Grundfos

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.10 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers:
 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig.
- B. Stainless-Steel Bellow, Flexible Connectors:
 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 2. End Connections: Threaded or flanged to match equipment connected.
 3. Performance: Capable of 3/4-inch misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- C. Spherical, Rubber, Flexible Connectors:
 1. Body: Fiber-reinforced rubber body.
 2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
 3. Performance: Capable of misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.

2.11 FEED/FILL EQUIPMENT

- A. Manual Bypass Feeders (Pot Feeder): Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 1. Capacity: 5 gal.
 2. Minimum Working Pressure: 125 psig.
- B. Glycol Mixing and Make-Up GMU: Packaged glycol mixing and feed unit with base, tank, strainer, isolation valve, pump, expansion tank, discharge pressure gauge, motor starter and control circuit.
 1. Manufacturer: Bell & Gossett
 2. Model: GMU-30
 3. Reservoir Tank: 55gal capacity, white, opaque Polyethylene with lid, and level scale.
 4. Automatic & Manual Start settings: Auto start function based on falling pressure
 5. Power Requirements: Single Phase 120V dedicated circuit
 6. Motor: ODP, single phase, 1/2 HP, automatic and manual start.
 7. Pump: Capable of delivering 10GPM at 30psi or 70' head.
 8. System connection: 3/4" NPT with isolation valve and pressure gauge.
 9. Expansion Tank: 5gal diaphragm type

2.12 HYDRONIC FILTRATION EQUIPMENT

2.13 WATER TREATMENT

- A. Water Treatment Vendor (WTV): JAYTECH, Inc. subcontracted by the Mechanical Contractor.

- B. Chemicals: As recommended by WTV and compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
- C. Chemicals and Cleaning Procedures: Provided by the Contractor
- D. Confirmation of proper cleaning to be provided by WTV based on on-site Millipore filter testing resulting in a ferric oxide corrosion by-product rate of less than 80ppb.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Hot-water heating and chilled-water piping, aboveground, NPS 3 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints; or grooved-copper mechanical joint couplings and fittings, and grooved, mechanical joints.
 - 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints; or welded joints.
- B. Hot-water heating and chilled-water piping, aboveground, NPS 3-1/2 and larger, shall be any 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.
- C. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- F. Air-Vent Piping:
 - 1. Inlet: Same as service.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- G. 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.

3.02 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 calibrated balancing valves at each branch connection to return main.
- C. Install calibrated balancing valves in the return pipe of each heating or cooling terminal.
- D. Install calibrated balancing valves as otherwise shown on the drawings
- E. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- F. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.03 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.
- 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 groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges or grooved joint couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- V. Install piping appurtenances provided by controls contractor, such as valves, sensor wells/taps, temp/press ports, etc where indicated on mechanical plans including floorplans, hydronic system flow diagrams, details, and controls schematics.

3.04 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. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. 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.
 - 7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - 8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 - 10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
 - 11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
 - 12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
- D. 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.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 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 or groove 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. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid or flexible where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

1. AGS Installation: Install the Victaulic AGS piping system in accordance with the latest Victaulic installation instructions. Use Victaulic grooving tools with AGS roll sets to groove the pipe. Follow Victaulic guidelines for tool selection and operation. AGS products shall not be installed with standard grooved end pipe or components. Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.
- I. Fusion Welding of PP-R Joints:
 1. Installer shall be trained by manufacturer's local representative prior to installation activities.
 2. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
 3. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
 4. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications.
 5. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
- J. Press-Connect/Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.06 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 expansion tanks on the floor or suspended from structure as shown on plans. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.07 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.08 SYSTEM FLUSHING AND FILLING

- A. Each hydronic system, including existing and new portions, shall be cleaned and flushed in full:
 1. Heating hot water systems.
 2. Heating glycol systems.
- B. First Flush (Cleaning)
 1. Flush only after completion of the ENTIRE new piping scope of work.
 2. Open all control valves, isolation valves, and run all pumps. Variable Speed Pumps shall be run at 40Hz
 3. Fill system with fresh water and add cleaning/pre-inhibiting/anti-microbial chemicals as recommended by WTV. Cleaner to be applied as recommended by WTV but not less than 5% solution by volume. Filtration equipment shall be incorporated in cleaning with 10 micron filters.
 4. Bleed the system of air and ensure fill pressure is as specified for final operation.
 5. Circulate throughout the system for at least 48 hours. All zone manual valves and automatic control valves shall be open for complete cleaning.
 6. The water treatment vendor shall test for suspended solids in several system locations (at least four (4) locations as identified by the water treatment vendor and approved by the engineer during submittals phase) using a millipore filter test. Written confirmation from water treatment vendor including attached test patches must be provided to engineer

- affirming testing results at all locations demonstrate ferric oxide corrosion by-product of less than 80 ppb.
7. Substantial removal of microbial contamination must also be confirmed by the WTV in a written report. A total bacteria count of 100RLUs or less using an ATP meter must be obtained.
- C. Second Flush:
1. Drain the system completely.
 2. Remove, and clean or replace (as required) strainer screens.
 3. Replace the filtration equipment media with new 10 micron filters.
 4. Fill system with fresh clean softened water or with contractor provided demineralized water. THE SECOND FLUSH FILL SHALL BE METERED AND THE SYSTEM VOLUME DOCUMENTED. PROVIDE THE ENGINEER AND WTV WITH THE METERED SYSTEM VOLUME FOR FINAL FILL chemical.
 5. Post the recorded system size, in gallons, by the chemical feeder.
 6. Bleed the system of air and ensure fill pressure is as specified for final operation.
 7. Circulate throughout the system for at least 24 hours. All zone manual valves and automatic control valves shall be open for complete flushing.
 8. The water treatment vendor shall test for suspended solids in several system locations (at least three locations as identified by the water treatment vendor and approved by the engineer during submittals phase) using a millipore filter test. Written confirmation from water treatment vendor must be provided to engineer affirming testing results at all locations demonstrate ferric oxide corrosion by-product of less than 80 ppb.
 9. If system is not found to be flushed to the satisfaction of the WTV repeat 2nd flush process in full.
- D. Additional Cleaning and Flushing shall be done per recommendation of the WTV to achieve required system cleanliness. All cleaning, flushing, and filling labor is the responsibility of the mechanical contractor.
- E. Final Fill:
1. Drain the system completely.
 2. Fill the entire glycol hot water and chilled water systems with a solution of SOFTENED or DEMINERALIZED WATER and Inhibited Glycol Solution:
 - a. Heating Water Systems feeding AHU/MAU coils: 35% Propelyne
 3. Fill heating water loop with soft water. WTV to provide corrosion inhibitors as required.
 4. Vent air from the entire system at all air vents until water movement noise is eliminated, ensure system fill pressure is met, and place the system into final operation.
 5. WTV & Contractor shall return to site, bleed air from all vents as required, provide additional solution fill to proper system static pressure, 30 days and 6 months after final fill. Additional water treatment chemicals shall be provided by contractor at that time.
- F. Written acceptance by the water treatment vendor will be required for each of the first 2 steps specified above before proceeding to the final fill and final acceptance.
- G. Final acceptance is subject to water treatment vendor's approval of final water treatment inhibitor concentrations. Re-cleaning, re-flushing, and re-filling are the responsibility of the mechanical contractor and shall be performed until final acceptance by, Owner, Engineer and water treatment vendor.
- H. Change Collection Bag in Sidestream Filtration Package after first 24 hours of operation and again after 1 week of operation. Check and change bag again after 1 subsequent month of operation.

3.09 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. 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.
 4. 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 the greater of the following:
 - a. times the system's working pressure (relief valve setting)
 - b. 100 psi
 5. 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."
 6. After hydrostatic test pressure has been applied for at least 15 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.
 7. Prepare written report of testing.
- 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