

SECTION 23 21 13 HYDRONIC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 ADDITIONAL RELATED DOCUMENTS

- A. Related Division 23 Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC" for general piping materials and installation requirements, and for flexible piping connectors.
 - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for expansion joints, loops, anchors, and guides applied to hydronic piping systems.
 - 3. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
 - 4. Division 23 Section "General-Duty Valves for HVAC Piping" for general-duty valves.
 - 5. Division 23 Section "Meters and Gages for HVAC Piping" for pressure/ temperature ports, thermometers, make up water meters, and pressure gages.
 - 6. Division 23 Section "Identification for HVAC" for labeling and identifying hydronic piping.
 - 7. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 8. Division 23 Section "Instrumentation and Control for HVAC" for temperature-control valves and sensors.
 - 9. Division 23 Section "Water Treatment for Closed Loop Systems" for cleaning and chemical treatment requirements, as well as treatment chemicals and equipment (e.g. pot feeders, bypass filters, etc.).

1.3 SUMMARY

- A. This Section includes piping and fittings, special-duty valves, and hydronic specialties for hot-water heating, and other circulating HVAC piping systems; makeup water for these systems; blowdown drain lines; and condensate drain piping. This Section also includes AC condensate pumps.

1.4 ACTION SUBMITTALS

- A. Product Data: Product Data including rated capacities where applicable, including piping, fittings, furnished options and accessories, and installation instructions for each specialty indicated. Include flow and pressure drop curves based on manufacturer's testing for balancing cocks and flow-control devices.

1. Grooved joint, pressure-sealed, and mechanical joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable manufacturer's style or series designation.
- B. Piping Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. Also include control valves, low measuring stations, temperature and pressure sensors, and all other control devices required. Coordinate with the work of the ATC Sub-contractor as described in Division 23 Section "Instrumentation and Control for HVAC".

1.5 INFORMATIONAL SUBMITTALS

- A. Delegated-Design Submittal:
 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
- B. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Other building services.
 3. Structural members.
 4. Other items required to be included as per the provisions of Division 23 Section "Common Work Results for HVAC".
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Pipe Fitter Certificates: Demonstrating that pipe fitters have been trained in the assembly of grooved end joint systems, pressure sealed joint systems, and Small Diameter Plain End Steel Pipe Mechanical Joint Coupling and Fitting System.
- E. Grooved End Joint Assembly Log: If the grooved coupling manufacturer's written installation instructions require a specific torque to be applied to the coupling fasteners submit a log of the torque applied to each fastener on each coupling.
- F. 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.
- G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators, buffer tanks, and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- C. Grooved Joint Systems: All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be supplied by the mechanical grooved coupling manufacturer and shall form grooves that conform to ANSI/AWWA C-606 standards.
 - 1. All mechanical grooved piping work including pipe grooving, shall be accomplished in accordance to the latest published grooved mechanical coupling manufacturer's installation instructions.
 - 2. The Contractor's field personnel shall be adequately trained by a factory-trained representative in the use of grooving tools, application of groove, and installation of grooved joint products prior to the start of the mechanical grooved piping installation. Submit a manufacturer's letter of certification for each pipe fitter demonstrating that they have been trained in the installation of the fitting system.
 - 3. If the coupling manufacturer's installation instructions require a specific, verified torque to be applied to the coupling fasteners rather than a simple visual verification of correct installation, a log of the torque applied to each fastener on each coupling shall be submitted to verify proper installation of the system.
- D. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- E. Installers of Small Diameter Plain End Steel Pipe Mechanical Joint Coupling and Fitting System: Installers shall be certified by the joint system manufacturer as having been trained and qualified to join piping with the small diameter plain end steel piping couplings and fittings.

1.8 SYSTEM PRESSURE AND TEMPERATURE RATINGS

- A. All components of the heating hot water system shall be suitable for a minimum continuous 125 psig working pressure at 220 deg. F, and higher where indicated or specified.
- B. All components of the following miscellaneous systems shall have the indicated temperature and pressure ratings:
 - 1. Blowdown and Drain Piping: 220 deg. F .
 - 2. Air-Vent Piping: 200 deg. F .

3. Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
4. Makeup-Water Piping: 125 psig at 100 deg. F

1.9 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe fitting pressure classes with products specified in related Sections.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 23 Section "Common Work Results for HVAC".
- D. Coordinate installation of pipe sleeves for penetrations through walls and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mechanical-Joint Fittings and Couplings for Grooved End Steel Pipe:
 - a. Victaulic Company.
 - b. Anvil International Gruvlok.
 - c. Or equal as approved by the Professional.
 2. Pressure-Seal Fittings and Couplings for Plain End Copper Tube:
 - a. Apollo Valve 'Apollo Press'
 - b. Nibco Inc. 'Press'
 - c. Viega LLC 'ProPress'
 - d. Or equal as approved by the Professional.
 3. Fitting and Coupling System for Small Diameter Plain End Steel Pipe:
 - a. Victaulic Co. 'QuickVic SD'
 - b. Nibco Inc. 'BenchPress'
 - c. Viega LLC 'MegaPress'
 - d. Or equal as approved by the Professional.
 4. Flow Control Devices / Flow Control Valves (i.e. Manual Calibrated Balancing Valves):
 - a. Anvil International
 - b. Armstrong Fluid Technology
 - c. Flow Design, Inc.(FDI); a Div. of IMI
 - d. Griswold Controls LLC
 - e. HCI, Inc.

- f. Bell and Gossett, a Div. of Xylem Inc.
 - g. Nibco Inc.
 - h. TA Hydronics/ IMI Hydronic Engineering
 - i. Taco, Inc.
 - j. Or equal as approved by the Professional.
- 5. Automatic Flow-Control (Flow Limiting) Valves:
 - a. Griswold Controls LLC
 - b. Hays Fluid Controls
 - c. HCI Inc.
 - d. Flow Design Inc. (FDI); a Div. of IMI
 - e. Nexus
 - f. Victaulic Co.
 - g. Bell and Gossett, a Div. of Xylem Inc.
 - h. Or equal as approved by the Professional.
- 6. Combination Valve Kits:
 - a. Belimo
 - b. Flow Design Inc. (FDI); a Div. of IMI
 - c. Griswold Controls LLC
 - d. HCI Inc.
 - e. Nexus
 - f. TA-IMI / Victaulic Co.
 - g. Bell and Gossett, a Div. of Xylem Inc.
 - h. Or equal as approved by the Professional.
- 7. Globe Type Silent Check Valves at Pumps:
 - a. Metraflex Company
 - b. Mueller Steam Specialty
 - c. Keckley Co.
 - d. Titan Flow Control, Inc.
 - e. Or equal as approved by the Professional.
- 8. Triple Duty Valves:
 - a. Armstrong Fluid Technology
 - b. Bell and Gossett, a Div. of Xylem Inc.
 - c. Mueller Steam Specialty
 - d. Keckley Co.
 - e. Taco Inc.
 - f. Titan Flow Control, Inc.
 - g. Or equal as approved by the Professional.
- 9. Pressure Relief Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Fluid Technology
 - c. Conbraco Industries, Inc.
 - d. Xylem/McDonnell & Miller.
 - e. Keckley Co.
 - f. Or equal as approved by the Professional.

10. Expansion Tanks:
 - a. Amtrol, Inc.
 - b. Armstrong Fluid Technology
 - c. Bell and Gossett, a Div. of Xylem Inc.
 - d. Grundfos Pumps Corp.
 - e. Taco, Inc.
 - f. Wessels Co.
 - g. Or equal as approved by the Professional.
11. Coalescing Media Type Combination Dirt Separators and Air Eliminators, Connection Size 2-inch NPS and Larger:
 - a. American Wheatley
 - b. Bell and Gossett, a Div. of Xylem Inc.
 - c. Wessels Co.
 - d. Or equal as approved by the Professional.
12. Make-up Water Pressure Reducing Valves:
 - a. Cla-Val
 - b. Conbraco / Apollo Valve
 - c. Flomatic Corp.
 - d. Watts
 - e. Zurn Wilkins
 - f. Or equal as approved by the Professional.
13. Y-Pattern Strainers:
 - a. Armstrong International Inc.
 - b. Bell and Gossett, a Div. of Xylem Inc.
 - c. Eaton / Hayward
 - d. Flexicraft Industries
 - e. Metraflex Co.
 - f. Mueller Steam Specialty
 - g. Nibco
 - h. Keckley Co.
 - i. Spirax Sarco
 - j. IMI-TA
 - k. Victaulic
 - l. Watts
 - m. Or equal as approved by the Professional.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 "Pipe Applications" Article for identifying where the following materials are used.
- B. Steel Pipe: ASTM A 53, Type E/ERW or S, Grade A or B, Schedule 40 and 80, plain ends. Only piping manufactured in the USA or Canada is acceptable.
 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, carbon steel, seamless for 2-inch NPS and smaller and electric-resistance welded for 2-1/2-inch NPS and larger.

Type, grade, and wall thickness schedule shall match that of the adjacent piping system in which they are installed.

- C. Drawn-Temper Copper Tubing: ASTM B 88, Type L. Only tubing manufactured in the USA or Canada is acceptable.
- D. PVC Plastic Pipe (AC Condensate Drainage Service): PVC Schedule 40 pipe shall be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D 1784. Piping shall be ASTM D 1785, solid wall, plain ends.
 - 1. Fittings: Solvent welded, socket-type pipe fittings, drainage pattern, conforming to ASTM D 2665.

2.3 FITTINGS

- A. General: Refer to Part 3 "Pipe Applications" Article for identifying where the following materials are used.
- B. Wrought-Copper Fittings (for Hydronic / Pressure services): ASME B16.22.
- C. Wrought-Copper Fittings for Gravity-fed (non-pumped) AC Condensate Drainage Service: ASME 16.29.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Small Diameter Plain End Steel Pipe Mechanical Joint Coupling and Fitting System: Piping couplings and fittings for use with Schedule 40 and Schedule 80 plain end carbon steel pipe conforming to the dimensional requirements of ASME B36.10 and the pipe standards of ASTM A53 and ASTM A106, for piping sizes of NPS 1/2" to 2". The coupling and fitting system shall be rated for a working pressure of 300 psi. Couplings and fittings shall consist of a ductile iron housing conforming to ASTM A536, Grade 65-45-12, with a paint coating. Couplings and fittings shall be complete with gasket liner, zinc-electroplated steel bolts and nuts as per the mechanical properties of ASTM A449, and 300 series stainless steel retainer.
 - 1. Manufacturer: Victaulic "QuickVic SD Installation Ready" system. Threaded fittings on steel pipe are only permitted on threaded connections to valves and equipment using the thread adapters that are part of this system.
 - 2. Continuous Gasket Lining: Pressure-responsive, synthetic rubber for use with the non-wetted interior housing surfaces. Gasket shall be "EHP" EPDM type, suitable for up to 250 deg. F.
 - 3. Available couplings and fittings shall include 45 and 90 deg. elbows, equal tees, reducing tees, equal couplings, reducing couplings, dielectric fittings, male and female threaded to plain end adapter nipples, and caps.
 - a. Couplings and fittings shall be designed for installation onto plain end pipe without prior disassembly of the fitting. Fittings require metal-to-metal contact across the entire bolt pad section for correct assembly. Inspection window provides visual post-installation verification of retainer engagement. Couplings and fittings shall incorporate a "Leak-if-Not-Tightened" feature provides immediate feedback as the system is being filled.
 - b. Dielectric Fittings: Copper-silicon casting conforming to UNS C87850, with plain ends.

- c. Adapter Nipples: Constructed of carbon steel conforming to the chemical and mechanical properties of ASTM A53 Grade A or B, or per GB/T 8163-2008 Grade 20 (or equivalent), or ductile iron conforming to ASTM A536 Grade 65-45-12.
- 4. Tool: Pipe preparation tool designed to cut, mark the insertion depth, and chamfer the OD of the pipe simultaneously to ensure proper coupling and fitting installation. (Knurled marks display a clear insertion depth on the pipe OD for proper coupling/fitting installation.)
- F. Wrought-Steel Fittings: ASTM A 234, Grade A or B, Thickness / schedule matching the adjoining pipe.
- G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 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.
 - 4. Fasteners: Galvanized steel where indoors. Type 304 or 316 stainless steel where outdoors and exposed to the weather.
- H. Copper Pressure-Seal Fittings for Copper Tube: Wrought copper fittings with elastomer O-ring seals, suitable for 200-psig working-pressure rating at 250 deg. F., and for use with copper tube.
 - 1. Housing: Copper.
 - 2. O-Rings and Pipe Stops: EPDM.
 - 3. Tools: Manufacturer's special tools. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
 - 4. Where permitted: Pressure-seal fittings are only permitted in sizes 2 inches and smaller, in accessible areas. Pressure-seal fittings may not be used above drywall ceilings, in shafts, or other difficult to access locations. 'Accessible areas' include mechanical equipment rooms and above lay-in tile ceilings.
- I. Pressure-Seal Fittings and Couplings for Small Diameter Plain End Steel Pipe: Suitable for working pressure of 200 psig in a temperature range from 0 deg. F. to +250 deg. F., and for use with ASTM A53 and A106 schedule 40 black steel pipe with plain ends. Threaded fittings on steel pipe are only permitted on threaded connections to valves and equipment using the thread adapters that are part of this system.
 - 1. Housing: Stainless steel or carbon steel with a zinc-nickel coating.
 - 2. O-Rings: EPDM.
 - 3. Tools: Manufacturer's special tools. Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
 - 4. Where permitted: Pressure seal fittings are only permitted in sizes 2 inches and smaller, in accessible areas. Pressure-seal fittings may not be used above drywall ceilings, in shafts, or other difficult to access locations. 'Accessible areas' include mechanical equipment rooms and above lay-in tile ceilings.
- J. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type E or S, Grade B factory fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders designed to accept grooved end couplings.
 - 1. Where permitted: Grooved mechanical joint fittings are only permitted in accessible areas. They may not be used above drywall ceilings, in shafts, or other difficult to access locations. 'Accessible areas' include mechanical equipment rooms and above lay-in tile ceilings.

2. Flange Adapter Nipples shall be the raised face type, Victaulic Type 45R, or equal by Anvil International.
 - a. Victaulic type 741 and 743 type flange adapter couplings, and similar fittings from Anvil International, are not acceptable.
 3. 'Vic-o-lets', reducing couplings, side branch couplings, boltless or snap-on joint couplings, and bolt-on / clamp-on 'mechanical tee' outlets and other hole-cut type fittings are not acceptable.
- K. Grooved Mechanical-Joint Couplings: Consist of two ductile-iron housings, a synthetic rubber (EPDM) gasket of a central cavity pressure-responsive design; with ASTM A449 and ASTM A183 electroplated nuts, bolts to secure grooved pipe and fittings. Couplings shall be a restrained design complying with ASTM F1476 - "Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications".
1. Where permitted: Grooved mechanical joint couplings are only permitted in accessible areas. They may not be used above drywall ceilings, in shafts, or other difficult to access locations. 'Accessible areas' include mechanical equipment rooms and above lay-in tile ceilings.
 2. 2-1/2 inches to 12 inches:
 - a. Rigid Type: Housings shall provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
 - 1) Sizes through 12 inches: Installation-Ready, for direct stab installation without field disassembly, with Victaulic grade EHP gasket rated to +250 deg. F; Victaulic Style 107H/107N. Couplings shall be installed with visual 'pad to pad' contact.
 - 2) ANVIL Gruvlok Style 7400 or 7401 Rigidlok Couplings with grade E (EPDM) gasket rated to +250 deg. F may be used in lieu of installation-ready type couplings.
 - b. Flexible Type: Use in locations as needed or where vibration attenuation and stress relief are required, such as on connections to equipment. The use of three flexible couplings may substitute for the use of flexible connectors where elsewhere specified or where shown on the Drawings. Flexible couplings may be used as part of the delegated design specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping".
 - 1) Sizes through 12 inches: Installation-Ready, for direct stab installation without field disassembly, with Victaulic grade EHP gasket rated to +250 deg F; Victaulic Style 177. Couplings shall be installed with visual 'pad to pad' contact.
 - 2) ANVIL Gruvlok Style 7000 or 7001 flexible couplings, with grade E (EPDM) gasket rated to +250 deg. F may be used in lieu of installation-ready type couplings.

2.4 JOINING MATERIALS

- A. Welding Materials: Comply with Section II, Part C of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

- B. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- C. Solder Filler Metals: ASTM B 32, Alloy Sb5, 95-5 tin antimony.
- D. Flux: ASTM B 813, non-self-cleaning type.
- E. Grooved Materials: Use grooving tools and lubricant for gaskets manufactured and supplied by the coupling manufacturer.

2.5 VALVES

- A. Check, ball, and butterfly valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Refer to Part 3 "Valve Applications" Article of this Section for specific uses and applications for each valve specified.
- C. Flow Control Devices / Flow Control Valves (i.e. Manual Calibrated Balancing Valves): 125-psig working pressure, 230 deg F maximum operating temperature, y-pattern globe or ball valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening and memory stop to retain set position. Valves 2-inch NPS and smaller shall have bronze body with threaded ends and 2-1/2-inch NPS and larger valves shall have ductile iron or cast iron body with flanged ends.
 - 1. Provide a flow control device where "balancing cocks", sized 2" and smaller, are indicated on the Drawings.
 - 2. Provide flow control devices where "flow control valve" is indicated on the Drawings.
 - 3. For flow control devices sized up to 6", provide a factory insulation kit. The kit shall consist of a polyurethane foam insulation with a plastic coated exterior surface and molded to fit the valve contours. The insulation shall be split into two interlocking pieces, held together with reusable nylon bands or straps. The insulation shall be easily removable and reinstalled. The foam shall be a minimum of 1" thick and suitable for valve body temperatures up to 230 deg. F.
- D. Brass, Automatic Flow-Control (Flow Limiting) Valves, Sizes up to 2": 150-psig cold working pressure (CWP), 250 deg F maximum operating temperature, DZR brass housing, 'stainless-steel operating parts; for threaded connections. Factory set to automatically control flow rates within plus or minus 5 percent design throughout a differential pressure range of 3 to 60 psid, while compensating for system operating-pressure differential. Valve body design shall permit flow regulating cartridge removal and replacement. Provide quick disconnect valves for flow measuring equipment. Provide metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and flow rate.
 - 1. Provide a factory insulation kit. The kit shall consist of a polyurethane foam insulation with a plastic coated exterior surface and molded to fit the valve contours. The insulation shall be split into two interlocking pieces, held together with reusable nylon bands or straps. The insulation shall be easily removable and reinstalled. The foam shall be a minimum of 1" thick and suitable for valve body temperatures up to 230 deg F.
- E. Combination Valve Kits: For hydronic branch piping to equipment sized at 1-1/4" and smaller, the Contractor, at his option, in lieu of the separate valves/ appurtenances shown on the drawings, may provide a valve combination package incorporating flexible hoses, a manual

calibrated balancing valve, pressure-temperature (P/T) ports, a strainer, unions, manual air vent, drain valve, a pair of isolation ball valves, and any other devices detailed on the Drawings. More than one function may be combined into a single device/appurtenance, however the full scope and arrangement of functions shall match that detailed on the drawings, at the minimum. Each kit shall be "bagged and tagged" for easy identification and storage. The entire kit shall be suitable for no less than 150-psig working pressure at 225 deg F.

1. Shut-off ball valves shall be as specified in Division 23 section "General-Duty Valves for HVAC Piping".
 2. Temperature control valves shall be provided separately under Division 23 Section "Instrumentation and Control for HVAC".
 3. Piping Hoses: Comply with requirements in Division 23 Section "Common Work Results for HVAC".
 - a. Hoses are only permitted or required on connections to, suspended fan coil units, and suspended blower coil units, suspended cabinet unit heaters.
 4. P/T ports shall be 1/4" size, have a self-sealing core, brass body, and a gasketed and threaded cap, with retention chain or strap.
 5. Manual air vents shall have a bronze body and nonferrous internal parts; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection.
 6. Strainers shall be on the supply side of the unit and shall be bronze body with threaded ends, stainless steel strainer, and ball-type drain valve with 3/4" threaded hose connection and cap. Straining element shall be 30 mesh.
 7. Manual calibrated balancing valves shall meet the requirements of the "Flow Control Devices (Manual Calibrated Balancing Valves)" paragraph herein. Provide an insulation kit.
- F. Globe Type Silent Check Valves (at Pumps), sizes smaller than 2-1/2": Provide on the discharge of pumps to control surge pressures and resulting water hammer, with a single center-guided, spring-loaded brass or stainless steel disc. Valve shall be suitable for 400 psi CWP. Valves shall be ASTM B62 bronze globe body, with stainless steel spring, seat and bushing, and threaded ends. Seat shall be resilient, replaceable, and suitable for up to 250 deg F. working temperature.
- G. Globe Type Silent Check Valves (at Pumps), sizes 2-1/2" and larger: Provide on the discharge of pumps to control surge pressures and resulting water hammer, with a single center-guided, spring-loaded bronze or stainless steel disc suitable for 150 psi CWP with Class 125 ANSI flanges. Valves shall be ASTM A126, Class B cast iron globe body, flanged, with stainless steel spring, seat, and bushing, conforming to MSS SP-125. Seat shall be resilient, replaceable, and suitable for up to 250 deg F. working temperature.
1. Note: Center guided wafer (non-globe type body) checks are not acceptable.
- H. Pressure Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heating capacity; according to ASME Boiler and Pressure Vessel Code, Section IV.
- I. Make-up Water Pressure Reducing Valves: Provide on cold water makeup piping to the hydronic system, water pressure reducing valves to provide automatic filling of the systems. Pressure reducing valve shall be suitable for 150 psi CWP, with cast bronze body and bronze trim. Reducing valves shall be set to system fill pressure.

2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg. F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection and 1/2-inch NPS inlet connection.
 - 1. Provide at all hydronic equipment connections that have piping connections sized 1" and smaller.
- B. Piping System Manual Air Vents: 3/4" ball valve with a threaded nipple (for hose connection) and cap. Valve shall comply with the provisions of Division 23 Section "General Duty Valves for HVAC Piping", except that one-piece bodies and both standard and reduced ports are acceptable (in lieu of 2-piece body and full port).
 - 1. Provide at all high points in the piping system, both local and overall, for venting of air as part of the system fill process.
 - 2. Provide at all hydronic equipment connections that have piping connections sized 1-1/4" and larger.
- C. Piping System Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure, 240 deg F operating temperature; with 1/4-inch NPS discharge with waste connector, and 1/2-inch NPS inlet connection.
 - 1. Provide at inaccessible high points in the piping system. Extend discharge with a copper tube matching the discharge size to an indirect waste receptor. Provide an isolation valve near the termination point, and label the valve's function.
- D. High Capacity Automatic Air Vent: Designed to vent automatically with float principle; bronze or cast iron body and stainless steel and brass internal parts; 150-psig working pressure, 250 deg F operating temperature; with minimum 1/2-inch NPS discharge with waste connector, and minimum 3/4-inch NPS inlet connection.
 - 1. Provide on top of air separators, and elsewhere indicated on the Drawings. Extend discharge with a copper tube matching the discharge size to a floor drain or other indirect waste receptor, unless indicated otherwise on the Drawings.
 - 2. Provide a ball valve on the inlet to the high capacity automatic air vent for isolation for vent service or replacement.
- E. Floor-Mounted, Full-Acceptance Bladder-Type Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 240 deg. F. maximum operating temperature. Provide taps for pressure gage and air-charging fitting, and drain fitting. Support vertical tanks with steel legs or base; Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 1. Bladders: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Bladders shall permit up to 100% acceptance, and shall be field-replaceable.
 - 2. Air-Charge Fitting: Schrader valve, stainless steel with EPDM seats.
- F. Y-Pattern Strainers: Class 125; cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2-inch NPS and larger, threaded connections for 2-inch NPS and smaller, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection. Select screen sizes as specified below, except where otherwise indicated in the Contract Documents, or where a manufacturer's recommendation indicates a finer screening.

1. Screening Size: Except as specifically indicated otherwise on the Drawings, provide the following:
 - a. Up to 2": 30 mesh.
 - b. From 2-1/2" to 4": 20 mesh.

2.7 COALESCING MEDIA TYPE COMBINATION DIRT SEPARATORS AND AIR ELIMINATORS, CONNECTION SIZES 2-INCH NPS AND LARGER.

- A. Features and Performance: Combination dirt separators and air eliminators shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes. Performance shall be third party tested by independent laboratory.
 1. Units shall include an internal bundle of corrosion resistant, coalescing media filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist an assembly of rigidly constructed vertical tubes of stainless steel or copper wire matrix designed to coalesce microbubbles out of solution and form larger air bubbles that rise to the top of the vessel and to separate dirt particles that collect at the bottom.
 2. Separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be a high capacity, automatic float actuated air venting mechanism
 - a. Also provide with a separate ball isolation valve of same inlet pipe connection size as auto air vent to enable repair or replacement of auto air vent without shutting off and/or drain the main piping.
 3. Units shall include a side tap near the top with a manual ball skim valve to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.
 4. The vessel shall extend below the main pipe connections for dirt separation with a bottom tap and blow down valve of sufficient size to not easily become blocked with separated dirt. Unit shall be designed such that pressure drop does not increase as the dirt collection area fills. Units shall include removable bottom cover for easy cleaning of interior of the vessel.
- B. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 240 deg. F. maximum operating temperature.
 1. Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged or grooved-end connections for NPS 2-1/2 and larger.
 2. Blowdown Connection: Threaded.
- C. Magnetic Insert: Provide a removable magnetic insert. Magnets shall be minimum 10,000 gauss rare earth neodymium type. Magnets shall be encased in stainless steel and shall be positioned on the bottom of the tank.
 1. Warning Signage: Provide permanent warning signage at the separator tank with magnetic inserts that states: *"CAUTION! Strong rare earth magnets in use. Magnets can affect the functioning of pacemakers and implanted heart defibrillators. They can also damage electrical devices, computer hard drives, credit / ATM cards, data storage media, mechanical watches, hearing aids and similar items. Keep tools and other loose metal objects away."*

- D. Sizing: Provide a high velocity model separator with system connection sizes no smaller than the system piping size, and with a pressure drop no greater than 5.0 ft. w.g. at the system design flowrate, at the scheduled design GPM of the system pumps. Provide piping transitions as required.

2.8 AC CONDENSATE PUMPS

- A. Simplex AC condensate pumps shall be a UL-listed packaged unit with corrosion-resistant pump impeller and stainless steel shaft, cast aluminum or plastic reservoir tank with cover and three drain holes, and fully automatic controls including snap action float switch and thermal overload protection. Suitable for up to 140 deg F. fluid (intermittent operation). Include factory- or field-installed barbed 3/8" check valve.
1. Pump shall be designed and fabricated specifically for a hard wired electrical connection.
 2. Provide a high level float switch on the reservoir tank.
 - a. Interlock the high level alarm with the operation of the associated water source heat pump, so that the unit shall be de-energized upon reaching the high limit level in the reservoir. An alarm shall be sent to the DDC system.
- B. Pump Schedule:
1. Pumping capacity: Minimum 0.63 GPM (38 GPH) at 10 feet of head w.g.
 2. Reservoir capacity: 1 quart.
 3. Motor: Minimum 1/30 HP. 115V, single phase, 60Hz.
 4. Maximum dimensions: 11.5" x 5.5" x 4.75" tall.
- C. Acceptable Manufacturers: Subject to compliance with requirements, provide one of the following:
1. Hartell "KL-1DG" series
 2. Liberty Pumps "LCU-PR" series
 3. Little Giant "VCC-20-P" series

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

- A. Hot Water, and other closed loop hydronic system piping , 2-Inch NPS and Smaller:
1. Schedule 80 or 40 steel pipe with a Small Diameter Plain End Steel Pipe Coupling and Fitting System or Pressure-Seal Fittings and Couplings for Small Diameter Plain End Steel Pipe.
 2. Type L drawn-temper copper tubing with soldered or pressure seal joints.
- B. Hot Water, and other closed loop hydronic system piping, 2-Inch NPS and Larger: Steel pipe with welded and flanged joints or grooved mechanical joints rated at Class 125/150. Use Schedule 40 pipe for sizes up to and including 10 inches in diameter.
- C. Domestic Cold Water Make-Up Piping, All Sizes: Use Type L drawn-temper copper tubing with soldered or pressure seal joints.

- D. Air Conditioning (AC) Condensate Drain Piping, All Sizes: Use Type L drawn-temper copper tubing with soldered joints and Type DWV fittings.
1. Interior Installations: At the Contractor's option, in areas other than HVAC air plenums (e.g. return air plenums) or where another material is explicitly identified, schedule 40 PVC pressure piping with solvent welded joints may be used in lieu of copper tube.
 2. Pumped AC Condensate Drain Piping: AC condensate pump discharge tubing shall be 3/8" diameter annealed (soft temper) Type K copper tube. The copper tube shall be joined to the plastic barbed discharge connection of the condensate pump with a 2-inch-long section of clear polyethylene tubing and a barbed to compression fitting adapter.
 - a. The annealed copper tubing shall be extended to a gravity drain line provided by Division 22, or discharge point / indirect waste connection, as indicated on the Drawings.
 - 1) If extended to a gravity drain line, provide a brass compression to NPT connector fitting, and thread adaptor fitting, to connect the annealed tubing to the hard drawn copper gravity drain tubing.
 - b. The piping shall be arranged so that the high point in the pumped portion of the system is located directly above the pump.
- E. Blowdown Piping and Hydronic System Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown or miscellaneous drain is installed.
- F. Pressure Relief Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
1. Shutoff Duty: Use ball and butterfly valves.
 2. Throttling Duty: Use flow control devices (i.e. calibrated balancing valves).
- B. Sizes: The size of valves and other pipeline appurtenances shall match the size of the pipe in which the valve or pipeline appurtenance is installed, unless otherwise indicated.
- C. Install shutoff-duty valves at each branch connection to supply and return mains, at supply and return connections to each piece of equipment, and elsewhere as indicated.
- D. Install flow control devices and balancing cocks on the outlet of each hydronic coil, circulating pump and elsewhere as required or shown to facilitate system balancing.
- E. Install drain valves at low points in mains, risers, branch lines, and elsewhere as shown or required for system drainage.
- F. Install spring loaded silent check valves on each pump discharge and elsewhere as shown or required to control flow direction.
- G. Install pressure relief valves on hot water heat exchangers, at expansion tanks, and elsewhere shown on the Drawings or as required by the ASME Boiler and Pressure Vessel Code or the PA Dept. of Labor and Industry, Boiler Division. Pipe discharge to floor without valves. Comply

with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

- H. Install make-up water pressure reducing valves on domestic cold water piping to the hydronic systems. Set the fill pressure to the lowest value that adequately fills the system and purges it of air.

3.3 PIPING INSTALLATIONS

- A. Install piping according to Division 23 Section "Common Work Results for HVAC".
- B. 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.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping free of sags and bends.
- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install air vents at all high points, both localized and overall, in the piping system consisting of a tee fitting, air collection chamber, 3/4-inch NPS ball valve, and short 3/4-inch NPS threaded nipple and cap. The quantity and locations of air vents shall be sufficient to completely purge the system of air.
- H. Install drains at low points in the piping system consisting of a tee fitting, 3/4-inch NPS ball valve, and short 3/4-inch NPS threaded nipple and cap. The quantity and locations of drains shall be sufficient to completely drain down the system.
- I. Install piping at a uniform grade of 0.2 percent downward towards drainage points / upwards towards air vents.
- J. Reduce pipe sizes using eccentric reducer fitting installed with level side up. Lap joint stub ends are not permitted.
- K. Wrought Steel Fittings, Butt Weld and Flanged: Comply with the following:
 - 1. Install factory-fabricated elbows for changes in direction. Long radius elbows shall be used, and changes in elevation shall be performed with two (2) 22.5 deg elbows in lieu of 45 or 90 degree elbows.
 - 2. Install branch connections to mains using factory-fabricated tee fittings in main with takeoff out bottom of main, except for up-feed risers with takeoff out top of main line.
 - a. Exceptions:
 - 1) The use of "fish-mouth" type fittings for branch connection to mains is permitted, but only when the size of the branch connection is two (2)

nominal pipe sizes smaller than the size of the main, and the main is size 5" or larger.

- 2) The use of weld-o-lets for branch connection to mains is only permitted when the size of the branch connection is three (3) or more nominal pipe sizes smaller than the size of the main pipe. Furthermore, weld-o-lets shall not be used for branches larger than 2".
- L. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.
 - M. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.
 - N. Unions and flanges for servicing and disconnection are not required in installations using grooved mechanical couplings or mechanical joint coupling systems for small diameter plain end steel pipe.
 - O. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps with motor sizes smaller than 3HP) and other vibration-producing equipment. Refer to Division 23 Section "Common Work Results for HVAC Equipment" for flexible piping connectors.
 1. Three (3) Victaulic flexible type grooved joint couplings may be used in lieu of a flexible connector at equipment connections for vibration attenuation and stress relief. Couplings shall be placed in close proximity to the source of the vibration.
 - P. Install strainers on inlet side of each control valve and elsewhere as indicated. Install a 3/4-inch NPS nipple and cap with a full port ball valve in blow-down connection of all strainers. The blow down size shall match the size of strainer blowoff connection where strainers have blowoff connections larger than 3/4-inch NPS.
 1. Locate and orient the strainer so that gravity will assist in retaining the entrapped solids in the screening element (or "leg") or basket so solids can be properly collected and held for disposal.
 - a. Install Y-strainers in vertical downflow lines, and in horizontal lines with the screening leg located on the underside of the strainer body. Do not install in upflow orientations.
 - Q. Anchor and guide piping to ensure proper direction of expansion and contraction. Install expansion loops, expansion joints, anchors, swing joints, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
 - R. Swing Connections: Branch piping connections to mains in heating hot water systems shall be made with swing connections. Swing connections are generally not indicated on the piping floor plans for clarity purposes only.
 1. Swing connections shall be made with at least five pipe fittings, including tee in main.
 - S. Plastic Piping Installation: Comply with the latest installation instructions published by the manufacturer, including hanger spacing and expansion compensation. Avoid point loading and protect piping from sharp edges. The system shall be protected from chemical agents, fire stopping materials, thread sealant, plasticized vinyl products, or other aggressive chemical agents not compatible with PVC compounds. Systems shall be hydrostatically tested after installation. Testing shall not be performed with compressed air or gas.

- T. Label piping as specified in Division 23 Section "Identification for HVAC."
- U. 'T-drill' and similar piping system tee forming techniques are not permitted. Use tee fittings.
- V. Gravity-fed Condensate Drain Piping: Provide a continuous slope to the indirect waste discharge, no less than 1 percent slope. Piping size shall match the drain pan connection size, 1-1/4", the size indicated on the Drawings, or the minimum size required by the 2018 International Mechanical Code, whichever is largest. Provide a venting tee on piping located downstream side of each condensate drain trap to ensure positive drainage. The top of the tee shall be extended vertically to an elevation above the flood rim of the highest drain pan connected to the drain piping system for those installations provided with a condensate overflow switches. Provide plugged clean outs on each change in direction that exceeds 45 degrees, and at intervals not exceeding 20 feet.
- W. Condensate Drain Traps: Construct traps of the dimensions required (trap seal depth and net 'fall') for each HVAC unit generating condensate, based on the predicted maximum static pressure in the cabinet at the location of each trap, including the effect of loaded filters, to ensure the proper drainage of condensate while preventing air passage through the trap (in either direction). After unit startup, flush and prime traps, then test for performance, simulating dirty air filters.

3.4 HANGERS AND SUPPORTS

- A. General: Hangers, supports, and related work are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Conform to requirements below for maximum spacing of supports.
- B. Comply with requirements in Division 23 Section "Vibration Controls for HVAC" for spring hangers.
- C. Install the following pipe attachments unless otherwise indicated, or required to meet the requirements in Division 23 Section "Vibration Controls for HVAC" or "Expansion Fittings and Loops for HVAC Piping":
 - 1. Adjustable clevis hangers for individually supported, straight horizontal piping sections less than 20 feet long between horizontal offsets or rises.
 - 2. Adjustable roller hangers or spring hangers for individually supported, straight horizontal piping sections 20 feet or longer between horizontal offsets or rises.
 - 3. Pipe Roller: ANSI / MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers and supports to support vertical runs as required in Division 23 Section "Expansion Fittings and Loops for HVAC Piping".
 - 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, or in accordance with ANSI / MSS-SP-58, whichever is more demanding. (Note: Rod sizes indicated are for single pipe / single rod hangers, and minimum schedule 40 pipe):
 - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 2. NPS 1: Maximum span, 7 feet minimum rod size, 3/8 inch.
 - 3. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch.

4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
 7. NPS 3 : Maximum span, 12 feet; minimum rod size, 1/2 inch.
 8. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
 9. Spacing listed above does not apply where valves or other appurtenances create concentrated loads between supports, or where there are changes in direction. Provide additional supports for these conditions.
 10. For piping 2-1/2" and larger, rod sizes may be reduced one nominal size where two rods are used.
- E. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes, or in accordance with ANSI / MSS-SP-58, whichever is more demanding. (Note: Rod sizes indicated are for single pipe / single rod hangers, and for minimum schedule 40 pipe):
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.
 7. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 8. Sizes larger than NPS 3: Refer to ANSI / MSS SP-58.
 9. Spacing listed above does not apply where valves or other appurtenances create concentrated loads between supports, or where there are changes in direction. Provide additional supports for these conditions.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- G. Provide additional hangers within 12" of each change of direction of piping, and at concentrated equipment loads.
- H. 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.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for soldered joints in copper tubing; welded, and flanged joints in steel piping.
- B. Pressure-Sealed Joints:
1. Pressure seal fittings shall be installed using the proper tools, actuator, jaws and rings as instructed and approved by the press fitting manufacturer. Leave insertion marks on pipe after assembly.
 2. Pressure-sealed connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting.
 3. Installers shall be familiar with the installation of pressure seal joint systems and shall have been project site trained by a factory representative at least once within the last 3 years.

4. To prevent distortion of the pipe, be sure to stringently maintain the minimum distance between fittings depending on tubing diameter as directed by manufacturer. Failure to provide this distance may result in an improper seal, and the Contractor shall be held liable for all associated costs of required repairs.
 5. The Contractor shall insure that sealing elements are properly in place and free from damage.
 6. Provide unions and arrangement of sufficient length of removable sections of tubing at valves and equipment connections to allow for easy removal and reinstallation for repairs without having to re-make the press connections.
- C. PVC Piping Joints: Solvent cement joints shall be made in a two-step process with primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D 2564.
- D. Mechanical Joints for Plain End Small Diameter Steel Pipe: Assemble joints according to fitting manufacturer's written instructions. This option does not permit the substitution of valves, cocks, strainers, or other piping system specialties marketed by the mechanical joint manufacturer unless those products are explicitly specified elsewhere in the Contract Documents, or those specialties meet the Specifications and the manufacturer is listed as an acceptable manufacturer for those items. Mechanical joints for small diameter steel pipe used on the project shall be the product of one manufacturer and shall be designed specifically for building hydronic heating and cooling systems.
1. Couplings and fittings shall be installed in accordance with the manufacturer's latest published installation instructions. Piping ends shall be clean and free from burrs, indentations, projections, and similar flaws that would compromise the joint. Gaskets shall be verified as suitable for the intended service prior to installation.
 2. The Contractor's field personnel shall have successfully passed an ANSI / IACET approved certification training course conducted on this or another project site within the last 2 years by a factory representative in the use of tools and installation of mechanical joint products prior to the start of the mechanical joint piping installation. All installation professionals and pipe fitters working on-site shall provide evidence of successful training course completion upon request.
 3. Factory-trained representative shall periodically visit the jobsite to insure the proper product installation procedures are being followed.
 4. Contractor shall remove and replace any improperly installed mechanical joint products and the factory-trained representative shall provide additional training to the contractor to mitigate any further improperly installed products.
- E. Grooved Mechanical Joints: Assemble joints according to fitting manufacturer's written instructions. This option does not permit the substitution of valves, cocks, strainers, or other piping system specialties marketed by the mechanical joint manufacturer unless those products are explicitly specified elsewhere in the Contract Documents, or those specialties meet the Specifications and the manufacturer is listed as an acceptable manufacturer for those items. Mechanical joints used on the project shall be the product of one manufacturer and shall be designed specifically for building hydronic heating and cooling systems.
1. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Grooves in piping for grooved mechanical joints shall only be made by the roll grooving method. Cut grooving is not permitted.
 2. The Contractor's field personnel shall have successfully passed an ANSI / IACET approved certification training course conducted on this or another project site within the last 2 years by a factory representative in the use of grooving tools, application of groove,

- and installation of grooved joint products prior to the start of the mechanical grooved piping installation. All installation professionals and pipe fitters working on-site shall provide evidence of successful training course completion upon request.
3. Factory-trained representative shall periodically visit the jobsite to insure the proper field grooving and product installation procedures are being followed.
 4. Contractor shall remove and replace any improperly installed grooved mechanical products and the factory-trained representative shall provide additional training to the contractor to mitigate any further improperly installed products.
 5. or replace any of their couplings which leak or otherwise fail during the warranty period.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Sizes: The size of hydronic specialties that convey the full flow of the connecting piping (e.g. strainer) shall match the size of the pipe in which the hydronic specialty is installed, unless otherwise indicated.
- B. Provide manual air vents at both local and overall high points in system, at heat-transfer coils, and elsewhere as indicated or required for system air venting.
- C. Provide dielectric fittings where required by Division 23 Section "Common Work Results for HVAC."
- D. Provide automatic air vents at air separator, and at inaccessible local high points in the system, and elsewhere as indicated. Route the discharge of inaccessible auto air vents to an approved indirect waste.
- E. Provide air separators in pump suction lines. Run piping to expansion tank with a 2 percent upward slope toward tank. Install drain valve on units 2-inch NPS and larger.
- F. Provide expansion tanks as indicated. Vent and purge air from hydronic system, and charge tank with proper air charge to match the system fill pressure or otherwise suit system design requirements. Isolation valves on the piping connecting the expansion tank to the system shall be fitted with a lockshield (so the valve may be locked open).

3.7 EQUIPMENT CONNECTIONS

- A. Piping size for supply and return connections to equipment shall be as indicated on the Drawings, or the same size as equipment connections, whichever is larger.
- B. Install control valves in accessible locations close to equipment.

3.8 HYDROSTATIC PRESSURE TESTING

- A. Hydrostatically test new piping and existing piping systems altered by the Project. The Contractor shall perform pressure tests. Advise the Client Agency and Architect/Engineer no less than 7 days in advance of testing.
 1. Hydrostatic testing shall occur either immediately before flushing, cleaning/passivation, and chemical treatment of the system, or after such work has been completed. The hydronic systems shall not be left idle, filled with untreated water, for a length of time longer than necessary to perform testing. Should flash rusting of the system occur, the Contractor

is responsible for whatever corrective measures are deemed necessary by the Architect / Engineer.

2. Test prior to installing insulation.

B. Testing Preparation: 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 system with clean water. Clean strainers.
4. Isolate equipment so that it is not subjected to test pressure from piping using valves or blinds in flanged joints. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
5. Install relief 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.

C. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
2. Use vents installed at the high points of system to release trapped air while filling system. Use drains installed at low points for complete removal of liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
4. Isolate expansion tanks and determine that hydronic system is full of water.
5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure, and not less than 100 psig, whichever is greater, however the test pressure shall not exceed maximum pressure for any vessel, heat exchanger, boiler, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
6. 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 with new materials as appropriate. Leak-sealing compounds and preening are not permitted.
7. Repeat hydrostatic test until there are no leaks.
8. Prepare written report of testing.

D. Use of pressurized air for testing of hydronic piping systems is strictly prohibited.

3.9 FLUSHING, CLEANING, AND CHEMICAL TREATMENT

- A. General: All hydronic systems require flushing, cleaning, and passivation. Refer to Division 23 Section "Water Treatment for Closed Loop Systems" for chemical treatment requirements, as well as treatment chemicals and equipment, and for additional system cleaning requirements.
- B. Supervision and Responsibilities: The water treatment service provider performing the work of Division 23 Section "Water Treatment for Closed Loop Systems" shall oversee the entire flushing and cleaning process performed by the Division 23 Contractor, and perform conductivity testing, in addition to performing final chemical treatment of the system. The

service provider shall provide all chemicals used throughout the process, including those used for cleaning, passivating, and final chemical treatment.

- C. Initial Flushing: Flush hydronic piping systems with clean water till clear prior to allowing flow through to heat exchange coils, control valves, heat exchangers etc. Flush the system till the water runs visibly clear and has a conductivity no more than 100 microSiemens greater than that of the fresh water supply. Provide temporary bypass connections between terminal branch supply and return piping at each piece of system equipment (e.g. coil, heat exchanger, etc.) to that flush water does not pass through the equipment or it's piping connection valves and other appurtenances. The flushing bypasses shall match the branch piping sizes or as otherwise indicated on the Drawings. The bypass isolation valves shall be fully open during the initial flushing process, and fully closed thereafter. Remove the flow regulating cartridge automatic flow balancing valves during flushing operations. Replace cartridges after the system is demonstrated to be fully flushed.
1. The Contractor may omit bypasses on branch piping runouts to coils, etc. that are sized 1-1/4" and smaller, and are shorter than 6 feet in total pipe length (e.g. supply length + return length < 6 feet), however the isolation valves serving the coil, etc. shall remain fully closed during the initial flushing procedure. Coils, etc. that are located on the end of sub-mains shall be provided with a bypass in all cases.
 2. Do not use the system pumps to perform the initial flushing of the hydronic system. Refer to Division 23 Section "Hydronic Pumps" for additional requirements. The Contractor shall furnish and install a temporary pump for this purpose, or shall utilize a clean water source in a once-through manner. All costs for temporary water and drainage connections and/or use of temporary pumps shall be included in the Contractor's bid price.
 3. After flushing operations are complete, the Contractor shall remove the temporary pump and/or fresh water and drainage connections, and shall install and operate the permanent pumps. The permanent pumps may be used for cleaning, passivation, and chemical treatment process. All temporary electrical and piping connections to perform the required system flushing without the use of the permanent pump are the responsibility of the Division 23 Contractor.
 - a. Refer to Division 23 Sections "Hydronic Pumps", and "Water Treatment for Closed-Loop Hydronic Systems" for additional requirements.
 - b. If the Contractor does not comply with the above, and exposes the permanent pumps to the flushing process, the Contractor shall replace the seals and volute gaskets in all pumps exposed to the flush water 11 months after system start-up at no additional cost to the Client Agency. Extra seals and volute gaskets shall be furnished by the Contractor for this purpose (i.e. do not use the spare materials required by the Article "Extra Materials" that appears in the Division 23 Section "Hydronic Pumps").
 4. Flush system until drain water runs visibly clear and meets the above specified conductivity. Demonstrate clear flush water to the Client Agency and the Architect/Engineer prior to continuing with the cleaning process.
 5. After the results of the initial flushing procedure is complete, connect system piping to terminal equipment, heat exchanger, coils, etc., and connect the permanent hydronic pumps to the system. Fully close any bypass valves that will remain in place permanently. Tag such valves with instructions to keep the valve closed during normal system operation.
- D. Cleaning and Passivating: After the above initial flushing process, clean and passivate the closed loop systems as follows:

1. Hydronic system piping, circulating pumps, equipment and all other permanent water passages shall be cleaned and passivated by circulating mixtures of a cleaning and passivating agent specified in Division 23 Section "Water Treatment for Closed Loop Systems". Replace strainer screens or flow cartridges removed earlier prior to cleaning.
 2. Fill, vent and circulate system with the solution. Allow solution to reach design or operating temperatures (for heating systems). After system has been circulated for the time period specified in Division 23 Section "Water Treatment for Closed Loop Systems", system shall be drained completely and refilled with fresh rinse water to remove the cleaner, and drained once again. The system shall be thoroughly vented of air each time the system is filled.
 3. After cleaning the piping system, but before final chemical treatment and testing and balancing, remove, clean and replace strainer screens, and drain the rinse water.
- E. Chemical Treatment: Immediately after draining the system rinse water, refill the system with fresh water, and chemically treat the system as specified in Division 23 Section "Water Treatment for Closed Loop Systems".
- F. Bypass Filtering: The combination bypass filter-feeder shall be first used during cleaning and passivating procedures. The 50-micron bag shall remain in place during these procedures. After cleaning and passivating is complete, and the system has been refilled with fresh water, remove the 50-micron bag filter and install a 5-micron bag media in the bypass filter just after completing chemical treatment.

3.10 COMMISSIONING

- A. Fill system and perform flushing, cleaning, and initial chemical treatment.
- B. Check that the system is completely full of water.
- C. Verify correct water fill pressure and corresponding air charge pressure in expansion tank. Perform these steps before operating the system:
1. Open valves to fully open position. Close coil bypass valves.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of systems 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. Check and set operating temperatures of hydronic equipment (e.g. boilers, chillers, heat exchangers, etc.) to design requirements.
 7. Lubricate motors and bearings.

END OF SECTION