

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.01 SUBMITTALS

A. Product Data:

1. Provide for each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

B. Project Record Documents:

1. Shop drawings:

- a) 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.
- b) Welding certificates: Copies of certificates for welding procedures and personnel.
- c) Field test reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - i) Test procedures used.
 - ii) Test results that comply with requirements.
 - iii) Failed test results and corrective action taken to achieve requirements.

C. Operation and Maintenance Data:

1. Hydronic specialties and special-duty valves.

1.02 Permits

- A. All field welding is subject to permitting through the Denver Fire Department. See General Conditions references to "Hot Work Permits".

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Steel Pipe:

1. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade A, Schedule 40, black steel, plain ends.
2. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade A, Schedule 40, black steel, plain ends.
3. Steel Pipe, NPS 14 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
4. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
5. Coordinate flange class with products in other parts of this Section and in related Sections to correlate face size and bolt patterns.
6. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
7. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
8. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
9. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
10. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

11. Flanges and fittings below are available in several classes, materials, facings, and end connections. Coordinate with Project requirements.
12. 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:
 - a) Material Group: 1.1.
 - b) End connections: butt welding.
 - c) Facings: raised face.
13. Flexible connectors: stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250° F maximum operating temperature. Flexible connectors shall not be used for to correct mis-alignment.
14. Packed, slip, expansion joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.
15. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
16. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

B. Copper Tube:

1. For NPS 3 and smaller: Piping shall be drawn-tempered Type L copper tube (ASTM B88).
2. Fittings shall be wrought copper (ASME B16.22).
3. Unions shall be wrought copper (ASME B16.22).
4. Solder for fittings with antimony-free and lead-free solder with shear strength not less than 7,250 PSI. Allstate "Aquasafe" or equal.
 - a) NPS 1-1/2 and smaller: Solder filler materials shall be ASTM B32, 95-5 tin antimony.
 - b) NPS 2 and larger: Solder brazing materials shall be AWS A5.8, Classification BAg-1 (silver).

2.02 RELIEF VALVES

A. Acceptable Manufacturers:

1. Kunkle
2. Lonegren
3. Lunkenheimer
4. McDonnell and Miller
5. Watts

B. Materials:

1. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME Boiler and Pressure Vessel Code IV certified and labeled.

2.03 [DIAPHRAGM] [BLADDER]-TYPE COMPRESSION TANKS

A. Acceptable Manufacturers:

1. Amtrol
2. American Tube and Controls
3. American Wheatley
4. Bell and Gossett
5. John Wood Co.
6. Taco

B. Materials:

1. Welded carbon steel, rated for 125-psig working pressure and 375° F maximum operating temperature.
2. Separate air charge from system water to maintain design expansion capacity by a flexible [diaphragm] [bladder] securely sealed into tank. Include drain fitting and taps for pressure gauge and air-charging fitting.
3. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles.
4. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

2.04 AIR-DIRT SEPARATORS

A. Acceptable Manufacturers:

1. Amtrol
2. American Wheatley
3. Armstrong
4. Adamson
5. Bell and Gossett
6. John Wood Co.
7. Spirotherm
8. Taco

B. Materials:

1. Tangential-type air separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375°F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blow-down connection. Provide units in sizes for full-system flow capacity.
2. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300° F.
3. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250° F.

2.05 STRAINERS

A. Acceptable Manufacturers:

1. Armstrong
2. AW Cash
3. Boylston
4. Hoffman
5. ITT
6. Keckley
7. Mueller
8. Plenty

B. Materials:

1. Basket Strainers: duplex, quick-opening covers, stainless steel baskets, single-handle or hand-wheel operation of valve. 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.

2. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

2.06 PUMP SUCTION FITTINGS

A. Acceptable Manufacturers:

1. Armstrong
2. Bell and Gossett

B. Materials:

1. Fitting to match specified pump. Angle or straight pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

2.07 COMBINATION PUMP DISCHARGE VALVES

A. Acceptable Manufacturers:

1. Armstrong
2. Bell and Gossett.

B. Materials:

1. Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features.

2.08 DIFFERENTIAL PRESSURE SWITCHES

A. Acceptable Manufacturers:

1. McDonnell and Miller
2. Mueller
3. Barksdale

2.09 FLOW MEASURING AND BALANCING DEVICES

A. Acceptable Manufacturers:

1. Manual balancing:
 - a) Armstrong (Tour & Anderson)
 - b) Barco
 - c) Bell and Gossett "Circuit Setters"
 - d) Flow Design "Flowset"
 - e) Gerand
 - f) Keystone

B. Materials:

1. Calibrated balancing valves, NPS 2 and smaller: bronze body, ball type, 125-psig working pressure, 250°F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
2. Calibrated balancing valves, NPS 2-1/2 and larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250°F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
3. Manual balancing valves: refer to Division 21-23 for requirements of manual balancing valves.

2.10 INHIBITED GLYCOL

- A. Acceptable Manufacturers:
 - 1. The Dow Chemical Company
 - 2. Texaco
 - 3. Lyondell
 - 4. Calcium Controls
- B. Product: Inhibited Propylene Glycol (Pure Virgin)
- C. Closed-Loop, Water Piping Chemicals: sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.
- D. Heating Steam and Condensate Piping Chemicals: sequestering agent to reduce hardness and prevent feedline congestion and to provide alkalinity, oxygen scavenger, carbon-dioxide neutralizer, and filming amines.
- E. Open-Loop, Condenser Water Piping Chemicals: sequestering agent to inhibit scaling, acid to reduce alkalinity and pH, corrosion inhibitor, and biocide.
- F. Provide the following system glycol concentrations:
 - 1. Chilled water system 30 percent
 - 2. Hot water system 30 percent
 - 3. All other heat transfer systems 30 percent
- G. The manual fill system fill shall be performed by means of a temporary fill tank totally isolated from domestic water system. Fill connection shall be a female hose-end ball valve. Supply shall be with a removable hose which can be connected to a male hose-end valve connected to a backflow prevention device.
- H. Temperature gauges across coils and pressure gauges across pumps are required. P&T taps are not sufficient.
- I. Specify that test and balance ports in chilled-water systems be long enough to extend beyond insulation. Cutting-back the insulation or covering the ports is not acceptable.
- J. Specify side stream filtration, either cartridge (25 micron) or cyclone style be installed in all hydronic systems.

2.11 HOSE KITS

- A. Manufacturers
 - 1. Pro Hydronics
 - 2. Flow Design
 - 3. Griswold
- B. General: Hose kits shall be designed for 200 psig maximum working pressure, and operating temperatures from 40 to 212 deg F. All cartridge flow surfaces must be stainless steel.
- C. Hose
 - 1. Length: 24 inches.
 - 2. Type: stainless steel, braided.
 - 3. Hose diameter shall correspond with the maximum flow below. Coil connection size hose kits will not be allowed.
- D. Maximum pressure loss
 - 1. Components included for pressure loss in the chart below: (2) 24-inch hoses, strainer with integral isolation valve and automatic flow limiting device with isolation ball valve.
 - 2. Hose diameter, maximum flow rate and maximum water pressure drop (pressure drop is less the temperature control valve):
 - a) ½": 2.8 GPM maximum, 8.5 FT WPD
 - b) ¾": 5.9 GPM maximum, 9.1 FT WPD
 - c) 1": 10.0 GPM maximum, 9.1 FT WPD

- d) 1-1/4": 16.0 GPM maximum, 9.0 FT WPD
 - e) 1-1/2": 23.0 GPM maximum, 9.0 FT WPD
 - f) 2": 39 GPM maximum, 8.5 FT WPD
- E. Y-Ball Strainer: Full port ball valve for shut off service with hose end drain valve, bypass plug and P/T port. Stainless steel construction. 8:1 ratio between strainer screen area and pipe diameter. If 8:1 strainer is not available, manufacturer shall increase the hose kit one full diameter.
- F. Control Valve
- 1. By others.
- G. Balancing Device
- 1. Automatic flow balance valves: Factory reset and +/-5% of the specified flow rate. Cartridge shall be permanently marked by a letter that corresponds to the specific flow rate. Cartridge shall be stainless steel (other materials not acceptable). Continuous operation at differential pressures from 2 to 60 psi. Pressure/temperature ports with high and low-pressure designation for flow verification. With bronze, full-port ball valve for shut off service.
 - 2. Manual balancing valve: not allowed on variable flow systems due to overflow at part flow.
- H. Configuration Order
- 1. Supply inlet: System connection, Y ball-strainer, hose, coil connection.
 - 2. Return outlet: Coil connection, hose, control valve by others, automatic flow balancing valve, system connection.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Do not install piping underground or under floor slabs. Below grade lines shall only be permitted outside of the building as necessary.
- B. Hot and Chilled Water, NPS 2 and smaller: aboveground, use Type L (Type B) drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- C. Hot and Chilled Water, NPS 2-1/2 and larger: Schedule 40 steel pipe with welded and flanged joints.
- D. Condenser Water: NPS 2 and smaller: aboveground, use Type L (Type B) drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- E. Condenser Water: schedule 40 steel pipe with welded and flanged joints.
- F. Condensate Drain Lines: Type L (Type B) drawn-temper copper tubing with soldered joints.
- G. Specify unions or flanges downstream of valves and at equipment and apparatus connections.
- H. Specify manual air vents at all changes in elevation downward in direction of flow with full size air chamber and pipe down to accessible location with 1/4-inch copper tubing to a petcock.
- I. Refer to Division 23 for basic piping installation requirements.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap at low points in piping, system mains, shutoff valves, bases of vertical risers, equipment, and elsewhere as required for system drainage.
- L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- M. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the top of the main pipe.
- N. Install strainers on supply side (upstream) 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 blow-down connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

- O. Anchor piping for proper direction of expansion and contraction.
- P. Provide isolation valves at all branch lines and equipment including coils, air vents, and all other hydronic equipment.. Provide access to all branch line isolation valves and valves to equipment. Coordinate locations of access panels with general contractor.
- Q. Provide flow measuring and balancing device combinations of orifices, venturis, throttling valves and temperature and pressure taps to provide accurate flow measurement for manual balancing of hydronic systems.

3.02 VALVE INSTALLATION

- A. Refer to Division 21-23 for additional requirements.

3.03 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23. Comply with requirements below 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. NPS 3 and larger: Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 3. Spring hangers to support vertical runs.
 4. Verify actual supported loads for hanger sizes and spacing. Consult structural engineer if required to support piping. Spacing and sizes below are from the 2000 ASHRAE HANDBOOK--"HVAC Systems and Equipment."
- 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.
- 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.

3.04 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.

3.05 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. Install air vents with isolation valves between vent and hydronic main or branch.
- B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.
- D. Install in-line air separators in pump suction lines. Install drain valve on units NPS 2 and larger.
- E. For vertical expansion tanks: install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.06 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve on heat exchangers. If multiple, parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure and temperature gages at coil inlet connections.
- E. Provide isolation valves at all equipment connections. Refer to Division 23 for additional requirements.

3.07 FIELD QUALITY CONTROL

- A. Mechanical contractor shall obtain approval in writing from Balancing Contractor for all balancing devices.
- B. 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 from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- C. 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 trapped air. Use drains installed at low points for complete draining of liquid.
 - 3. For initial fill of glycol systems, meter volume to determine correct mix for specified concentration. Include system volume in report.
 - 4. Check expansion tanks to determine that they are not air bound and that system is full of water.
 - 5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "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, and repeat hydrostatic test until there are no leaks.
 - 7. Prepare written report of testing. Testing report shall be submitted to DPS for approval.

- D. Water Analysis: submit a copy of the water analysis to illustrate water quality available at Project site. Refer to Specification Section 23 25 00 HVAC Water Treatment for additional requirements.

3.08 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments 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 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. Check operation of automatic bypass valves.
 - 7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 - 8. Lubricate motors and bearings.
- C. Submit written documentation to DPS that the pump adjustments have been made prior to balancing of the system by the Test and Balance Contractor.

END OF SECTION 23 21 13