SECTION 23 21 13

HYDRONIC PIPING

PART 1 - DESIGN DIRECTIVES

1.1 QUALITY ASSURANCE

A. Regulatory Requirements: comply with the provisions of the following:

1. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.2 DESIGN CRITERIA

A. This section applies to piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, condensate drain piping, or any other HVAC water and/or glycol piping system.

B. The designer is to confirm the application of the specified valves to insure suitability of use in the specified systems.

C. Suction diffusers are not allowed except in extenuating circumstances. The designer is to arrange equipment and piping such that there will be a minimum of three pipe diameters of straight pipe to the inlet of end suction pumps.

D. The designer is responsible for determining the pressure class and operating temperature of safety relief valves and compression tanks.

E. The designer shall confer with DC-FO&M to determine the piping materials to be used in hydronic systems. Typically, copper shall be used for pipe sizes ≤3" and steel for sizes >3".

F. The designer shall calculate the size of the pipe serving the expansion tank and indicate on the drawings.

G. The design documents shall include a flow diagram of the hydronic system indicating all major components of the system, isolation & control valves, unions/flanges, pipe sizes, pressure &/or temperature relief devices, direction of flow, etc.

H. Within each building there shall be a building valve to isolate the service to the building. Provide low point drains and high point vents with ball valves and caps (minimum ½"), in the distribution piping.

I. Triple duty valves are not allowed.

J. The designer shall always consider constructability of a hydronic system, specifically start up and flushing of the system. Where major additions are added to a building necessitating a new pump set, consider a bypass (half the main pipe size) and air

separator to allow the system to operate as a closed loop. This condition will typically occur in chilled water systems connected to the central chilled water plant.

PART 2 - PRODUCTS

2.1 PIPE, FITTING, AND JOINT MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

B. Annealed Temper Copper Tubing:

ITEM	SIZE	ASTM SPEC NO.	MATERIAL WEIGHT & TYPE
Pipe	≤3"	B88 copper	Type L, drawn
Fittings	≤3"	Wrought copper or cast bronze	ANSI B16.22 & B16.18
Bolts	Per flange standard	A193, grade B7 carbon steel	Hex head (ANSI B18.2.1), B1.1, class 2A course thread
Nuts	Per flange standard	A194, Grade 2H, Carbon steel	Heavy hex (ANSI B18.2.2), B1.1,class 2B course thread
Gaskets	Per flange standard	1/16" Compound fiber	

C. Grooved and ProPress fittings are allowed where approved by Dartmouth FO&M.

1. Press-connect Fittings (copper pipe only): IAPMO PS 117, ANSI/ICC LC1002, ASME B16.51 (Viega ProPress). Fittings shall have EPDM sealing element and leak detection feature (SmartConnect).
2. Grooved-End Copper (Victaulic) Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed
fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
Flange Adapters: For use with grooved end pipe and fittings. ASTM A536 ductile iron coated. Class 150 bolt hole pattern with synthetic rubber gasket.

D. Steel Pipe: Threaded and welded ends.

ITEM	SIZE	ASTM SPEC NO.	MATERIAL WEIGHT & TYPE
Pipe	all sizes	A53, grade B, type S	Schedule 40, ANSI B36.10
Fittings	≤2"	A197, Malleable Iron	Standard, threaded, ANSI B16.3
	>2"	A234, WPB, wrought carbon steel	Schedule 40, butt weld, ANSI B16.9
Flanges	≤2"	A105, forged carbon steel	class 150, RF, threaded, ANSI B16.5
	>2"	A105, forged carbon steel	class 150, RF, weld neck or slip on, ANSI B16.5
Bolts		A193, grade B7 carbon steel	Hex head (ANSI B18.2.1), B1.1, class 2A course thread

Nuts		A194, Grade 2H, Carbon steel	Heavy hex (ANSI B18.2.2), B1.1,class 2B course thread
Gaskets	Per flange standard	A304, stainless steel, Grafoil filled, spiral wound	class 150, RF, ring style, ANSI B16.20

E. PVC pipe and fittings, schedule 80 pressure pipe (pipe: ASTM# D-1784 & D-1785; fittings ASTM# D 2467 & D2464; latest edition). 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. PVC is only allowed for low pressure and temperature systems, not exceed manufactures recommended operating temperatures and pressures. Radiant Snow-melt System Tubing and Fittings

1. Spiral-braided multi-composite design constructed of a “Durel” inner tube,and Aluminum “AlumaShield” solid oxygen diffusion barrier, a contour extrusion layer, an “Aramid” reinforced fiber,an outer cover of “HiGuard.
2. Tubing shall be listed to 180°F at 100 psi. and shall be capable of withstanding temperatures of -35°F to 325°F intermittently without delimitation. Tubing shall be UV resistant and crush proof.
3. Manifolds shall be made of type Type L copper and fitted with isolation valves (supply and return), vents and flow setters.
4. Fittings shall be barded type and use constant-tension spring clamps or screw clamps. Materials shall be UNS 31400 Copper Alloy, UNS 36000 Copper Alloy, and/or UNS 37700 Copper Alloy, as appropriate for the system design.

F. Provide dielectric fittings between dissimilar materials.

G. Copper diverting tee fittings with factory installed devices to divert the flow of water to or from a branch piping run.

1. Bell & Gossett - Monoflo Tee
2. Taco, Inc. - Venturi Fittings

2.2 SPECIAL DUTY VALVES

A. Safety relief valves shall be designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and BTU capacity.

2.3 HYDRONIC SPECIALTIES

A. Manual air vents shall be bronze body and nonferrous internal parts; 150 psig working pressure, 225°F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8" discharge connection and 1/2" inlet connection.

1. Bell and Gossett - No 4V
2. Taco, Inc. – 417
3. Armstrong Pumps, Inc. - #72

B. Automatic air vents shall be cast iron body with stainless steel, brass, EPDM, and silicone rubber internal components, two stage air relief, 150 psig maximum pressure, and 250°F maximum temperature.

1. Bell and Gossett - #107 High Capacity Air Vent
2. Taco – Hy-Vent
3. Spirax Sarco – 13WS

C. Diaphragm-type expansion tanks shall be constructed of welded carbon steel. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1. Expansion tanks must be gravity drainable.

1. Bell and Gossett - Series D or B-LA
2. Taco, Inc. - CBX series

D. Air separator ≥2" shall be welded black steel; ASME constructed and labeled for minimum 125 psig water working pressure and 350°F operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections; threaded blowdown connection; sized as required for full system flow capacity. Do not include strainers in air separators.

1. Bell and Gossett – Rolairtrol
2. Spirotherm - Spirovent
3. Taco, Inc. - Air Separator

E. Air separator ≤2" shall be brass or cast iron; minimum 125 psig water working pressure and 240°F operating temperature; perforated stainless steel or copper air collector tube designed to direct released air to atmosphere via integral automatic air vent; sized as required for full system flow capacity.

1. Bell and Gossett –model EAS or EASB-JR
2. Spirotherm – Spirovent Junior
3. Taco, Inc. – Vortech Air Separator, VRTX series

F. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens shall be Type 304 SS, with 20 mesh perforations, 125 psi WP.

1. Cast iron body for non-steam steel piping systems, cast steel for steam systems, and cast bronze body for copper piping systems. Include removable screen retainer with blowdown fitted valve and pipe plug.
2. Strainers in condensate systems prior to steam traps shall be cast iron.

G. Flexible connectors shall be stainless steel bellows with woven flexible bronze wire (for copper piping systems) or stainless steel (for steel piping systems) reinforcing protective jacket; minimum 150 psig working pressure, maximum 250° F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected, and shall be capable of 3/4″misalignment.

1. Keflex, Div. of Flex-Weld, Inc.
2. Mason Ind., Inc.
3. Metraflex

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. All water and glycol systems with operating temperatures of 40°F to 210°F, install Type L, drawn copper tubing with wrought copper fittings and solder joints for 3" and smaller, above ground, within building.

B. Install steel pipe with welded joints and fittings for sizes larger than 3”.

C. Schedule 80 PVC or stainless-steel piping shall be used in condenser water systems between the cooling tower and the chiller.

3.2 PIPING INSTALLATIONS

A. Make reductions in pipe sizes at pump connections using eccentric reducer fitting installed with the level side up as required to allow for complete drain-down of piping system.

B. Install flexible connectors at inlet and discharge to pumps (except inline pumps) and other vibration producing equipment.

C. Use minimum three elbows to form a swing connection for supply and return runouts to risers and/or heating equipment.

3.3 VALVE APPLICATIONS

A. Install isolation valves at each branch connection to mains and at connections to each piece of equipment. Install isolation valves at each branch-off from vertical riser and mains serving individual floors and areas respectively. Refer to Section 23 05 23, General Duty HVAC Valves.

B. Install high performance butterfly valves where chilled water enters the building from the central distribution system. Use resilient seated butterfly valves at other locations within the building. Refer to Section 23 05 23, “General Duty HVAC Valves.

A. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve with hose connection, cap and chain. Install vents at high points. Pitch water piping to permit air to be vented to system high points and to permit complete drainage to low points. Always use eccentric fittings in horizontal piping when pipe is pitched. Refer to Section 23 05 23, “General Duty HVAC Valves

B. Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Refer to Section 23 05 10, “HVAC Basic Mechanical Materials and Methods.

C. Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Sectio 23 05 10, HVAC Basic Mechanical Materials and Methods and fire sealing requirements in Division 1.

D. Temporarily cover the open ends of all pipes not actively being installed and at the end of each work day to prohibit the influx of foreign materials.

E. Arrange piping to provide adequate provision for thermal expansion and contraction. Arrange branches to individual heating units to take up motion or strain by installing three elbows.

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. Install air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting.

B. Vent and purge air from hydronic systems, charge diaphragm type expansion tanks with proper air charge to suit system design requirements. Use pipe size as recommended by the tank manufacturer.

C. Arrange the piping in the vicinity of the expansion tank such that the system connection pipe, with isolation valve, is beside the tank creating a drip leg with a drain valve (with hose connection). Elevate the expansion tank if necessary to create the drainable drip leg. Charge the expansion tank with air when the system is at ambient air temperature.

D. Install strainers on steam systems with the wye oriented horizontally. Install strainers immediately preceding steam traps with wye oriented vertically down. Install strainers for water systems with wye oriented vertically down.

E. Welded forged steel branch connections may be used to create branch pipe taps in steel piping systems when the main to branch size ratio is not less than three to one, and the maximum branch pipe size is 2 1/2". Do not 'fish mouth' pipe to create branch piping runs.

F. Reductions in pipe size made with eccentric reducers shall have the tops level for water piping and bottoms level for steam piping as required to allow for complete drain-down of piping system.

G. Run all horizontal building drains at uniform pitch. Follow indicated lines generally, but make exact layout on the job to work actual fitting dimensions, align piping and avoid interferences. Unless otherwise specified or required by code, provide proper support to maintain uniform pitch of 1/4" /foot for lines 3 inches and smaller and 1/8 "/ foot for lines larger than 3 inches.

H. Provide side stream filters in condenser water and chilled water systems where flow is ≥400 gpm. Install filter feeders provided by the chemical treatment contractor in heating and glycol systems. Furnish isolation valves serving filter feeders near the mains and near the filter feeders. Refer to Section 23 05 00, "Basic Mechanical Requirements" for more information.

3.5 FIELD QUALITY CONTROL

A. Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing or if steel piping is exposed to air for more than one week before the water treatment is implemented.
2. Subject piping system to a hydrostatic test pressure of 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code For Pressure Piping, Building Services Piping.
3. After the hydrostatic test pressure has been applied for at least two hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks and pressure holds for a period of two hours. Contractor shall coordinate with Owner for

witnessing the test and shall complete a test report to be signed by the owner's representative.

4. Install radiant snow-melt tubing and system components in strict accordance with manufacturer instructions. Protect from damage due to sun light, construction traffic, etc. Pressure test prior to, during and after back filling and embedment in concrete.

END OF SECTION 23 21 13