SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and certain specialties for the following:

1. Chilled water piping in CUP.
2. Underground chilled water piping.
3. Chilled water piping in tunnels.
4. Chilled water piping above the floor in buildings where used.
5. Pressurized waste water piping.
6. Unions and flanges.
7. Dielectric fittings.
8. Butterfly valves.
9. Ball valves.
10. Drain and vent valves.
11. Swing check valves.
12. Pressure equalizing valves.
13. Heating hot water piping.
14. Condenser water piping.
15. Make-up water piping.
16. Condensate drain piping.
17. Blowdown drain piping.
18. Air-vent piping.
19. Safety vent piping.
20. Tracer wire.
21. [***From pages 2 and 3 of NU Tech Standards Section 23 2113, Item 3 Pipe support guides, Item 4 Expansion loops, moment guided, ells and tees, Item 5 Anchors, Item 6 End seals and gland seals, and Item 7 Field joints. AE MUST DETERMINE HOW THESE REQUIREMENTS FIT IN AND FOR WHICH SYSTEMS ON EACH PROJECT AND ADD TO THIS SPECIFICATION AS REQUIRED.]***

B. Related Section:

1. Section 23 0529 "Mechanical Supporting Devices."
2. Section 23 0550 "Vibration Isolation."
3. Section 23 0553 "Mechanical Systems Identification."
4. Section 23 0594 'Testing, Adjusting, and Balancing (TAB)."
5. Section 23 0700 "Mechanical System Insulation."
6. Section 23 2116 "Hydronic Piping Specialties."
7. Section 23 2123 "Pumps."
8. Section 23 8216 "Coils."

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Makeup-Water Piping: 80 psig at 150 deg F.
3. Condensate Drain Piping: 150 deg F.
4. Blowdown Drain Piping: Equal to pressure of the piping system to which it is attached.
5. Chilled water piping in CUP: 120 psig at 50 deg. F.
6. Chilled water piping in tunnel: 120 psig at 50 deg. F.
7. Chilled water piping above the floor in buildings where used: 120 psig at 50 deg. F.
8. Underground chilled water piping: 300 psig minimum working pressure.
9. Condenser water piping: 120 psig at 50 deg. F.
10. Air-Vent Piping: Equal to pressure of the piping system to which it is attached.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and pipe fittings.
2. Unions and flanges.
3. Dielectric fittings.
4. Valves: And include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
5. Grooved joint couplings and fittings specifically identified with the applicable style or series number

B. ***[LEED Submittal:***

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.]

C. Shop Drawings: Detail the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

D. Field quality-control test reports.

E. Operation and maintenance data.

F. Northwestern University Maintenance Requirement Forms, see Division 01.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

B. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by the same manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

C. Piping materials shall bear label, stamp, or other markings of specified testing agency, and shall conform to ASTM standards.

D. Comply with FM Global requirements for pressure vessels and piping and for pressure relief devices.

1.5 SPECIAL WARRANTIES

A. Five (5) years, see Division 01.

PART 2 - PRODUCTS

2.1 CHILLED WATER IN CENTRAL UTILITY PLANT (CUP)

A. 2½ inches and Smaller:

1. Pipe: ASTM A106, Grade B, extra strong, carbon steel.
2. Fittings: ASME A105, Grade II/ASME B16.11, 3000 lb., forged steel, socket weld.
3. Unions: Forged steel, 3000 lb., socket weld. Refer to Unions and Flanges in this Section

B. 3 inches through 24 inches:

1. Pipe: ASTM A53, Grade B, Type E or S, standard weight, carbon steel.
2. Fittings: ASTM A234 Grade WPB/ASME B16.9, standard weight, seamless, carbon steel weld.
3. Flanges: Class 150. Refer to Unions and Flanges in this Section.

C. 30 inches through 42 inches:

1. Pipe: API-5L, Grade B, Type DSAW, 0.375” wall thickness, carbon steel.
2. Fittings: ASTM A234, Grade WPB/ASME B16.9, 0.375” wall thickness, seamless, carbon steel weld.
3. Flanges: Class 150. Refer to Unions and Flanges in this Section.

2.2 CHILLED WATER (UNDERGROUND)

A. Piping and Fittings 6 inches through 36 inches:

2.3 Trace-Safe water blocking tracer wire with Copperhead Snakepit access boxes, refer to their drawings and specs. TRACER WIRE

A. Non-electrical pipe installed below grade shall have 12 AWG Copperhead Reinforce Tracer Wire, or approved equal. Tracer wire to be accessible at each end in manholes, 8 AWG wire to be installed in 1 inch conduit run next to piping. Conduit shall be rigid steel piping with PVC coating.

2.4 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil International, Inc.
b. Grinnell
c. Victaulic Company of America.

E. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.

F. 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.

G. Wrought-Copper Unions: ASME B16.22.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness or schedule as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

G. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.6 PRESSURIZED WASTE WATER

A. Pressurized Waste Water:

1. Type K copper water tube, (drawn) temper, ASTM B88; with copper drainage fittings (DWV), ANSI B16.23; wrought copper drainage fittings (DWV), ANSI B16.29; lead free (<.2%) solder ASTM B32; flux, ASTM B813.

2.7 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

2.8 UNIONS AND FLANGES

A. Unions:

1. 2½ inches and Smaller:

a. Forged steel, ASTM A105 Grade 2, ASME B16.11, socket weld, 3000 lb. WOG with steel to steel seats.

B. Flanges:

1. 3 inches and Larger:

a. ASTM A105, ANSI B16.5, hot forged steel flanges, welding neck pattern. Slip-on pattern flanges are not allowed. Bore dimension of welding neck flange shall match inside diameter of connected pipe. Use raised face flanges for mating with other raised face flanges with self-centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.

2. Flange pressure class indicated in respective piping service is minimum required. Mating flange pressure class shall match pressure class of device connected to such as valves and piping specialties. Flanged connection will on be permitted at specialty connections such as at a vessel or specialty valve.

C. Flange Gaskets:

1. Gasket material to be asbestos free and suitable for pressure temperatures and fluid of piping system. Non-metallic gaskets shall be in accordance with ANSI/ASME B16.21 and ASTM F104.
2. Gaskets shall be equal to Flexitallic Style CG, graphite filler, 304 SS winding, carbon steel centering ring, 0.175" thickness.

D. Bolting:

1. For all connections to valves, use bolts studs.
2. Bolts, bolt studs, nuts and washers used on piping systems in Central Utility Plant (CUP), tunnel and manholes shall have zinc plated finish.
3. Threads shall be in accordance with ANSI/ASME B1.1, Class 2A tolerance for external threads and Class 2B tolerance for internal threads. Threads shall be coarse-thread series except that alloy steel bolting 1 1/8" and larger in diameter shall be 8 pitch thread series.
4. Threaded rods are not allowed as fastening elements on steam systems.
5. For Class 150 and Class 300 flanges at 400°F or lower temperature, use carbon steel bolts or stud bolts conforming to ASTM A307, Grade B with nuts conforming to ASTM A307.
6. For Class 300 flanges at 500°F or lower temperature, use alloy steel bolts or stud bolts conforming to ASTM A193, Grade B7 or B16, with nuts conforming ASTM A194, Grade 2H.

2.9 VALVES- GENERAL

A. General: Install valves as shown on plans, details, and according to the valve manufacturer's installation recommendations.

B. Provide chain operators for manually operated valves 4" and larger, located more than 8'-0" above normal working surface.

C. ***Refer to Division 23 Section "General-Duty Valves for HVAC Piping" for additional requirements for valves and, from that section, refer to this section!***

2.10 BUTTERFLY VALVES FOR LINES IN CHILLED WATER TUNNELS

A. Valves to conform to latest revision of AWWA C-504. Valves to be tight closing, rubber seated. Valves to be zero-leakage at 200 psig, and shall be suitable for throttling service and operation after long periods of inactivity. Valves shall be rated for 250-psi non-shock working pressure minimum.

B. Cast iron body ASTM A-126B, Class B, restrained flanged (ANSI B16.1) ends. Valves shall be furnished complete with joint accessories (bolts, nuts, and gaskets). Flanging shall be lugged type permitting removal of downstream piping while using valve for system shutoff.

C. Resilient seat shall be Ethylene Propylene Diene Monomer (M-class) rubber (EPDM). EPDM seats shall be peroxide cured.

D. Valves 20" and smaller shall have the seat bonded directly to the body. Valve 24" and larger shall have seats that are mechanically retained in the valve body. Either seat shall be capable of mechanical adjustment in the field and field replacement.

E. Valve discs shall be constructed of cast iron ASTM A-126, Class B or ductile iron ASTM A-536. Disc shall have stainless steel seating edge to mate with valve seat.

F. Valve shaft to be 18-8, Type 304 stainless steel with "V" / "cup" PTF style self-adjusting packing.

G. Valve assembly shall be furnished with a non-adjustable factory set thrust bearing designed to center the valve disc at all times.

H. Shaft bearings shall be contained in the integral hubs of the valve body and shall be self-lubricated sleeve type and shall be sealed in place with "V" / "cup" PTF style self-adjusting packing.

I. Prior to shipment, valves to be hydrostatically and leak tested at the factory in accordance with AWWA C-504. Factory hydrostatic test shall be performed at 200 psig for all valves.

1. NU and Architect / Engineer shall have option to be present to witness factory testing for the first valves that are 20" and smaller and the first valves that are 24" and larger. Valve manufacturer shall be responsible for providing transportation and accommodations for two (2) NU representatives and one (1) representative of the Architect / Engineer.

J. Provide worm gear operators. Provide rotary hand wheels with adjustable position stop and position indicators. Size hand wheel operators with no higher than 40 lb rim pull at full valve pressure rating.

2.11 BUTTERFLY VALVES FOR UNDERGROUND CHILLED WATER LINES

A. Valves to conform to latest revision of AWWA C-504. Valves to be tight closing, rubber seated. Valves to be zero-leakage at 200 psig, and shall be suitable for throttling service and operation after long periods of inactivity. Valves shall be rated for 250-psi non-shock working pressure minimum. Valves to be designed for direct buried application.

B. Cast iron body ASTM A-126B, Class B, restrained mechanical joint (AWWA C-151/ANSI 21.11) or flanged (ANSI B16.1) ends. Valves shall be furnished complete with joint accessories (bolts, nuts, gaskets and glands).

C. Resilient seat shall be Ethylene Propylene Diene Monomer (M-class) rubber (EPDM). EPDM seats shall be peroxide cured.

D. Valves 20" and smaller shall have the seat bonded directly to the body. Valves 24" and larger shall have seats that are mechanically retained in the valve body. Either seat shall be capable of mechanical adjustment in the field and field replacement.

E. Valve discs shall be constructed of ASTM A-126 cast iron, Class B or ductile iron ASTM A-536. Disc shall have stainless steel seating edge to mate with valve seat.

F. Valve shaft to be 18-8, Type 304 stainless steel with "V" / "cup" PTF style self-adjusting packing.

G. Valve assembly shall be furnished with a non-adjustable factory set thrust bearing designed to center the valve disc at all times.

H. Shaft bearings shall be contained in the integral hubs of the valve body and shall be self-lubricated sleeve type and shall be sealed in place with "V" / "cup" PTF style self-adjusting packing.

I. Prior to shipment, valves to be hydrostatically and leak tested at the factory in accordance with AWWA C-504. Factory hydrostatic test shall be performed at 200 psig for all valves.

1. NU and Architect / Engineer shall have option to be present to witness factory testing for the first valves that are 20" and smaller and the first valves that are 24" and larger. Valve manufacturer shall be responsible for providing transportation and accommodations for two (2) NU representatives and one (1) representative of the Architect / Engineer.

J. Valves to be complete with grease packed buried service gear operator, shaft extensions with centering disk located on shaft, to within one foot of finished grade and soil pipe.

K. Refer to drawings for length of shaft extensions and soil pipes.

L. Valves shall be Pratt Groundhog or approved equal.

2.12 BALL VALVES IN TUNNELS

A. 2" and Smaller: bronze body, threaded, stainless steel ball and stem, full port, teflon seat rings, blowout-proof stem, three piece construction, 600 psi WOG, 150 psi SWP.

2.13 DRAIN AND VENT VALVES IN TUNNELS

A. Ball valves as specified above with hose thread adapter and cap. Provide 2” minimum drain valves provided with short threaded nipple and cap. All vent valves shall be minimum ¾” in size.

2.14 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Nipples: With like material unions, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. For chilled water piping in CUP, underground chilled water piping, chilled water piping in tunnels, and pressurized waste water piping, install per normal University standards and procedures.

B. Hot-water heating and chilled water piping, aboveground, NPS 4 and smaller, shall be Type L, drawn-temper copper tubing, wrought-copper fittings, with soldered joints 2" and smaller, and brazed joints larger than 2".

C. Hot-water heating and chilled water piping, aboveground, larger than NPS 4, shall be any of the following:

1. Schedule 40 Type E or S, Grade B steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Flanged joints only at valves, etc.
2. Schedule 40 Type E or S, Grade B steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints with the approval of the Engineer.

D. Condenser-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. Schedule 40 steel pipe; Class 125 cast-iron or 150 malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

E. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Schedule 40 type E or S grade B black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Flanged joints only at valves, etc.

F. Makeup-water piping installed aboveground shall be Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

H. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

I. Air-Vent Piping:

1. Inlet: Same materials and joining methods as for piping specified for the service in which air vent piping is installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

J. Safety-Valve-Inlet and -Outlet Piping for Hot Water and Chilled Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed

3.2 VALVE APPLICATIONS AND INSTALLATION

A. Install shutoff-duty valves at each branch connection to supply mains, at supply connections to each piece of equipment, and at other locations in systems for convenient system isolation.

B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

F. All valves with position indicators are to be installed so that the indicators are facing in a direction that is visible from floor level. Ball valve handles, if located near ceilings, are to be located on the 3 or 9 o'clock positions to allow for actuation. All butterfly isolation valves that are higher than 5' above the floor are to have chains for actuation. All valves need to have free and clear access, minimum of 24" from valves to adjacent work.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise, and are allowed if necessary, at common lines of chilled water bridges.

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

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded hose end with brass cap, at low points in piping system mains and elsewhere as required for complete system drainage. Locate as shown on drawings, and as required based on actual installed conditions.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow for supply and 0.2 percent downward in direction of flow for return.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the side or 45 degrees from the bottom of the main pipe.

P. ***Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."***

Q. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each coil, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in ***Division 23 Section "Expansion Fittings and Loops for HVAC Piping."***

U. Identify piping as specified in Division 23 Section "Mechanical Systems Identification."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in ***Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."***

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in ***Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."***

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in ***Division 23 Section "Escutcheons for HVAC Piping."***

3.4 TRACER WIRES

A. Tracer wire shall be installed on the piping as shown on the contract drawings.

B. Tracer wires shall terminate in each tunnel and manhole where new utilities penetrate. Tracer wires shall be provided with labels noting what pipe the wire is affixed to (ie. Chilled Water Supply, Pumped Condensate Return, etc).

C. Tracer wires shall be installed with a separate access point from and next to vault.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Mechanical Supporting Devices." Comply with the following requirements for maximum spacing of supports and minimum rod diameters.

B. Install the following pipe attachments:

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

C. Install hangers for steel piping with the following maximum spacing (with minimum rod sizes per MSS):

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 3 and larger: Maximum span, 12 feet.

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 3 and larger: 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.

3.6 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Grooved Joints If Used In Copper Systems: Assemble joints with coupling and gasket, lubricant, and bolts. Create grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and HVAC Shop approved grooved-end-pipe couplings.

3.7 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as shown and required for complete system air venting. Vents points to have isolation valves, pressure gages, and drain valves with hose connections.

3.8 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to ***Division 23 Section "Meters and Gages for HVAC Piping."***

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 2113