SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Condenser-water piping.
   4. Makeup-water piping.
   5. Blowdown-drain piping.
   6. Air-vent piping.
   7. Safety-valve-inlet and -outlet piping.

B. See Section 232123 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

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: [125 psig] at 200 deg F.
   2. Chilled-Water Piping: [125 psig] at 200 deg F.
   3. Condenser-Water Piping: [125 psig] at 150 deg F.
   4. Makeup-Water Piping: 80 psig at 150 deg F.
   5. Blowdown-Drain Piping: 200 deg F.
   6. Air-Vent Piping: 200 deg F.
   7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.
   3. Hydronic specialties.
   4. [Mechanical joint couplings.]

B. Operation and maintenance data.
1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

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

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe:
   1. NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade B, Schedule 40, black steel [or hot-dip zinc coated], plain ends.
   2. NPS 2-1/2 through 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel [or hot-dip zinc coated], plain ends.
   3. NPS 4 and Larger: ASTM A 53, Type E (electric-resistance welded), Grade B, Standard Weight, black steel [or hot-dipped zinc coated], plain ends.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
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:
   2. End Connections: Butt welding.
   3. Facings: Raised face.
G. Wrought Cast- and Forged-Steel Welding Fittings: ASME B16.9 or ASME B 16.11.
H. [Grooved Mechanical-Joint Fittings and Couplings:]

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Victaulic Company of America.

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.3 [STAINLESS STEEL PIPE AND FITTINGS]

A. Stainless Steel Pipe: ASTM A312, Type 304/304L full finish annealed, 0.049 inch wall, plain ends, certified for use with Vic-Press 304 piping system.

B. Stainless Steel Fittings:

1. Manufacturer: Subject to compliance with requirements, provide products by Victaulic Company.

2. Fittings: Precision cold drawn austenitic stainless steel with synthetic rubber O-rings.


2.4 PROTECTIVE COATING

A. Piping:

1. Manufacturer and Product: Subject to compliance with requirements, provide 3M Extrucoat or approved equal.

2. Coating: Factory applied, corrosion-resistant, minimum 2 mils thick, polyethylene coating for protection of steel piping in corrosive atmospheres or below ground.

B. Fittings and Joints:

1. Manufacturer and Product: Subject to compliance with requirements, provide Tyco Adhesives Polyken #1027 primer and #930-35 tape or approved equal.

2. Primer: Rubber adhesive primer.

3. Tape: Minimum 35 mils thick polyethylene tape with butyl adhesive on one side.

2.5 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.


D. Brazing Filler Metals: AWS A5.8, BAg-1, silver alloy.

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

2.6 VALVES

A. Gate, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "General Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 22 Section "Instrumentation and Controls for HVAC."

C. Bronze, Calibrated, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Armstrong Pumps, Inc.
      c. Bell & Gossett Domestic Pump; a division of ITT Industries.
      d. Gerard Engineering Co.
      e. Griswold Controls.
      f. Tour & Andersson; available through Victaulic Company of America
   2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.
   6. End Connections: Threaded or socket.
   8. Handle Style: Lever, with memory stop to retain set position.
   10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Flow Design Inc.
e. Gerand Engineering Co.
f. Griswold Controls.
g. MEPCO (Marshall Engineering Products Co.)
h. Taco.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
9. Handle Style: Lever, with memory stop to retain set position.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Fisher Controls, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Fisher Controls, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design Inc.
   b. Griswold Controls.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
5. Identification Tag: Marked with valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over an operating pressure differential range of at least 14 times the minimum required for control.
9. Maximum Operating Temperature: 250 deg F.

2.7 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Empire.
   d. Hoffman.
   e. Spirax Sarco.
f. Taco.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
5. Inlet Connection: NPS 1/2
6. Discharge Connection: NPS 1/4
7. CWP Rating: 150 psig
8. Maximum Operating Temperature: 240 degrees F.

C. Bladder Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. John Wood Company.

2. Tank: Welded carbon steel, rated for 125-psig working pressure and 240 degrees F maximum operating temperature, with taps in top of tank for system connection and tank charging, and tap in bottom of tank for draining. Tank shall be fitted with lifting rings. Provide a floor mounting skirt for vertical installations. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.


D. Centrifugal Air Separator:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. Spirax Sarco, Inc.
   d. Spirotherm, Inc.

2. Separator: Cast-iron or steel body with tangential connections, perforated stainless steel air collector tube. Body diameter shall be not less than three times the nominal inlet/outlet pipe diameter with a body volume for sufficient velocity reduction. Maximum working pressure of 125 psig and temperature of 250 degrees F. Air separator shall be fabricated and labeled according to ASME Boiler and Pressure Vessel Code Section VIII, Division I.

E. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
4. Maximum Operating Temperature: Up to 300 deg F.

2.8 HYDRONIC PIPING SPECIALTIES

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

B. Y-Pattern Strainers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Armstrong Pumps, Inc.
      b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
      c. Griswold Controls.
      d. Guvlok.
      e. Mueller Steam Specialty.
      f. Spirax Sarco Inc.
   2. Body: ASTM A 126, Class B, cast iron, or ASTM A 395, Grade 64-45-15 or ASTM A536, Grade 64-45-12 ductile iron, with bolted cover and bottom drain connection for NPS 2-1/2 and larger. Bronze body with threaded cover and bottom drain connection for NPS 2 and smaller.
   3. End Connections: Threaded ends for NPS 2 and smaller; flanged [or grooved] ends for NPS 2-1/2 and larger.
   4. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   5. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flex-Hose Co., Inc.
      b. Flexonics.
      c. Metraflex.
      d. Twin City Hose.
   3. End Connections: Threaded or flanged to match equipment connected.
   5. CWP Rating: 150 psig.
   6. Maximum Operating Temperature: 250 deg F.

D. Flexible Pump Connectors:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries.
   b. Metraflex Co.
   c. Proco Products, Inc.
   d. Vibration Mountings & Controls, Inc.

2. Body: Flexible, single- or double-sphere of EPDM liner and cover, Kevlar tire cord fractioning with steel ring embedded in raised face of rubber-flanged end. Provide ductile iron, external ring between double-spheres.

3. End Connections: Split ductile-iron or steel flanges with hooked interlocks.

4. Control Rods: Required where recommended by manufacturer or indicated on Drawings.

5. CWP Rating: 150 psig.

6. Maximum Operating Temperature: 250 degrees F.

E. Expansion fittings are specified in Division 15 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, [NPS 2 and smaller,] shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
   4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]

B. Hot-water heating piping, aboveground, [NPS 2-1/2 and larger,] shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]

E. [Condenser-][System-]water piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
   4. [Stainless steel pipe, Vic-Press 304 fittings and couplings subject to gasket suitability.]
   5. [Steel pipe and fittings installed outside shall be galvanized.]

F. [Condenser-][System-]water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. [Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.]
   4. [Steel pipe and fittings installed outside shall be galvanized.]

G. [Condenser-][System-]Water Piping below ground and within slabs, NPS 2 and smaller shall be any of the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use fewest joints possible.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
   3. Steel pipe and fittings installed belowground shall have protective coating as specified in “Protective Coating” Article in Part 2.

H. [Condenser-][System-]Water Piping below ground and within slabs, NPS 2 and smaller shall be any of the following:
   1. Type K, annealed-temper copper tubing, wrought-copper fittings, and brazed joints. Use fewest joints possible.
   2. Schedule 40 steel pipe; Class 125, cast-iron or Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Steel pipe and fittings installed belowground shall have protective coating as specified in “Protective Coating” Article in Part 2.

I. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

J. Makeup-Water Piping Installed Belowground and within Slabs: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

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

L. Air-Vent Piping:
   1. Inlet: Same as service where installed.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

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

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply and return mains, and at supply connection to each piece of equipment.

B. Install calibrated balancing valves in the return pipe of each heating or cooling terminal and elsewhere as required to facilitate system balancing.

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. Install safety-valve discharge pipe without valves to nearest floor sink or 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- and fill-water connection to regulate system pressure.

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 at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

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

E. Install piping to permit servicing of valves and specialties.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

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

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using concentric reducer fittings. Exception: Use eccentric reducer fitting installed with level side up on condenser water pump suction piping.

O. Make branch connections to mains using flow tees where branch size is not less than 1/3 the diameter of the main. Weld-O-Lets and Thread-O-Lets, may be used in other applications. Hot-taps shall only be used to connect branch lines to live mains.

P. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.

Q. Install valves according to Division 15 Section "General-Duty Valves for HVAC Piping."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. [Unions may be omitted in piping systems with mechanical joints.]

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. [Flanges may be omitted in piping systems with mechanical joints.]

T. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Select mesh opening size based on item being protected.

U. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15 Section "Pipe Expansion Fittings and Loops for HVAC Piping."
V. [Provide concrete thrust blocks at all changes in direction, dead ends, reducers and valves in underground piping.]

W. Identify piping as specified in Division 15 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. [Seismic restraints are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."]

C. Vibration control devices are specified in Division 15 Section “Vibration Controls for HVAC Piping and Equipment.”

D. 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 horizontal piping adjacent to the top and bottom of vertical runs.
5. Provide spring hangers on the first three hangers adjacent to spring-isolated, rotating equipment.

E. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size 5/8 inch.
10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. NPS 14 thru 16: Maximum span, 25 feet; minimum rod size, 1 inch.
13. NPS 18 thru 20: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.

F. 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.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 14 feet; minimum rod size, 1/2 inch.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 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.


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: 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.]

1. [Use grooved-end fittings and rigid, grooved-end-pipe couplings in all locations.]

I. [Vic-Press 304 Joints: Construct and install in strict conformance with manufacturer's written recommendations.]

3.6 [PROTECTIVE COATING]

A. Field Applied Tape.
1. Apply to all joints, fittings and other areas where the factory applied coating is missing or damaged.
2. Apply to clean and dry surfaces.
3. Apply adhesive primer prior to application of tape.
4. Wrap tape with minimum 50 percent overlap.
5. Extend tape a minimum of 4 inches over intact, factory-applied coating.

3.7 HYDRONIC SPECIALTIES INSTALLATION

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

B. Install automatic air vents in mechanical equipment rooms at high points of system piping, at heat transfer coils, at the air outlet on the air separator, and elsewhere as required for system air venting.
   1. Provide shutoff valve on inlet side of each automatic air vent.
   2. Provide drain piping from each automatic air vent outlet to nearest floor sink, mop sink or floor drain.

C. Install piping from [boiler air outlet] air separator, or air purger to expansion tank with a 2 percent upward slope toward air vent.

D. Install in-line air separators in pump suction NPS 1-1/2 and smaller and centrifugal air separators in NPS 2 through NPS 24. Install drain valve on air separators NPS 2 and larger.

E. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder where indicated on Drawings, using full port ball valve on inlet and outlet. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks where indicated on Drawings.
   1. Charge tank to initial fill pressure.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

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 15 Section "Meters and Gages for HVAC Piping."

D. Install flexible connectors at the inlet and outlet of all moving equipment, except pumps. Match size of adjacent pipe.
E. Install flexible pump connectors at the inlet and outlet of all pumps, except in-line pumps. Match size of adjacent pipe.

### 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:

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.
3.10 CLEANING

A. Clean interior of piping systems using chemicals supplied by HVAC Water Treatment Contractor. Circulate chemicals as directed to remove oils, dirt, and other compounds detrimental to the proper operation of the system.

B. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh start-up strainers in pump suction diffusers and replace with permanent strainer.