

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Hot-water piping
 - 3. Condensate piping
- B. See Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Chilled-Water Piping: 250 psig at 200 deg F (93 deg C)
 - 2. Hot Water Piping: 250 psig at 200 deg F (93 deg C)

1.4 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pressure-seal fittings.
 - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 3. Air control devices.
 - 4. Hydronic specialties.
- B. Shop Drawings: Detail, at 1/4 (1:50) scale, 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.
- C. Field quality-control test reports.

- D. Operation and maintenance data.

1.5 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 (ASTM B 88M, Type B).
- B. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- C. 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.
- D. Slip-On flanges are not permitted.
- E. All piping shall comply with ASTM A105.

2.3 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 (3.2-mm) 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: ASTM A307A bolts or studs only.
- 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 BA9-1, 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.
- F. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- G. Insulating Material: Suitable for system fluid, pressure, and temperature.
- H. Dielectric Unions:
 - 1. Not Permitted; use Dielectric nipples or bronze ball valve to connect dissimilar metals.
- I. Dielectric Couplings:
 - 1. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
 - g. 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.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250 deg F (121 deg C).

2.5 AIR CONTROL DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amtrol, Inc.
 2. Armstrong Pumps, Inc.
 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
 4. Taco.
- C. Manual Air Vents:
 1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Screwdriver or thumbscrew.

4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225 deg F (107 deg C).

D. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.

E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig (1207 kPa).
3. Maximum Operating Temperature: Up to 300 deg F (149 deg C).

2.6 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 1 (DN 50) and smaller, shall be any of the following:
 - 1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings; and threaded joints.
- B. Chilled-water piping, aboveground, NPS 1 to NPS 2, shall be any of the following:
 - 1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings; and threaded joints.
- C. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
 - 1. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings.
- D. Hot-water piping, aboveground, NPS 1 (DN 50) and smaller, shall be any of the following:
 - 1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings; and threaded joints.
- E. Hot-water piping, aboveground, NPS 1 to NPS 2, shall be any of the following:
 - 1. Type L (B), drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 2. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings and threaded joints.
- F. Hot-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
 - 1. Schedule 40 steel pipe; Class 250, malleable-iron fittings; malleable-iron flanges and flange fittings.
- G. Condensate piping, aboveground, shall be the following:
 - 1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

3.2 DIRECT BURIED PIPING SYSTEM

- 1. General: All underground piping for chilled water system distribution shall have a minimum diameter of 4" and shall be cement lined ductile iron.
- 2. Pipe Joint Restraint Calculations: Submit complete calculations for underground chilled water pipe joints indicating the requirements for restrained and push-on joints. Submission of output data from an approved vendor computer selection/calculation

program will be required to justify the use of push-on joints in certain locations. This program shall utilize the depth of cover indicated on the profile drawings.

3. Ductile Iron Pipe: Pipe shall conform to AWWA C151 minimum class 50. All ductile iron pipe shall be cement mortar lined in accordance with AWWA C104 and shall have asphaltic coating. Piping 4" – 12" shall have 350 psig minimum working pressure. Piping 14" – 24" shall have a 300 psig minimum working pressure.
4. Select backfill material shall be provided for bedding and backfill 12" above pipe.
5. System drains and vents – Provide system drains at low points and system vents at high points according to details as attached.
6. Fittings: Fittings for ductile iron pipe shall be ductile iron and rated a minimum of 250 psi working pressure. Fittings shall be cement mortar lined equivalent to the pipe lining.
7. Mechanical Joint Fittings: Comply with AWWA C110. Where restrained joints are identified, use Megalug Series 1100 system or approved equal. Gasket material shall be SBR
8. Push-on Joint: Comply with AWWA C111
9. Butterfly Valves: Comply with AWWA C504. Valve shaft to be type 304 stainless steel. Cast valves from gray or ductile iron. Provide interior coating of body and disk. Valves shall be furnished with buried service gearbox operator, shaft extensions, ground level position indicators and valve boxes.
10. Gate Valves: Comply with AWWA C509. Stem shall be non-rising and shall be cast bronze. Valve body and wedge shall be ductile iron and shall be coated inside and outside with epoxy. The coating shall meet or exceed AWWA C550. Valves shall have a minimum pressure rating of 250 psi. Gate valves shall be US pipe or approved equal.
11. Valve Boxes: Valve boxes shall be 2 piece cast iron with heavy duty traffic weight lid marked with valve number as shown on drawings (such as CWS –22). Valve boxes not in paving shall be supplied with a pre-cast concrete mowing ring.

3.3 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating terminal as indicated.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and 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.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- G. Brazed fittings for copper pipes.

3.4 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.
- D. Use ASTM A307 A Bolts and nuts.
- 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 or thread-o-let, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage. Piping nipple shall be long enough to clear insulation.
- N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- P. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- Q. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

- R. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- S. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- 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 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- V. Arrange piping to minimize the occurrences of dielectric connections.

3.5 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Support vertical runs at roof, at each floor, and at 10-foot (3-m) 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.

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 piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
- D. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches (1200 mm) above the floor. Install feeder in minimum NPS 3/4 (DN 20) bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 (DN 20) pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.
- E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 1. Install tank fittings that are shipped loose.
 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 23 Section "Meters and Gages for HVAC Piping."

3.9 CHEMICAL TREATMENT

- A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

- B. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.10 FLUSHING & CLEANING PIPING SYSTEMS GENERAL

- A. All water used during the hydrostatic pressure tests, cleaning, flushing and filling of piping systems shall be provided by the contractor and included in the project cost unless specifically agreed upon by the Director of Utilities and Engineering Services. This water is to be metered from project beginning until the piping system is cleared to be connected to the campus utility systems and/or at project close-out
- B. Flush all water systems thoroughly for a minimum of 1 hour or longer, as required, to ensure removal of all dirt and foreign matter from piping system. Flushing shall continue until water draining from the pipe is clear and clean of any dirt and debris as determined by the Engineer or Owner and verified by the NCSU Utilities Distribution Shop. Bypass all pumps and equipment and remove all strainers from strainer bodies. Provide circulation by Contractor supplied pumping apparatus
- C. Contractor shall be responsible for phasing and scheduling piping installation work such that all sections of the new piping will be cleaned and flushed as specified. Contractor shall provide temporary access tapping at all high points and low points through valves, tees, flanges, etc. to facilitate the cleaning and flushing process.
- D. Contractor shall provide all water for flushing. Coordinate rental of fire hydrant meters with the City of Raleigh or NCSU Utilities Distribution, as determined by the Project Manager and based on hydrant system owner (NCSU or City of Raleigh).
- E. Contractor shall provide all temporary piping from water source to piping system and shall provide means for conducting testing and cleaning water from underground piping system to the appropriate sewer; i.e. pumps, piping, hoses, etc. Contractor to remove all temporary piping, pumps, hoses, etc. from the site after flushing has been completed.
- F. Provide temporary piping or hose to bypass coils, control valves, heat exchangers, other factory cleaned equipment, and any component which may be damaged, unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place.
- G. Sectionalize system to obtain minimum velocity of 6 fps. Provide temporary piping to connect dead-end supply and return headers as necessary. Flush bottom of risers.
- H. Coordinate with NCSU Utilities Distribution personnel to visually inspect piping systems as installed and/or flushed to verify cleanliness from the owner's perspective.
- I. Add chemical inhibitor Nalco 8338 or equivalent to closed loop water systems. (see below)
- J. Provide NCSU Utilities & Engineering (Water Treatment Technician) with records of flushing, treating chemicals (quantities and concentrations) and final water chemistry.
- K. Contractor shall be responsible for filling and treating water for final fill.

3.11 FLUSHING & CLEANING PIPING SYSTEMS FINAL

- A. Flush all water thoroughly for a minimum of 1 hour or longer, as required, to ensure removal of all dirt and foreign matter from piping system. Flushing shall continue until water draining from the pipe is clear and clean of any dirt and debris as determined by the Engineer or Owner and verified by the NCSU Utilities Distribution Shop. Bypass all pumps and equipment and remove all strainers from strainer bodies. Provide circulation by Contractor supplied pumping apparatus.
- B. After initial flushing of system discussed in paragraph A above, use portable pumping apparatus for continuous 24 hour minimum circulation of cold water detergent similar to Nalco 2567 cleaner. Flush detergent clear with continuous draining and raw water fill for additional 12 to 24 hours or until all cleaner is removed from system and conductivity, pH, and iron concentrations are within guidelines and verified by the NCSU Water Treatment Technician. Replace strainers and reconnect permanent pumping apparatus and all apparatus bypassed.

3.12 WATER ANALYSIS REQUIREMENTS

- A. Specific numbers will be determined at the time of construction as city water and system values can vary from location to location within the NCSU campus.
- B. Hot Water Piping:
 - 1. Conductivity: Approximate existing system conditions
 - 2. pH: Approximate existing system conditions
 - 3. Target inhibitor PPM level: Approximate existing system conditions
 - 4. Iron concentration: Approximate existing City of Raleigh water conditions

3.13 SYSTEM PRESSURE AND LEAK TEST

- A. Length of test, unless otherwise approved, shall be a minimum of 4 hours. Contractor shall have conducted a preliminary pressure test prior to final acceptance test to locate and correct any pipe leaks.
- B. Water piping shall be leakage rate tested. Leakage rate test shall be conducted at the same time as the hydrostatic pressure test. Leakage rate is defined as the quantity of water that must be supplied into respective underground piping system to maintain pressure within 5 psig of the specified hydrostatic test pressure after system has been vented and filled. Contractor shall document test results and sign/date each test.
- C. The maximum allowable leakage is determined by the following formula
 - 1. $L = N * D * (P)^{2/3} / 7,400$

where:

L = allowable leakage (GPH)

N = number of joints in length of pipe line tested

D = nominal pipe diameter (inches)

P = average test pressure during leakage test (psig)

2. If measure leakage rate exceeds maximum leakage rate, repair with new materials and repeat test until satisfactory results have been obtained.

3.14 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 16 hours, 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 232113