

SECTION 231000 – PIPING, VALVES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 23.
- B. This Section covers piping, fittings, valves and accessories for heating, ventilating, and air conditioning systems, and, except as otherwise specified herein, does not cover fuel, plumbing, or fire protection systems.
- C. Testing, adjusting, and balancing is specified in Section 230095, Testing, Adjusting and Balancing.
- D. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification.

1.2 QUALITY ASSURANCE

- A. Piping systems shall meet ASME B31.9-2017, Building Services Piping.
- B. Components of the same type shall be products of the same manufacturer.
- C. Welder certification: welders shall be certified under the rules of the National Certified Pipe Welding Bureau and qualified by either the National Certified Pipe Welding Bureau or an independent testing laboratory for the procedures used on this Project.
- D. Welding procedures: in accordance with ASME B31.9-2017, for the service involved. Welds shall be full penetration type, accomplished by proper beveling and spacing of pipe ends. Where backing rings are specified herein, root pass shall penetrate into the backing ring.
- E. Pressure/temperature ratings of components and accessories shall meet or exceed design conditions for the system in which they are installed. Components and accessory items shall be designed for operating conditions of not less than:

<u>System</u>	<u>Rating</u>
Chilled	200 psig and 250°F

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Pipe:

<u>Service</u>	<u>Joints</u>	<u>Material</u>
Chilled, water, 2.5" through 10"	Welded	Black steel, schedule 40, ASTM A53/A53M-2018

<u>Service</u>	<u>Joints</u>	<u>Material</u>
Chilled, 2" and smaller	Soldered <u>or</u> <u>Threaded</u>	Copper tubing, type L, hard drawn ASTM B88-2016 or Black steel, schedule 40, Grade B, ASTM A53/A53M-2018
Refrigerant	Brazed	Copper tubing, type ACR, hard drawn, ASTM B280-2019
Chilled water chemical treatment systems	Threaded	Black steel, schedule 40, ASTM A53/A53M-2018
Coil condensate drain	Soldered	Copper tubing, type L, hard drawn, ASTM B88-2016

- B. Fittings for type L copper 2" and smaller shall be wrought copper, solder joint fittings,
 - 1. Solder joint fitting manufacturer: Elkhart, Mueller, or NIBCO.
 - 2. Press joint fitting manufacturer: NIBCO Press, Victaulic Vic Press, or Viega Pro Press.
- C. Fittings for black steel schedule 40 pipe, 2" and smaller, shall be standard weight black malleable iron. Fittings for black steel pipe 2.5" and larger shall be black steel ASTM A234/A234M-2019 Grade WPB of a service class to match the adjacent pipe, except that connections to valves and equipment shall be made with ASTM A105/A105M-2018 flat face welding neck flanges. or grooved ends.
- D. Branch connections: forged steel, welding nipple type.
 - 1. Manufacturer: Bonney Forge, Capital, or WFI.
- E. Fittings for steel tubing shall be slip fit or slip coupling type, same material and gauge as tubing. Provide threaded adaptors for installation of ball valves.
 - 1. Manufacturer: Spencer Turbine Company, Keystone Energy Tools, or McMaster-Carr.
- F. Elbows: long radius type, except where space conditions do not permit.
- G. Solder: 95/5 tin/silver or tin/antimony alloy type.
- H. Flux: ASTM B813-2016.
- I. Refrigerant Pipe and Accessories:
 - 1. Fittings: sweat type, wrought copper.
 - 2. Stop valves: up to 3.125" od, ball type, designed for refrigerant service, with seal caps; above 3.125" od, globe type, back-seating, with seal caps.
 - a. Manufacturer: Alco, Henry, Kerotest, or Watsco.
 - 3. Test valves: 0.25" male flare globe type, back-seating with seal caps.
 - 4. Expansion valves: thermostatic, pressure balanced type with external equalizer connections.
 - a. Manufacturer: Alco, Parker, or Sporlan.

5. Filter-dryers: molded porous core type, serviceable for systems 10 tons and larger and nonserviceable for systems smaller than 10 tons.
 - a. Manufacturer: Alco, Parker, or Sporlan.
6. Moisture and liquid indicators: Alco, Henry, Parker, or Sporlan.

J. Brazing Alloys:

1. For copper-to-copper joints: AWS A5.8/A5.8M-2011, Classification BCuP-5, 15% silver brazing alloy with a melting point range of 1300°F to 1500°F.
2. For dissimilar metal joints: AWS A5.8/A5.8M-2011, Classification BAG-1, 45% silver brazing alloy with a melting point of 1145°F to 1400°F.
3. Flux: approved by brazing alloy manufacturer.
4. Manufacturer: Airco, Handy & Harman, or Harris.

2.2 VALVES AND STRAINERS

A. Body construction, unless specified otherwise herein:

1. 250 psig service and lower: cast iron.
2. 300 psig service and higher: forged steel.

B. Butterfly valves: lug type with cast or ductile iron body, EPT (EPDM) seat designed for service at 200°F, type 304, 316, or 416 stainless steel stem, and conforming to MSS SP-67-2017. Shaft bushings shall be permanently lubricated bronze, TFE-coated stainless steel, nylon, or acetal. Operators shall be the lever and quadrant type with memory stops for valves 6" and smaller. and valves used for balancing. Operators shall be the manual handwheel gear type for valves 8" and above. Butterfly valves shall be factory hydrostatically tested at 150% of the pressure rating specified herein and shall be factory-tested bubbletight at 150 psi disc differential. and shall be designed for dead-end service without a back-up flange. Butterfly valves shall be 2.5" size and larger.

1. Manufacturer: Apollo, Bray, Crane, Keystone, Kitz, Milwaukee, NIBCO, or Stockham.

C. Ball valves: bronze body, full port, chromium-plated brass ball, TFE seals and seats, blowout-proof stem, and soldered or threaded ends conforming to MSS SP-110-2010. Ball valves shall be 2" size and smaller. Ball valves in insulated piping shall be provided with extended lever or stem. Ball valves used for balancing shall have memory stops.

1. Manufacturer: Apollo, Crane, Kitz, Milwaukee, NIBCO, or Stockham.

D. Check valves installed in horizontal pipe: swing-type with full flow area. Valves 2" and smaller shall be threaded bronze body with Teflon or composition discs conforming to MSS SP-80-2019. Valves 2.5" and larger shall be flanged body with Teflon, cast iron, or composition discs conforming to MSS SP-70-2011. Check valve hanger pins shall be supported at both ends by removable side plugs.

1. Manufacturer: APCO, Hammond, Kitz, Milwaukee, NIBCO, or Wheatley.

E. Check valves installed in vertical pipe and at pump discharges: spring-loaded silent-type. Seats, discs, and guides shall be bronze or stainless steel with stainless steel or bronze return spring. Disc shall be fully guided top and bottom. Valves shall have an open area equal to 10% more than the related pipe size area. Valves 2" and smaller shall be threaded bronze body. Valves 2.5" and larger shall be flanged conforming to MSS SP-125-2018.

1. Manufacturer: APCO, Hammond, Kitz, Milwaukee, NIBCO, or Wheatley.

F. Control valves: as specified in Section 238000, Automatic Temperature Controls.

- G. Strainers: Y-type, flanged body with removable type 316 stainless steel or monel screens. Strainers 2.5" and larger shall be provided with a plugged gate valve and nipple the full size of the strainer blowdown outlet. Strainers 2" and smaller shall be threaded, bronze body type. Strainers 2.5" and larger shall be flanged.

1. Water Service:

<u>Pipe Size</u>	<u>Strainer Perforation Size</u>
0.75" to 1.5"	20 mesh
2" to 3"	0.062"
4" and above	0.125"
Chiller inlet (all sizes)	20 mesh

- H. Suction diffusers: angle type body with inlet vanes and combination diffuser strainer-orifice cylinder with 0.188" diameter openings. Unit shall be equipped with disposable fine mesh start-up strainer. Strainer free area shall be no less than 5 times the section area of the pump connection. Unit shall be provided with adjustable support foot.

- I. Water pressure relief valves: bronze body construction with a steel spring. Valves for hot water applications shall be ASME rated.

1. Manufacturer: Aquatrol, Kunkle, Watts, or Wilkins.

- J. Water pressure reducing valves: bronze body construction with a stainless steel spring, and renewable seat.

2.3 ACCESSORIES

- A. Unions:

- Unions in black steel piping 2" and smaller, except as specified herein, shall be black malleable iron, ground joints, bronze seated of the service class to match the adjacent piping, with screwed end connections.
- Unions in copper piping shall be cast brass or bronze with copper soldered connections.

- B. Dielectric fittings: threaded, flanged, brazed, or soldered to match adjacent piping. Metal parts of the union shall be separated so that the electrical current is below 1% of the galvanic current which would exist with metal-to-metal contact.

1. Manufacturer: Bolt-Pak, Epco (with high temperature gasket), Perfection Clearflow, or Watts.

- C. Automatic air vents: float-operated automatic type with cast iron body, stainless steel trim, 0.75" piping connections, and minimum 175 psig water working pressure.

1. Manufacturer: Anderson, Armstrong, or Hoffman.

- D. Thermostatic air vents: self-adjusting, balanced thermostatic type with welded multiple plate stainless steel bellows. Body shall be brass with 0.5" piping connections and stainless steel internal components. Thermostatic air vents shall be rated for 125 psig.

1. Manufacturer: Armstrong TV-2, Hoffman 8C, or Spirax Sarco T202.

- E. Vacuum breakers: brass or stainless steel body, stainless steel retainer tube, ball or spring, and resilient seat.

1. Manufacturer: Armstrong, Colton, Hoffman, Johnson, or Spirax Sarco.

- F. Pressure gauges: bourdon tube type with metal case, 4.5" dials, accuracy within 1% of full scale range, equipped with snubbers and needle valves. Gauges at pumps and chillers shall be liquid-filled

<u>Service</u>	<u>Range</u>
Chilled water pumps	0/100 psig

1. Manufacturer: Ashcroft, Marsh, Terice, Weiss, or Weksler.

- G. Dial thermometers: bimetallic element, dial type with minimum 3" dials, stainless steel case, angle or straight as required. Thermometers installed in uninsulated piping shall have 4" stems with brass separable sockets. Thermometers installed in insulated piping shall have 6" stem with brass separable socket with extension neck equal to thickness of insulation. Thermometers installed in ducts shall have 6" stems with duct mounting flanges.

<u>Service</u>	<u>Range</u>
Chilled water	0°/150°F

1. Manufacturer: Ashcroft, Marsh, Palmer, Taylor, Terice, Weiss, or Weksler.

- H. Thermometer test wells: brass construction with brass plug and chain, designed for use with partial immersion laboratory type test thermometers. Test wells in insulated piping shall have an extension neck equal to thickness of insulation.

1. Manufacturer: Ashcroft, Moeller, Taylor, Terice, Weiss, or Weksler.

- I. Flow Meters:

1. Venturi Type:

- a. Venturi type, complete with venturi, pressure taps, quick connect couplings, and bar stock needle valves. Venturies 4" through 8" shall be zinc-plated cast or fabricated steel, and 10" and larger shall be fabricated steel. Venturies shall have weld ends.
- b. Provide vinyl laminated tag attached to venturi with chain indicating size, location, flow rate and differential pressure reading. Venturi shall be selected for the required minimum and maximum flow rates to read within the appropriate range on a 0" wg to 300" wg master meter.
- c. Venturi accuracy over flow range shall be $\pm 1\%$.
- d. Venturi shall have a minimum working pressure rating of 300 psig at 150°F.
- e. Provide one portable meter set, including checking hoses, check seal and carrying case. Wetted parts of the meter shall be stainless steel. Meter shall be diaphragm type with variable pulsation damping control, zero adjustment control, and bleed valves. Meter shall be designed for system velocities and temperatures. Accuracy of complete system shall be $\pm 3\%$.
- f. Venturi shall be provided with wall-mounted meter reading gpm with $\pm 5\%$ accuracy, in addition to master meter taps.
- g. Manufacturer: Bailey, Barco, or BIF, or.

- J. Automatic Flow Control Valves:

1. Valves 2" and smaller shall have soldered or threaded ends with brass or bronze body; and 2.5" and larger shall have flanged ends with iron body. Valves shall have pressure/temperature test plugs for verifying the pressure differential across the assembly and system temperature.
2. Valves shall automatically control flow rates within $\pm 5\%$ accuracy over an operating pressure differential range of at least 14 times the minimum required for control. At least 2 operating pressure ranges shall be available with the minimum range requiring less than 3 psig to activate the mechanism. Provide flow capacity characteristic curves or tables for each valve size.

3. Valve internal control mechanisms shall consist of a corrosion resistant cartridge with segmented port design and full travel linear coil spring. Valves shall have Y-body housing or other means to provide access to internal control mechanism without removing the valve.
 4. Manufacturer shall provide certified independent laboratory test verifying accuracy of performance.
 5. Provide one portable meter set, including checking hoses, check seal and carrying case. Wetted parts of the meter shall be corrosion resistant. Meter shall be diaphragm type with variable pulsation damping control, zero adjustment control, and bleed valves. Meter shall be designed for system velocities and temperatures.
 6. Manufacturer: Flow Design, Griswold, IMI, or Kates.
- K. Expansion Tanks:
1. Expansion tanks shall be bladder type, welded steel, designed, constructed, certified, and stamped in accordance with ASME BPVC-VIII-1-2019 for a working pressure of 125 psig. Bladders shall be replaceable elastomeric butyl rubber type, designed for a maximum operating temperature of 240°F.
 2. Manufacturer: Bell & Gossett, MEPCO, Taco, Wessels, or Wheatley.
- L. Combination Pressure and Temperature Test Plugs:
1. Combination pressure and temperature test plugs may, at the Contractor's option, be used on pipe sizes 2" and smaller, for maximum 150 psig service, in lieu of the needle valves and thermometer test wells specified herein or indicated on the Drawings. Plugs shall not be used at locations specified herein or indicated on the Drawings to have a pressure gauge or thermometer permanently installed. Plugs shall have brass bodies, and internal valve seat material designed for specific system operating temperature and pressure. Plugs shall be provided with adaptors to connect pressure gauges or thermometers identical to those used elsewhere on the Project.
 2. Manufacturer: Fairfax, Flow Design, Peterson, or SISCO.
- M. Temperature Maintenance Cable:
1. Self-Regulating Heating Cable:
 - a. Cable shall consist of 2 #16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature along its length. Cable shall be covered by a crosslinked, modified polyolefin dielectric jacket. Cable shall have a braid of tinned-copper and an outer jacket.
 - b. Cable components shall be UL listed to provide freeze protection flow maintenance as required.
 - c. System shall be controlled manually, either directly or through a contactor.
 - d. System shall be controlled by an ambient line sensing thermostat set at 40°F, either directly or through a contactor.
 - e. Manufacturer: Brisk-Heat SL series, Chromalox, Easy Heat, Nelson Electric, Raychem XL-Trace, or Thermon.
 2. Constant Wattage Cable:
 - a. For maximum surface temperature of 150°F: UL listed, self-regulating type with TPE sheath, tinned-copper braid, and thermoplastic rubber outer jacket, complete with power connection kits. Surface temperature of plastic pipe shall not exceed manufacturer's recommendation for service and type of pipe.
 - b. For surface temperatures between 150°F and 250°F: UL listed, constant-watt zone type cable with TPE sheath, tinned-copper braid and thermoplastic outer jacket, complete with power connection kits.
 - c. For surface temperature of 250°F or higher: UL listed, mineral insulated type with fire resistant sheath, complete with power connection kits.
 - d. Provide 2 thermostats in series. The first thermostat shall remain open until the ambient temperature drops below 45°F and the second thermostat shall be the line sensing type to maintain pipe temperature at 35°F with an ambient temperature of -20°F. Each set of

- thermostats shall control all temperature maintenance cable in a common location, up to maximum 30 A.
- e. Manufacturer: Brisk-Heat FE series, Chromalox, Easy Heat, Nelson Electric, Raychem, or Thermon.
- N. Inline air separators: centrifugal inline tank type, capable of handling the water flow indicated on the Drawings, and constructed for 125 psig working pressure.
1. Manufacturer: Armstrong, Bell & Gossett, Taco, Thrush, or Wheatley.
- O. Gaskets: 0.063" thick, conforming to ASME B16.5-2017, asbestos-free, selected for the pressure, temperature and service of the specific joint.
1. For other services: composition sheet type.
- P. Bolting Materials:
1. For maximum system ratings of 250°F and 160 psig:
- a. Bolts and studs: ASTM A307-2014e1, Grade B, zinc-plated.
- b. Nuts: ASTM A563-2015, Grade A, heavy hex, zinc-plated.
- Q. Pipe Alignment Guides:
1. For steel piping: bolted 2-section outer cylinder type, with a 2-section guiding spider.
- a. Manufacturer: Anvil 255, Elcen 411A, or ERICO 650.
2. For copper tubing: same as for steel piping but with a copper spider.
3. Guides and spiders shall be designed to clear pipe insulation and to prevent overtravel.

PART 3 - EXECUTION

3.1 GENERAL

- A. Before erection, clean interior and exterior of pipe and fittings of slag, spatter, rust, dirt and debris by wire brushing and swabbing.
- B. Workmanship: pipe shall be cut to measurements established at the Project site and worked into place without springing or forcing. Pipes shall be installed to permit free expansion and contraction without damage to joints, hangers, or the building.
- C. Changes in direction shall be made with fittings, except where branches are two or more sizes less than the size of the main, the branch may be made using branch connections, weldolets, threadolets, latrolets, sweepolets, and elbolets.
- D. Pitch/grade: piping shall be installed with sufficient pitch to ensure drainage and venting.
- E. Solder joint connections shall be cut, deburred, cleaned and assembled in accordance with ASTM B828-2016.
- F. Threaded connections: screw-thread joints shall be made with cut tapered threads. Joints shall be made tight with Teflon tape unless otherwise specified herein. Not more than 2 threads shall show after the joint is made tight. Pipes shall have burrs removed by reaming cut end.

G. Welding:

1. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the standards specified herein and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20% of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
2. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F.
3. Welders shall stamp each weld with their personal symbol or code number.
4. Current welder certifications for welders performing welding on this Project (on or off-site) shall be maintained at the Contractor's site office and shall be readily available for review.
5. A random sample of completed pipe welds may be chosen by the Engineer for visual testing by an independent testing agency, not to exceed 5% of the total welds on the Project. Costs for testing shall be borne by the Contractor. Acceptance criteria shall be as specified by ASME B31.9-2017. If any of the tested welds are unsatisfactory, additional welds may be chosen for testing at the Contractor's expense.
6. Defective welds shall either be cut out and rewelded or ground down to base metal and rewelded. Reworked welds shall be tested as specified herein.

H. Flanged joints in water piping shall be made with ring type gaskets, extending to inside of bolt holes. Flanged connections to equipment shall be made with full face gaskets to match flanges on equipment.

I. Install piping so as to preserve access to valves, air vents, and equipment requiring access, and to provide the maximum headroom.

J. Provide offsets to maintain ceiling height and to coordinate with other trades.

K. Install piping such that when insulation is applied it will not come in contact with adjacent surfaces.

L. Provide reducing fittings for changes in pipe sizes.

M. Perform pressure tests required by Section 230095, Testing, Adjusting and Balancing before work is concealed or buried.

N. Piping failing the tests specified in Section 230095, Testing, Adjusting and Balancing shall be repaired until satisfactory.

3.2 VALVES AND STRAINERS

A. Valves in horizontal piping shall be installed with stems at or above the pipe centerline.

B. Butterfly valves may be used in lieu of the gate and balancing valves indicated on the Drawings for 125 psig and 200°F chilled, and condenser water service.

C. Ball valves may be used in lieu of the gate and balancing valves indicated on the Drawings for chilled, hot, and condenser water service.

D. Butterfly valves adjacent to equipment shall be functional when equipment is removed.

- E. Control valves: install in accessible locations, with room for actuator removal and service. Adjust the actuators to provide tight closure. Provide valve stem travel indicators and adjust to indicate proper travel. Where butterfly valves are used, permanently mark the end of the valve shafts to indicate valve position.
- F. Strainers in water piping shall be installed with blowdown outlets at the low point.
- G. Suction diffusers: install at the inlet of end suction pumps, in lieu of the strainer indicated on the Drawings.

3.3 ACCESSORIES

- A. Pressure Gauges:
 - 1. Install a gauge at the highest point of each closed hydronic system.
 - 2. Install as indicated on the Drawings, unless otherwise specified herein.
- B. Dial thermometers: install as indicated on the Drawings, unless otherwise specified herein.
- C. Thermometer test wells: install as indicated on the Drawings, unless otherwise specified herein. Fill with a thermally conductive material.
- D. Thermometers and thermometer test wells shall be installed on a 45° angle in vertical piping and vertically in horizontal piping.
- E. Thermometers, needle valves, pressure gauges, and thermometer test wells shall be installed so as to not be obscured by piping, building structure, or equipment.
- F. Flow meter connections with isolation valves shall be extended and attached to the wall 5' above the floor with channel struts. Wall-mounted meters shall be mounted 5' above the floor.
- G. Install control valves, thermometers, and valved pressure taps provided under Section 23 80 00, Automatic Temperature Controls.
- H. Temperature Maintenance Cable:
 - 1. Install and test before insulation is applied, in accordance with manufacturer's recommendations.
 - 2. Install on exterior water supply and return piping,
 - 3. Secure cable to the piping with cable ties or fiberglass tape.
 - 4. Do not cross cable with itself.
 - 5. Hard wire power connections to junction box.
- I. Inline Air Separators:
 - 1. Provide a 0.75" drain with valve on the separator tank.
 - 2. Support with hangers independently from the adjacent piping.
- J. Bolting Materials:
 - 1. Lubricate bolt and stud threads with molybdenum disulfide anti-seize compound.
 - 2. Bolts and studs, when installed, shall extend not less than 2 full threads through nuts when tightened to the required torque.
 - 3. Install washers under bolt heads and nuts.
- K. Pipe Alignment Guides:
 - 1. Pipe alignment guides shall be bolted to piping and the spiders shall be fully insulated.
 - 2. Bolt outer housings of guides to the structure.

3.4 UNIONS AND FLANGES

- A. Provide unions or flanges for disconnecting pipe from valves and equipment, and as indicated on the Drawings.
- B. Dielectric fittings shall be used for connections between ferrous piping or equipment and nonferrous piping or equipment, except that brass and bronze valves shall not be isolated in predominantly steel piping systems.

3.5 WATER SUPPLY AND RETURN PIPING

- A. Arrange piping for the venting of air and for drainage of the entire system.
- B. Changes in size of vertical piping shall be made with concentric reducers, and in horizontal piping shall be made with eccentric reducers to maintain uniform top elevation of pipe.
- C. Extend drain piping from chilled water pump drain pans to floor drain. Route pipe tight to equipment foundations and avoid obstructing access paths and maintenance areas.
- D. At each low point of the system, provide a 0.75" drain valve with hose thread, and at each high point and in every drop in the direction of flow of supply and return mains provide a manual air vent valve, unless otherwise indicated on the Drawings or specified herein.
- E. Provide 1.5" fill and drain valves at each connection of new water piping to existing water piping. Locate fill valves on top of new supply pipe and drain valves at bottom of new return pipe.
- F. Provide crossover connections and valves as required in order to perform cleaning as specified in Paragraph 3.6, Cleaning.

3.6 CLEANING

- A. Chilled, Piping:
 - 1. Fill and flush with clean water.
 - 2. Refill with clean water, then add cleaning/degreasing detergent.
 - a. Approved by local, state and federal authorities for the intended use.
 - b. With nonfoaming wetting agent.
 - c. Concentration of the detergent shall be 2% of the active ingredients of the chemicals used for cleaning.
 - d. Supplied and supervised by water treatment company.
 - 3. Circulate water, using temporary pumps as required, in each system at respective design flow rates, minimum, for three 8 hour periods.
 - a. At the end of each 8 hour period: remove and clean strainers. Blow-off low points.
 - 4. After third period of pumping, drain entire system of cleaning solution.
 - a. Clean out cooling tower basins and hose down.
 - 5. Refill systems with clean water and circulate for an additional 8 hour period. Remove and clean strainers. Drain and refill with clear water. Continue to circulate water.
 - 6. Test for alkalinity, not more than 200 ppm in excess of alkalinity of rinsing water.
 - 7. Repeat process described above until 200 ppm in excess of alkalinity of rinsing water, or less is maintained for 10 days.
 - 8. Protect against damage from freeze-up or discharge of water.

9. When cleaning is completed, fill systems with clear water, and circulate with appropriate water treatment chemicals to protect pipe and equipment until the date of the Architect's final certificate.
10. Immediately prior to the date of the Architect's final certificate, remove and clean strainers.
11. Use and disposal of chemicals shall comply with local, state, and federal regulations.

3.7 PIPING SYSTEMS

- A. Manually operate relief valves and verify that discharge openings and piping are clear and free flowing.
- B. Open air vents until air is removed from the systems.

END OF SECTION 231000