

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. The requirements of the General Conditions, Supplementary Conditions and the following Specification sections apply to all Work herein:
1. Section 23 00 10 - General Requirements
 2. Section 23 00 20 - HVAC Scope of Work
 3. Section 23 05 07 - Design Conditions
 4. Section 23 05 30 - Miscellaneous Equipment
 5. Section 23 05 48 - Vibration Isolation
 6. Section 23 05 93 - Testing, Balancing, and Adjusting
 7. Section 23 07 00 - Thermal Insulation
 8. Section 23 13 23 - Emergency Power Fuel Oil System
 9. Section 23 21 23 - Pumps
 10. Section 23 25 00 - Water Treatment Systems
 11. Section 23 41 00 - Tanks and Vessels
 12. Section 23 52 00 - Boilers – Gas
 13. Section 23 64 16 - Centrifugal Water Chilling Units
 14. Section 23 65 13 - Factory Assembled Cooling Towers

1.2 SUMMARY

- A. Furnish and install all pipe, valves, fittings and accessories herein specified and as indicated on the Drawings, complete with all appurtenances required for a complete and operating system.

1.3 REFERENCE STANDARDS

- A. All pipe, valves, fittings and accessories shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:
1. ASTM
 2. ANSI B16.22, B16.3, B16.9, B31.9.0 and B36.10
 3. AWS – American Welding Society
 4. MSS SP-69-1996 – Manufacturers Standardization Society
 5. MSS SP-58-1993 – Manufacturers Standardization Society
 6. MSS SP-89-1998 – Manufacturers Standardization Society
- B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

- A. The following submittal data shall be furnished according to the General Conditions and Section 23 00 10 and shall include, but not be limited to:
1. Schedule of Pipe and Fitting Materials, complete with typical mill reports.
 2. Pipe Cleaning Certification*.
 3. Gate Valves, Globe Valves, Ball Valves, Butterfly Valves, Check Valves and Strainers.
 4. Thermometers, Gauges and Test Ports.
 5. Pipe Hangers and Supports.
 6. Galvanized Pipe.
 7. Cut/Roll Grooved Couplings and Fittings.
 8. Subcontractor's Roll and Cut Groove Machine Certifications.
 9. Bypass Filters.
 10. Welder Performance Qualification Test Certificates.
 11. Chemical treatment manufacturer report for chemicals used during hydrostatic testing.
 12. Pipe Cleaning Certification.
 13. Expansion loops and flexible expansion loops
 14. Expansion compensators

15. Pipe alignment guides and anchors
 16. Expansion joints
 17. Proposed test procedures, recording forms, test equipment, and list of personnel and qualifications for all tests proposed. Refer to Section 23 05 93 "Testing, Balancing, and Adjusting" for additional requirements.
- B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification "MCA" as set forth in Section 23 00 10. See Section 23 00 10 for certification requirements.
- C. Product Data: For each type of expansion fitting indicated.
- D. Shop Drawings: Signed and sealed by a qualified professional engineer.
1. Design Calculations: For thermal expansion of piping systems and selection and design of expansion fittings and loops.
 2. Anchor Details: Detail fabrication of each indicated. Show dimensions and methods of assembly.
 3. Alignment Guide Details: Detail field assembly and anchorage.
- E. Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting.

1.5 WARRANTY

- A. Comply with the requirements of the General Conditions and Section 23 00 10.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. If it complies with these Specifications, all pipe, valves, fittings and accessories herein specified shall be manufactured by one of the manufacturers listed within the individual sections hereinafter.

2.2 CHILLED, HEATING HOT WATER AND CONDENSER WATER PIPING

- A. This Project will utilize pressure classes for various water piping systems. Piping shall conform to the requirements of the working pressures as indicated in Section 23 05 07 titled "Design Conditions".
- B. Piping 4" and smaller shall be ASTM A 53 continuous weld or ERW black steel manufactured in the United States by Laclede, LTV, Maverick, Newport, Sawhill Tubular, Tex-Tube, U.S. Steel, Wheatland. Electric resistance welded pipe shall be fully normalized in the weld area after fabrication welding.
- C. Chilled water and heating hot water pipe 2" and smaller, serving fan coil units, unit heaters, fin tube and fan powered terminals, may be copper Type "K" with brazed joints for pressure classes through 300 psig on this Project. Pipe shall be ASTM B 88-72, H23.1-59 Type "K" hard drawn seamless copper water pipe. Copper pipe shall be manufactured in the United States by Cerro, Halstead, Mueller, Wolverine or approved equal. Connection from steel to copper shall be a dielectric nipple entering the shutoff valve. Chilled water and heating hot water piping 2" and smaller shall be brazed with AWS classification BCUP-2 brazing alloy.
- D. Piping 5" and larger shall be ASTM A53 black steel Type "S" or Type "E" (electric resistance welded) manufactured in the United States by LTV, U.S. Steel or approved equal. Electric resistance welded pipe shall be fully normalized in the area of the weld after fabrication welding.
- E. Steel pipe thickness shall be in accordance with ANSI B36.10, current edition and shall be as follows:
1. For 150 psig:
 - a. 6" and smaller - Schedule 40
 - b. 8" through 16" - Schedule 30 (minimum)
 - c. 18" and larger - Schedule 0.375" minimum wall thickness
 2. For 300 psig:
 - a. 8" and smaller - Schedule 40
 - b. 10" through 16" - Schedule 30 (minimum)

- c. 18" and larger - 0.50" minimum wall thickness (Grade A)
- 0.375" minimum wall thickness (Grade B)
3. For 450 psig:
 - a. 10" and smaller - Schedule 40
 - b. 12" through 14" - 0.375" minimum wall thickness (Grade A or B)
 - c. 16" through 18" - 0.50" minimum wall thickness (Grade A)
- 0.375" minimum wall thickness (Grade B)
 - d. 20" through 24" - 0.50" minimum wall thickness (Grade B)
- F. Steel piping systems shall be butt-welded construction in strict accordance with Chapter 5 of ANSI B31.1.0, except in locations where flanges are required for servicing and/or removal of equipment for repair, etc. Screwed unions may be installed, instead of flanged fittings for sizes 3" IPS and smaller. Flanged and screwed joints shall be accessible for repair. Screwed or flanged fittings shall not be permitted in inaccessible furred ceilings or chases. Copper piping systems shall be brazed with AWS classification BCuP-2 brazing alloy as required by system working pressure and temperature.
- G. Fitting material shall be as follows:
 1. Pipe fittings for 150 psig working pressure systems, 2-1/2" and smaller, where permitted, shall be Grinnell, Ward or approved equal, Class 150, ANSI B16.3 screwed malleable iron. Other fittings shall be welded fittings, ANSI B16.9 with wall thickness and material identical to pipe in which installed and manufactured by Grinnell, Ladish, Hackney, Taylor Forge, Tube Forgings of America, Tube-Line, Tube-Turn, Weld Bend or approved equal. Flanges where specified and/or required, shall be Cofer Flange, Federal Flange, Hackney, Ladish, National Flange, Taylor Forge, Weld Bend or approved equal, Class 150, ANSI B16.5, forged steel, screwed or welding neck type as required.
 2. Pipe fittings for 300 and 450 psig working pressure systems, 2-1/2" and smaller, where permitted, shall be Grinnell, Ward or approved equal, Class 300, ANSI B16.3 screwed malleable iron. Other fittings shall be welded fittings, ANSI B16.9 with wall thickness and material identical to pipe in which installed and manufactured by Hackney, Ladish, Taylor Forge, Tube-Line, Tube-Turn, Weld Bend or approved equal. Flanges where specified and/or required, shall be Cofer Flange, Federal Flange, Grinnell, Hackney, Ladish, National Flange, Taylor Forge, Weld Bend, or approved equal, Class 300, ANSI B16.5, forged steel, screwed or welding neck type as required.
 3. Copper pipe fittings and accessories for chilled water and heating hot water for 150 psig and 300 psig working pressure systems 2" and smaller shall be as follows:
 - a. Copper tube fittings shall be Elkhart, Mueller, Nibco or approved equal, wrought copper joint fittings conforming to the latest edition of ANSI B16.22 suitable for the working pressure of the system.
 - b. All brazed fittings shall be brazed with AWS classification BCuP-2 brazing alloy as required by the system temperature and working pressure.
 - c. EPDM seals manufactured by Viega and installed with a RIDGID ProPress crimping tool may be used in lieu of brazed fittings.
 4. Weld fittings shall be factory made and shall be full line size. For branch pipes more than one size smaller than the diameter of the main pipe, Anvil, Bonney Forge or WFI "Weldolet" or "Threadolet" integrally reinforced branchlets, ANSI B16.9, may be used. Shaped nipple welding fittings with factory beveled ends manufactured by Grinnell, Tube Forgings, Tube-Turn or Wheeling may be used at the Subcontractor's option for branch sizes 3" and smaller with working pressures up to 150 psig. Shaped nipples shop fabricated with patterns and assembled in the shop will be acceptable. "Weldolets" and "Threadolets" fittings and shaped nipples shall have a wall thickness as required by the ANSI B31.1.0 and ANSI 36.10 Code and shall be suitable for the working pressure and temperature of the pipe to which they connect. No branch shall be made by burning a hole in the main and welding in the branch line.
 5. At each joint the flanges shall have matching flat faces or raised faces and the flanges shall be identical in configuration and pressure rating. Steel flanges shall have a minimum tool finish. When 150 lb. steel flanges are connected to 125 lb. cast iron flanged valves or fittings, the steel flanges shall be flat face medium finish.
 6. Screw joints shall be made up with LACO, Rector-Seal, WKM "Key-Tite" or approved equal pipe joint compound. Screw threads shall be in accordance with American Pipe Thread Standards.
 7. Gasket material shall be as specified herein and shall be suitable for the service and pressure class intended.
 - a. Gaskets shall be 1/16" thick for all pipe sizes 10" and smaller and 1/8" thick for all pipe sizes 12" and larger. Gaskets shall be ring type between raised face flanges and full face type between flat face flanges with punched bolt holes and pipe opening.

- b. Gaskets shall be J. M. Clipper Style 960 or 961 or Durlon 8500 Green compressed non-asbestos with a nonstick clean surface and factory applied parting agent applied to both sides of the gasket.
- c. Gaskets shall contain no asbestos.
- d. Gaskets manufactured by J. M. Clipper, Crane, Dallas Gasket or Garlock will be acceptable if they comply with these Specifications.
8. Flange bolting materials for flanges where the pressure does not exceed 400 psig (water) shall be carbon steel ASTM A 307 Grade A hexagon head bolts and hexagonal nuts. Furnish Grade A bolts for flanged joints in piping systems where one or both flanges are cast iron. Cap screws utilized with flanged butterfly valves shall be ASTM A 307 Grade A cap screws with hexagon heads. Flange bolt thread lubricant shall be an anti-seize compound designed for temperatures up to 1000°F and shall be Crane Antiseize Thread Compound or approved equal. Where the configuration or arrangement of flanged fittings prevents the use of machine bolts, stud bolts shall be used.
9. If the capability of the HVAC Subcontractor is demonstrated to the Engineer, at the HVAC Subcontractor's option, and as approved by the authorities having jurisdiction, grooved couplings and fittings may be used for 150 and 300 psig working pressure pipe sizes 12" and smaller in lieu of welded or screwed joints as specified herein. **Condenser water system piping shall be welded.**
- a. Piping: Victaulic Style 07 "Zero Flex", Grinnell/Gruvlok 7401 or equal UL listed painted ductile iron couplings with cut groove or roll groove may be used subject to the Special Requirements in Subsection 2.03F.9.e. herein.
- b. Victaulic Style 77, Grinnell/Gruvlok 7000 or equal couplings with cut or roll groove may be used in association with spring isolated systems as described in Section 23 05 48 titled "Vibration Isolation", subject to the Special Requirements in Subsection 2.03F.9.e. herein.
- c. For Fittings: Victaulic or equal UL listed galvanized or painted ductile iron full flow fittings and Style 920 or Grinnell/Gruvlok 7045/7046 mechanical tees with cut or roll groove suitable for the design working pressures specified in Section 23 05 07 titled "Design Conditions" may be used subject to the Special Requirements in Subsection 2.03F.9.e. herein.
- d. For Strainers: Victaulic or equal UL listed galvanized or painted ductile iron Style 732 strainers with groove suitable for the design working pressure specified in Section 23 05 07 titled "Design Conditions" may be used subject to the Special Requirements in Subsection 2.03F.9.e. herein.
- e. Special Requirements: Victaulic or equal full flow fittings and couplings shall be made of ASTM A 47 Grade 32510 malleable iron or ASTM A-536 Grade 65-45-12 ductile iron with grooved ends. Gaskets for water service below 230°F shall be "Triple Seal" Grade E synthetic. Couplings shall be provided with heat treated zinc or cadmium plated bolts and units. Grooved piping system manufacturer shall be ISO 9000 approved.
10. At the HVAC Subcontractor's option, Victaulic AGS style grooved couplings and fittings may be used for 150 and 300 psig working pressure for pipe sizes 14" through 24" in lieu of welded or screwed joints as specified herein. **Condenser water system piping shall be welded.**
11. All piping larger than 24" shall be welded, no options.

A cut or roll groove machine shall be used for all grooves in piping. The coupling and fitting manufacturer shall provide a certified letter with the Shop Drawing stating that the Subcontractor's roll or cut grooving machine and the couplings and fittings utilized on this Project will provide a system complying with the pressure class and piping materials previously specified. A cut groove depth control tool shall be used for field and shop grooving of piping. A hole cutting tool shall be used in lieu of burning a hole in the piping. When using joining materials the piping shall be installed in accordance with the joint manufacturers written instructions. Gaskets shall be UL listed for the service and working pressure of the systems. The manufacturer shall provide a training class to the Subcontractor's personnel involved in installing all grooved systems. After the installation is complete, the manufacturer's factory technician shall inspect all couplings and verify to the Engineer in writing the installation is in accordance with the manufacturer's published installation instructions. Flanges, reducing couplings and outlet couplings shall not be allowed. If they comply with these Specifications, UL listed couplings, full flow fittings and gaskets manufactured by Grinnell Corporation (Gruvlok), or Victaulic Company of America will be acceptable. Couplings and fittings installed throughout the Project shall be the product of one manufacturer.

2.3 EXPANSION JOINTS

- A. Bellows Type:
1. Acceptable Manufacturers
 - a. Expansion Joints:
 - b. Metal-Bellows: Flexicraft - EP, Hyspan - Series 3500, MetraFlex – Metragator.

- c. Pipe Alignment Guides: Pipe Shields Series E2000 for insulated pipes; B-Line, Grinnell, Hyspan Series 9500 or MetraFlex for uninsulated pipes
 2. Flanged, packless, self-equalizing type constructed of Type 304 stainless steel bellows and carbon steel fittings. Construct control rings of cast steel or nickel iron. Include limit stops and tie rods to prevent over traversing and to constrain pressure thrust forces on the joints. Units shall be rated at 300 psi at 400 degrees F.
 3. Include an external sheet metal shroud on all joints that will be insulated. Shroud shall be removable for field inspection of the joint.
 4. Include an internal sleeve of Type 304 stainless steel with sufficient clearance between the bellows and the sleeve to permit full rated rotational and lateral movement. Inside diameter of sleeve is not to be less than that of the adjoining pipe.
 5. Joints for steel piping shall be single- and two-ply, stainless-steel bellows and carbon-steel shroud.
- B. Miscellaneous Materials
1. Guides shall be steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
 3. Washers: ASTM F 844, steel, plain, flat washers.
 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.
- C. Installation
1. Provide at least two (2) guides each side of each expansion loop or joint. Size guide cylinder to allow the full insulation thickness to be carried through the guide with ample clearance and without restricting the free movement of the pipe. Size guide cylinder for sufficient length to contain the total movement of the spider. Rigidly anchor pipe guide to building structure.
 2. Install expansion fittings according to manufacturer's written instructions in sizes matching pipe size in which they are installed. Align expansion fittings to avoid end-loading and torsional stress.
 3. Provide expansion joints as shown on the Drawings.
 4. Install expansion within four (4) pipe diameters, both upstream and downstream, from a pipe guide or anchor.
 5. The bellows element shall be protected from damage. Dents, scores, arc strikes, weld spatter, and other damage can cause the joint to fail. Damaged joints shall not be used.
 6. Align joint flange and pipe flange holes. Do not try to compensate for flange or pipe misalignment by putting a torsional, compressive, extension, or offset loads on the expansion joint. Good practice requires that a mating flange in the piping system remain unwelded until the expansion joint has been bolted into position.
 7. All anchors, guides, and supports must be installed according to manufacturer's recommendations.
 8. Internally pressurized expansion joints shall be installed in the proper orientation with respect to direction of flow.
 9. Unit lengths must not be altered during installation except for the application of cold pull.
 10. Remove shipping restraints after installation, but before hydrotesting. Test pressure shall not exceed 1.5 times design pressure. Water free of halogens shall be used for hydrotesting.
 11. If testing medium is significantly heavier than the product to be carried in the system, care must be taken to support the additional weight.
 12. Paints containing low melting point metals or their compounds, particularly aluminum, lead or zinc, must not be allowed to come into contact with the bellows convolutions.

2.4 DRAIN PIPING

- A. Drain piping from each air handling unit drain pan, heat exchanger, pump base drains, tank and vessel overflows, auxiliary drain pans, piping system drains, blow downs and strainers (not less than 2"), shall be extended to the nearest floor drain, hub drain or condensate drainage system, except in the central mechanical plant. In the central mechanical plant all drains on water chilling units, heat exchangers, strainers, piping systems, etc., shall be equipped with full bore ball valves and full size quick disconnect type couplings with caps for drains 1" and larger and hose end adapters for smaller drains. At the contractor's option, 1/2" and 3/4" drain valves with integral nose cap and chain similar to Nibco T&S-585-70-HC will be acceptable. Quick disconnect couplings shall be constructed of brass or



aluminum and shall be manufactured by SealFast, Huddleston Equipment Co., or Andrews. Drains shall be of the sizes indicated but not less than the full size of the drain pan, strainer or equipment connection. Air handling unit drains shall have deep seal traps to permit unit pan drainage under normal unit operation and complete drainage of the pan upon unit shutdown. A deep seal trap shall be installed for each blow through or draw through air handling unit to maintain the water seal.

- B. Drain piping downstream of the stop valve shall be Schedule 40 ASTM A 53 galvanized steel pipe with Class 150 ANSI B16.3 galvanized malleable iron fittings or Type "K" or "L" copper pipe with wrought copper fittings.

2.5 CONTROLLING WATER VALVES

- A. Furnish and install all valves that are shown on the Drawings and/or specified herein. Packing and gaskets shall contain no asbestos and shall be so certified. See Section 23 00 10 for certification requirements. Prior to purchase of any valve manufactured outside the United States the Subcontractor shall submit complete construction details, material list of all components, pressure test data and certified compliance with the reference standards listed herein.

- B. Chilled, Heating Hot Water and Condenser Water Valves:

1. All chilled, heating hot water and condenser water valves shall be in accordance with the following:

- a. General:

- 1) Ball valves shall be constructed to permit repacking without removal of the valve body from the line and stem shall not blow out under pressure. Valves used for chilled water service shall be insulated and vapor sealed to the protective sleeve around the stem to maintain the integrity of the chilled water piping insulation as detailed on the Drawings. Extended, non-thermal conductive handle ball valves similar or approved equal to Nibco "Nib-Seal" shall be utilized. The ball valve stem shall be extended so that the operating handle is above the pipe insulation surface. All valves utilized for tenant connections on chilled or condenser water risers shall have factory handles, which can be padlocked, in the open or closed position.
- 2) Butterfly valves 2-1/2" through 5" in size shall have lever multi-position (throttling) type operators with memory stop and position lock. For valves 6" and larger, operators shall be enclosed self-locking worm gear type, waterproof and factory lubricated. Operator shall have built in position indicators. Provide chain operators with chain cleats for all valves located more than 10'-0" above the floor. Manufacturer shall certify compliance with bubble tight shutoff requirements at full rated design pressure when flanged and at a differential pressure not less than the design working pressure and temperature specified with the downstream flange removed with flow in either direction. In addition, valves used for balancing shall be certified suitable for continuous throttling service at a position thirty-five (35%) percent open. Butterfly valves installed in horizontal piping shall be mounted with the stem in the horizontal position and rotation so that the bottom of the disc lifts in the direction of flow.
- 3) At the Subcontractor's option, if a Victaulic coupling and fitting system is provided as specified herein, Victaulic VIC-300 or Gruvlok 7700 series butterfly valves 2 1/2" through 4" with EPDM encapsulated disc and PPS inner wall coating may be used, if the contractor submits an acceptable detail for insulating the valve with his bid proposal for acceptance by the Owner and the Engineer.
- 4) Valves with special seats to meet temperature requirements shall have special markings clearly identified on the Shop Drawings.
- 5) Check valves, strainers, etc., shall be as specified herein under Subsection titled "Miscellaneous Piping Accessories".

- b. 150 Psig Working Pressure (Chilled, Heating Hot Water and Condenser Water):

- 1) Stop valves for insulated piping systems up to and including 2 1/2" shall be similar and approved equal to Nibco Nib-Seal full port ball valves, with extended non thermal conductive handles. Ball valves for non-insulated condenser water piping shall be full port valves similar to Nibco T-585-70. Ball valves shall be red brass or cast bronze with brass, stainless steel, or bronze ball and stem, 400 psig non-shock WOG at 200°F. Valve shall have a stem extension of sufficient length to position the operating handle, protective sleeve to maintain integrity of piping insulation, mechanical memory and position lock devices above the insulation. If it complies with these Specifications, valves manufactured by one of the following manufacturers will be acceptable: Flow Design, Inc., Apollo, Grinnell, Bray/FlowTek, Jamesbury, Milwaukee, or Nibco.

- 2) Elastomer seated stop valves 3" and larger shall be butterfly type, 150 psig non-shock WOG at 200°F, ANSI Class 125/150 flanges with full tapped and threaded lugs and cast iron or ductile iron body. The resilient elastomer seat shall be field replaceable and suitable for the service intended. Disc shall be fabricated from aluminum, manganese bronze, or Nylon II coated ductile iron and the shaft shall be fabricated from 416, 316 or 17-4 pH stainless steel. Provide seals at the top and bottom of the upper and lower shafts so that there will be guaranteed zero leakage to the shaft. If it complies with these Specifications, valves manufactured by one of the following manufacturers will be acceptable: Bray, Centerline, Demco, Dezurik, Grinnell, Keystone, Mission, Muessco, NIBCO, Norris or Weeco.
 - 3) At the Subcontractor's option, factory built piping assemblies containing such items as ball valves, strainers, flow control devices, automatic control valves, pressure/temperature test ports, etc., manufactured by Flow Design Inc., Dallas, Texas or HCI, Madison Heights, MI. will be acceptable. The individual components shall comply with the specifications herein. All automatic control valves within the factory built flow assembly shall have unions on both sides for ease of removal.
- c. 300 and 450 Psig Working Pressure (Chilled, Heating Hot Water and Condenser Water):
- 1) Stop valves for insulated piping systems up to and including 2 ½" shall be similar and approved equal to Nibco Nib-Seal full port ball valves, with extended non thermal conductive handles. Ball valves for non-insulated condenser water piping shall be full port valves similar to Nibco T-585-70. Ball valves shall be red brass or cast bronze with brass, stainless steel, or bronze ball and stem, 400 psig non-shock WOG at 200°F. Valves shall have a stem extension of sufficient length to position the operating handle, mechanical memory and position lock devices above the insulation. A protective sleeve integral to the valve around the stem shall be provided to maintain the integrity of the chilled water piping insulation. Refer to the Detail on the Drawings. Packing and gaskets shall be Teflon. If it complies with these Specifications, one of the following manufacturers will be acceptable: Apollo, Flow Design Inc., Grinnell, Bray/McCannaLok, Jamesbury, Milwaukee, NIBCO or Red and White/Toyo.
 - 2) High performance offset shaft type butterfly stop valves 3" and larger shall be 720 psig non-shock WOG, ANSI Class 300 compatible with ANSI B16.5 flanges, full tapped and threaded steel lug body. Valves shall have 300# body drilling and shall be suitable for service intended. Stop valves shall be suitable for bi-directional zero leakage dead end service to the fully rated pressure with either the downstream or the upstream flange removed to the fully rated pressure. Disc shall be fabricated from stainless steel and the shaft shall be fabricated from 316, 416 or 17-4 pH stainless steel and have the eccentric double or triple off-set design. Provide adjustable PTFE stem seals as required so that there will be guaranteed zero leakage. Seats and backing rings shall be PTFE or RPTFE. The seat assembly shall be locked in the body recess by a full face seat retainer. Bearings shall be constructed of stainless steel/PTFE. Seat retainer ring fasteners shall be a non wetted part. If it complies with these Specifications, valves manufactured by one of the following manufacturers will be acceptable: Bray/McCannaLok, Dezurik, Grinnell-Winn BFV, Crane-Flowseal MS, Jamesbury, Keystone, Posi-Seal or Tufline.
 - 3) At the Subcontractor's option, 2-1/2" and smaller factory built flow assemblies for water balancing containing such items as ball valves, butterfly valves, strainers, flow control devices, automatic control valves, pressure/temperature test ports, etc., manufactured by Flow Design Inc., Dallas, Texas or Grinnell will be acceptable. The individual components shall comply with the specifications herein. All automatic control valves within the factory built flow assembly shall have unions, flanges, or grooved ends on both sides for ease of removal.

2.6 BALANCING VALVES

- A. Furnish and install balancing/stop valves where shown on the Drawings and/or specified herein. Valves shall comply with the general requirements specified for chilled, heating hot water and condenser water stop valves.
- B. Balancing valves 2-1/2" and smaller shall conform to the Specifications for chilled, heating hot water and condenser water stop valves 2-1/2" and smaller as described herein for 150 psig, 300 psig working pressures and temperatures.
- C. Balancing valves 3" and larger shall conform to the specifications for chilled, heating hot water and condenser water stop valves 3" and larger as described herein for 150 psig, 300 psig working pressures and temperatures.

2.7 MAKEUP WATER AND QUICK FILL CONNECTIONS

- A. Domestic water shall be connected to equipment as shown on the Drawings. Each of the systems requiring domestic water shall be provided with a manual quick fill, makeup water connection, in addition to the automatic feed connections. Makeup water piping shall be copper or galvanized steel as specified in Section 22 10 00 titled "Domestic Water Systems" for domestic hot and cold water piping up to the tap into the main system line.
- B. Clayton "RP", Hersey or Watts No. 909 reduced pressure backflow preventer assembly shall be installed in makeup water line to each of the systems subject to approval by the local authorities having jurisdiction. Assembly shall be complete with strainer and inlet and outlet shut off valves. Drain connection on the reduced pressure backflow preventer shall be piped through a Josam Series 1801 or Watts Series AG air gap, to the nearest floor drain. Equipment manufactured by Hersey will be acceptable if it complies with these Specifications. See Section 23 05 30 titled "Miscellaneous Equipment" for additional requirements. Install reduced pressure backflow preventer assembly in accordance with the American Society of Sanitary Engineers Standard 1013, latest edition.

2.8 AUTOMATIC AIR VENTS

- A. Automatic air vents shall be constructed of brass or stainless steel and be installed where required. Automatic air vents shall be suitable for the system and for the system working pressure and temperature. Vents shall be designed to eliminate air from the system automatically without permitting the passage of any water and shall be similar and approved equal to the following:
1. 150 psig working pressure service - Sarco Type 13WS, Taco or approved equal.
 2. 300 psig working pressure service - Sarco Type 13WHS, Taco or approved equal.
 3. Automatic air vents shall have an approximate 3/4" IPS inlet connection and 3/8" outlet. Provide 3/4" steel pipe suitable for the pressure service between main pipe and inlet. Provide 3/8" OD hard drawn Type L copper tubing from vent outlet for overflow in case of defective action. Copper tubing shall run to a suitable drain. Provide 3/4" stop valve, as specified in the Subsection titled "Controlling Valves" herein, in the inlet line for servicing of automatic air vent.

2.9 PIPE HANGERS AND SUPPORTS

- A. All pipes throughout the building shall be thoroughly and substantially supported with U.L. listed hangers and supports. Furnish and install any special hangers or supports that may be required by the building construction. The design, selection, spacing, and application of horizontal pipe hangers, supports, restraints, anchors, and guides shall be in accordance with the latest editions of the Standard Code for Pressure Piping (ANSI B31.1) and the following Manufacturers' Standardization Society Standards: MSS SP-69 1996, "Pipe Hangers and Supports: Selection and Application"; MSS SP-58 1993, "Pipe Hangers and Supports: Materials, Design and Manufacture"; and MSS SP-89 1998, "Pipe Hangers and Supports: Fabrication and Installation Practices". The Power Piping Code, ANSI B31.1, shall take precedence over the MSS Standards.
- B. All horizontal black or galvanized steel water pipe shall be supported on Anvil Figure 260 or approved equal, adjustable wrought clevis hangers with the following exceptions. 6" and larger Chilled and Heating Hot Water Piping subject to movement shall be mounted on Anvil Figure 177 or approved equal pipe roller supports, or on Anvil Figure 257 or approved equal pipe sliding supports. Roller guides are not acceptable to support horizontal water piping subject to both longitudinal and transverse movement. Certain piping, as shown on the Drawings, shall be supported from structural frames mounted on the floor. The structural frames shall be provided and installed by this Subcontractor and they shall be reviewed by the Project Structural Engineer.
- C. Horizontal copper pipe shall be supported on Anvil Figure CT-65, or approved equal, plastic coated clevis hangers. Steel hangers similar to Anvil Figure 65, CT-65, or approved equal, may be used if taped at each horizontal and vertical support point with Scotchrap No. 43 or approved equal pipe protection dielectric tape. Dielectric tape shall be spiral wrapped to at least 1/2" on either side of the support device.
- D. All vertical pipes not specified to be supported on vibration isolation shall be supported as follows:
1. Vertical pipes 12" in diameter and smaller shall be supported at least at every other floor with a minimum of two (2) bolt riser clamps, designed for the load and manufactured by Anvil or approved

- equal riser clamps. Any welding, extensions or modifications of the riser clamps shall be reviewed by the Project Structural Engineer.
2. Vertical pipes 14" in diameter and larger shall be supported at least at every other floor, with structural steel channels and gussets welded to the pipe. Structural steel supports shall be provided by this Division and they shall be reviewed by the Project Structural Engineer.
 3. Vertical copper pipes shall be supported on Anvil Figure 261C or approved equal, minimum two (2) bolt plastic coated riser clamps at least at every other floor.
- E. All vertical pipes requiring vibration isolation shall have spring isolators as specified in Section 23 05 48 titled "Vibration Isolation". Riser clamps and steel channels supports shall be as specified herein and as indicated on the Drawings with provisions for attachment to the vibration isolators. Welded extensions to riser clamps to accommodate vibration isolators are unacceptable.
- F. Concrete inserts for hanger rods shall be Anvil Figure 282, Figure 152 or approved equal, for pipe sizes up to 8" IPS. For over 8" IPS pipe, an insert reinforced with steel anchor bars or suitable steel plate embedded in the concrete may be used. Hanger rods, inserts, etc., shall be sized and installed as recommended by the hanger manufacturer for the service intended.
- G. Metal deck concrete insert shall be Carpenter & Patterson, Inc. Figure 143, galvanized fabricated steel metal deck ceiling bolt, Rawl Double FF-S-325 or approved equal.
- H. Anchors in concrete shall be ICC approved and shall be installed in strict accordance with approved ICC "Research Reports" for the specific anchor used.
- I. The Subcontractor shall submit pipe hanger and support details and other details as required by the Architect or Mechanical Engineer, to the Project Structural Engineer for review and approval prior to submission to the Engineer.
- J. Hangers on piping exposed to weather or in the cooling tower enclosure shall be hot dipped galvanized after fabrication.
- K. Refer to Section 23 05 48 titled "Vibration Isolation" for additional requirements. The location and type of supports, load imposed on the structure at the support, anchor points and forces shall be indicated on the "Coordination Drawings" and submitted to the Project Structural Engineer. Refer to Section 23 00 10 for additional requirements.
- L. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable: B-Line, Anvil International, Inc., Michigan Hanger, National, PHD or Tolco.

2.10 PIPE COVERING PROTECTION SADDLES AND SHIELDS

- A. Furnish and install pipe covering protection shields or saddles as required by MSS SP-69 for all insulated piping at the locations of all supports. The insulation may be applied directly over a clevis type pipe hanger without the use of pipe shields for domestic water, storm water and heating hot water systems only.
- B. Protection shield length and gauge thickness for use with clevis type hangers and any type of cold water (33°F to 59°F) support shall be as specified for Type 40 protection shields in the current edition of MSS SP-69. Protection shields shall be galvanized and shall be arranged to cover one-half of the circumference of the insulation and shall be mounted on the outside of the insulation with insulation blocking between the pipe and shield to prevent crushing of insulation. Blocking on piping shall be furnished and installed as specified in Section 23 07 00 titled "Thermal Insulation". The Subcontractor shall provide factory certification of gauge thickness and length of shields subject to point loading or used with roller supports.
- C. Pipe covering protection saddles equal to Anvil Figure 160 Series shall be provided at all supports, other than the steel band or sliding types, as required by the current edition of MSS SP-69 for hot water systems (120°F and above). Protection saddles shall be welded to the piping and shall be of sufficient length to maintain contact at supports at all conditions of the pipe movement. After welding, fill void between saddle

and pipe with sectional insulation or approved insulating cement as specified in Section 23 07 00 titled "Thermal Insulation".

2.11 THERMOMETERS

- A. Thermometers shall be filled with blue or green colored spirit (organic) fluid having scale length of not less than 9" and scale divisions of 2°F or less, similar and approved equal to Moeller Instrument Company, Inc., Style AJ. Range shall be as specified or as required for the duty.
- B. Thermometers shall be installed as shown on the Drawings. Thermometer wells only shall be installed in like manner. All thermometer wells shall be constructed of brass or stainless steel and where installed in insulated piping shall have at least 2-1/2" lagging extension. Pressure temperature ratings of each well shall be suitable for the system in which it is installed in accordance with Section 23 05 07 titled "Design Conditions" and as indicated on the Drawings. All wells shall be filled with silicon and be complete with caps and chains.
- C. Thermometers and thermometer wells shall have the following insertion lengths:
1. Located in Horizontal Piping and Vertical Piping Below 6'-0":
 - a. 4" and 5" Pipe - 2-1/2"
 - b. 6" and 8" Pipe - 1/2"
 - c. 10" and Larger Pipe - 5"
 2. Located in Vertical Piping Above 6'-0":
 - a. 3", 4" and 6" Pipe - 2-1/2"
 - b. 8" and 10" Pipe - 5"
 - c. 12" and Larger Pipe - 5"
- D. Thermometers shall have the temperature ranges listed herein and shall be installed at the following locations and where indicated on the Drawings or specified elsewhere.
1. Chilled water supply to and return from each outside air handling unit: 0-100°F.
 2. Heating hot water supply to and return from each outside air handling unit: 30-240°F
 3. Chilled water entering the Central Plant machine room and leaving each water chilling unit and each heat exchanger: 0-100°F.
 4. Heating hot water supply to and return from each outside air handling unit and each heat exchanger: 30-240°F
 5. Condenser water entering the Central Plant machine room and leaving each water chilling unit and each heat exchanger: 0-100°F.
- E. Thermometers and wells must be of at least the quality and design specified. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable: Moeller, Trerice or Weksler. Submit a list detailing design and construction of thermometers for review by the Engineer.
- F. Provide pressure or temperature test plugs at the supply and return to all field and factory air handling units and water cooled packaged air conditioning units with multiple coils and at the inlet and outlet of each automatic control valve and as indicated on the Drawings. At the Subcontractor's option, factory built flow assemblies containing such items as stop valves, strainers, flow control devices, pressure-temperature test ports, etc., manufactured by Flow Design Inc. Dallas, Texas will be acceptable. Taps shall be Pete's Plug, 1/2" NPT, brass with Nordel core, Model 710 Fairfax, and model 710XL for insulated pipe, Flow Design Inc. Super Seal, SISCO or Watts. In addition, the Contractor shall supply the Owner with six (6) pressure gauge adapters with 1/8" O.D. probe and six (6) 5" stem pocket testing thermometers: four (4) 25-120°F and two (2) 0-220°F.

2.12 GAUGES AND GAUGE STOP VALVES

- A. Gauges shall be bourdon tube with minimum 4-1/2" dial and die cast aluminum case with black enamel finish. The movement shall be all stainless steel with Grade A phosphor bronze bourdon tube brazed at socket and tip. The accuracy of the gauge shall be within 1/2 percent of the scale range. The pointer shall be the micrometer adjustment type recalibrated from the front. Pressure, compound and differential pressure gauges shall have suitable scale ranges, shall be submitted and are subject to the review of the

- Engineer. Graduations shall be one pound or less on all gauges where this is standard for the required range.
- B. Gauges shall have 1/4" IPS connections and shall be Moeller "Vantage" gauges with Case Style No. 2, ASME B 40.1 Grade 2A Trerice 500X series with case style FSL or approved equal with needle valve.
 - C. Gauges shall be installed on the suction and discharge piping for each pump, inlet and outlet of each heat exchanger and at other locations indicated on the Drawings. Gauges shall be furnished complete with stop valves as specified herein suitable for the pressure and temperature ratings of the system in which they are installed in accordance with Section 23 05 07 titled "Design Conditions".
 - D. In addition, differential pressure gauges shall be installed across each central plant strainer and at other locations indicated on the Drawings. Gauges shall have at least a 2" diameter dial with five (5%) percent full scale accuracy and a differential pressure range of 0-5 psig unless otherwise noted on the Drawings and shall be similar to Orange Research (Orange, Connecticut) Type 1201PG-1-2, Dwyer or approved equal.
 - E. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable: Ashcroft, Marsh, Midwest, Moeller, Taylor, Trerice, Weiss or Weksler.

2.13 GAUGE TEST COCKS

- A. Gauge test cocks shall be provided in the entering and leaving piping to every vessel and at other locations indicated on the Drawings and as required to perform specified tests. Gauge test cocks shall be stop valves as specified herein, or approved equal. Install gauge test cocks at pressure control or indication points of the temperature control system.

2.14 DIESEL ENGINE EXHAUST PIPING

- A. Diesel engine exhaust piping shall be the same as specified for "Chilled, Heating Hot Water and Condenser Water Piping", except all piping and fittings may be Schedule 20 ASTM A53 black steel in accordance with the latest edition of NFPA 37. A stainless steel flexible connector with a minimum 18" long flexible corrugated section, flanges with gaskets on both ends between exhaust pipe and engine and a muffler will be provided by Division 26 to the Divisions 21, 22, 23 Subcontractors for installation.

2.15 MISCELLANEOUS PIPING ACCESSORIES

- A. Furnish and install all necessary miscellaneous piping accessories that are shown on the Drawings and/or specified herein:
 - 1. Check valves 2" and smaller shall be Jenkins Figure 996 for 150 psig working pressure systems for 300 psig systems. Valves of equality and construction manufactured by Grinnell, Hammond, Nibco or Walworth will be acceptable.
 - 2. Check valves, larger than 2", located in chilled and condenser water pipes and in domestic water pipes shall be spring loaded quiet type as manufactured by APCO, CPV, Grinnell, Mission, Muessco, Nibco, Techno Corporation or Williams-Hager. Check valve non-shock pressure temperature rating shall be same as specified for piping in which it is installed. Check valve shall have full circle threaded lug body or flanged body. At the contractor's option, spring loaded quiet type check valves with grooved ends similar to Victaulic Style 716 will be acceptable. Wafer valve type installed between companion flanges will not be acceptable. Check valves on pump discharges shall be installed with the valve shaft perpendicular to the pump shaft.
 - 3. Check valves located in pumped sewage pipes and in storm pipes shall be Crane No. 383 outside weight, 200# WOG, iron body, bronze trimmed, swing check design or approved equal. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable: Crane, Hammond, Jenkins, Lukenheimer, Nibco/Scott, Stockham or Walworth.
- B. Strainers shall be similar and approved equal to the following:
 - 1. All water strainers shall be similar and approved equal to the following Mueller Steam Specialty Company Model numbers listed. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable: Crane, Flow Design Inc., Grinnell, Keckley, McAlear, Muessco, Victaulic or Zurn.

- a. 150 psig system working pressure - up to 2". Muessco No. 11, 400# WOG, iron body with perforated 20 mesh monel or stainless steel screen with clean out and screwed ends.
 - b. 150 psig system working pressure - 2-1/2" through 24". Muessco No. 758, 150# WOG, iron body with perforated monel or stainless steel screen with 1/8" perforations for sizes through 4" and 5/32" perforations for 5" and above, with clean out and Class 125 ANSI B16.1 flanged ends.
 - c. 300 psig working pressure - up to 2". Muessco No. 11, 400# WOG, iron body with perforated 20 mesh monel or stainless steel screen with clean out and screwed ends.
 - d. 300 psig working pressure - 2-1/2" to 24". Muessco No. 752, 300# WOG, iron body with perforated metal monel or stainless steel screen with 1/8" perforations in sizes through 4" and 5/32" perforations for 5" and above, with clean out and Class 250 ANSI B16.5 flanges.
 - e. At the contractor's option, Victaulic grooved and wye type strainers similar to Style 732 will be acceptable.
- C. Branch Pressure Reducing Valves:
1. Branch pressure reducing valves shall maintain a constant downstream pressure (plus or minus 3 psig) regardless of changing inlet pressures and/or flow rates. All flow conditions from zero to full flow are to be handled in a stable manner. The valve shall close drop tight when the downstream pressure rises to the setting of the spring. No pressure "creep" or leak can be tolerated. Valve body and cover shall be of an all bronze construction. The trim shall be 416 stainless steel. The valve shall contain an integral chrome nickel stainless steel strainer and low flow bypass. All repairs shall be possible without removing the valve body from the line. The valve body shall be constructed of NPT union tail pieces at the inlet and outlet of the valve. The valve shall be similar in all respects to "Cla-Val Co. 990" or 90-42 pressure reducing valve as manufactured by Cla-Val Co. or "JRG Gunzenhauser" PRV valve of same configuration is an approved alternate. No other substitutions will be accepted.
- D. Bypass Filters:
1. Bypass filters shall be similar and approved equal to MSO (150 psig) and UMO (300 psig) Series medium pressure flow filters as manufactured by PALL Corporation, Harmsco, or Nowata Filtration "A" Series and shall be constructed as follows:
 - a. Bypass filter shall be 304 stainless steel vertical tank type housing with integral angle iron leg supports and base plates for floor mounting. Housing shall have 2" NPT side inlet and outlet connections with 1/2" NPT drain and 1/4" vent connections as shown on the Drawings.
 - b. Housing shall have easy opening and closing top with ethylene propylene or Buna N O-ring seal and four (4) or six (6) captive eye bolts for internal cartridge filter tube replacement. Bypass filter shall be rated for working pressures of the system in which they are installed as indicated on the Drawings.
 - c. Internal cartridge filters shall be CUNO Micro-Klean III filter cartridges with 10 micron porosity on a tin-plated core. Provide and install a new, clean set of filter tubes in all bypass filters at time of issuance of a Substantial Completion Certificate by the Owner.
 - d. Bypass filters shall be rated for at least 18 gpm flow with 3.0 psig initial pressure drop and shall have configuration as indicated on the Drawings.
 - e. Bypass filters shall be installed into a bypass piping system on the chilled and heating hot water system. Filters may also be used for feeding an aqueous solution of sodium nitrite based corrosion inhibitor into the water systems as outlined in Section 23 25 00 titled "Water Treatment Systems".

2.16 WATER CHILLING UNIT REFRIGERANT RELIEF PIPING

- A. Relief piping from the water chilling unit rupture disc shall be same as for "Chilled, Heating Hot Water and Condenser Water Piping", except it may be Schedule 20. Relief piping shall be routed outside the building. Provide a braided flexible connector at the connection to the water chilling unit.

2.17 WATER TREATMENT PIPING

- A. Piping for the chilled water treatment system shall be as specified for "Chilled, Heating Hot Water and Condenser Water Piping".
- B. Piping for the condenser water treatment system shall be as specified in Section 23 25 00 titled "Water Treatment Systems".

2.18 FUEL OIL PIPING

- A. The fuel piping system for the emergency generator shall be furnished and installed by this Subcontractor as specified in Section 23 13 23 titled "Emergency Power Fuel Oil System" and under the direction of the emergency generator system manufacturer as specified in Division 26. The emergency generator system is furnished under Division 26. See Division 26 Specification Section 26 32 13 titled "Engine Generators" for requirements.
- B. All other above ground fuel oil piping such as for heating boilers, etc., shall be sized as indicated on the drawings and shall comply with Underwriters Laboratories standards, the latest edition of NFPA 37, all current EPA Standards, as well as all state and local codes. Vent line, fuel oil supply/return lines and diked area drain lines shall be steel pipe or alternate piping material listed herein below, if acceptable to the authorities having jurisdiction, suitable for 100 psig working pressure and set into fittings with ample sealing compound around joints to protect all metal surfaces. Pipe, valves and fittings shall meet the requirements of ANSI B31.4 as required by NFPA 37. Pipe wall thickness shall be determined according to the provisions of ANSI B31.3 and ANSI B34.1.
- C. Underground fuel oil piping shall comply with the following:
1. Diesel fuel oil underground piping including supply, return, vent, fill and overflow lines shall be double containment piping system and UL listed for use in conveying petroleum products underground.
 2. Primary internal piping material may be manufactured of thermosetting epoxy resin with continuous glass fibers and in compliance with ASTM D 2996, RTRP, Type 1, and Grade 1. Similar to Ameron Dualoy 300/L Fiberglass Pipe and Fittings.
 3. All pipe, fittings and adhesive shall be produced by the same manufacturer. The fittings and adhesive shall be UL listed for petroleum products. Adhesive shall be approved in writing by the piping system manufacturer. Fittings shall be compression molded of the same resin as the pipe. Joining method shall be either bell and socket or threaded and bonded, as recommended by the manufacturer.
 4. The inner product piping shall be centered within the outer containment piping by using carrier guides, permitting continuous leak monitoring. All components of the double containment system shall be manufactured by the pipe manufacturer and intended for installation as an integral system. The inner product pipe and the outer containment pipe shall slope towards the underground fuel storage tank. Provide a flexible piping connection at least 12" long of the wire reinforced type suitable for diesel fuel oil application at the connection to each generator and each pump within the tank sump enclosure.
 5. The outer containment piping system shall have a minimum 75 psi internal pressure rating at 150°F. Acceptable products shall be "Dualcast" as manufactured by Fibercast or "Red Thread II" manufactured by Smith Fiberglass Products Inc. or Contain/It manufactured by G.S.R. Sloan.
 6. Provide fuel system piping accessories and specialties as specified in Section 23 41 00 titled "Tanks and Vessels."
- D. Pipe fittings shall be screw type, Class 150 ANSI B16.3 malleable iron. Cast iron fittings are not permitted. Apply Underwriters Laboratories listed fuel oil resistant sealing compound on all threaded joints to provide a liquid tight connection.
- E. Slope drain piping a minimum of 1% away from diked area. Drain piping shall terminate in a full size quick disconnect type couplings with caps chained to pipe. Quick disconnect couplings shall be manufactured by Andrews or Sealtest.
- F. Fuel oil piping stop valves up to and including 2" in size shall be Nibco T-580-70 or Engineer approved equal ball valves. Ball valves shall be red brass, cast bronze or yellow forged bronze with brass body and stainless steel or bronze ball and stem, 400 psig non-shock WOG at 200°F.
- G. Furnish and install at location indicated on the Drawings a UL listed [and/or FM approved] thermally actuated safety valve in fuel supply line leaving bulk storage tank. Safety valve shall automatically close in the event of a fire (fusible link set to melt at 160°F). Valve shall have carbon steel body with all internal wetted working parts of Type 316 stainless steel. Valve shall be provided with internal bypass valve. Thermally activated shutoff valve shall be similar and Engineer approved equal to a Proctoseal C3000T.
- H. Furnish and install at location indicated on the Drawings a UL listed [and/or FM approved] full port, normally open, internal pilot operated solenoid valve in fill line to bulk storage tank. No differential pressure shall be required to open valve. Coil shall be Class "H" construction, 120V AC and 60 hertz. Solenoid valve shall be

explosion proof and water tight construction suitable for oil service at a maximum differential pressure of 100 psig and maximum temperature of 212°F solenoid valve shall be similar and approved equal to Magnetrol Model No. F36AR47-0 with Model No. STN-7 bronze strainer and stainless steel screens.

- I. All piping connected to storage tank shall have double swing joints to permit tank or building to settle without impairing the tightness of the pipe connection.
- J. Fill line shall terminate in a liquid tight, wall mounted, dry disconnect coupling, similar and Engineer approved equal to Dover (OPW) Kamvalok Model No. 1712-D with 1612-A adapter and 634-B dust cap. Coupling, adapter and cap shall be all aluminum with Viton seals.
- K. See Section 23 05 93 titled "Testing, Balancing, and Adjusting" for fuel oil piping system leak testing requirements.
- L. Submit Shop Drawings for review.
- M. The piping system shall be electrically connected to an electrolytic protection grid system to absolutely prevent all corrosion of subsoil metal parts.
- N. The Subcontractor will install inside the tanks, a fuel transfer pump controlled automatically by the demand for fuel at the day tank.
- O. Fuel filter shall be removable, reusable and shall have valved bypass line for "online" maintenance purposes.
- P. Install the manual fuel bypass pump provided by Division 26.
- Q. Submit Shop Drawings for review before fabrication of the piping system is commenced.

PART 3 EXECUTION

3.1 GENERAL

- A. All pipe materials shall be as specified herein and shall be installed in accordance with the latest industry standards, per the manufacturer's recommendations, and as indicated on the Drawings. All piping shall be made up and installed in a manner that permits expansion and contraction caused by changes in temperature and pressure. This shall be accomplished by the use of expansion loops as required and as shown on the Drawings and by installation of supports that will permit the movement of the pipe without undue stress and by any other precautions that might be deemed necessary by the Engineer. Refer to Section 23 05 48 titled "Vibration Isolation".
- B. Piping exposed in all rooms shall be installed as nearly as possible parallel with or at right angles to the building walls. Install all pipe straight and true. Springing or forcing piping into place will not be permitted unless specifically called for. Install piping in such a manner as to prevent strain on equipment connections. Install piping in such a manner as to eliminate all static and dynamic conditions of loading on equipment connections.
- C. Piping in finished portions of the building, except in mechanical equipment rooms or where otherwise indicated on the Drawings, shall be concealed.
- D. All piping shall be carefully graded so as to eliminate traps and pockets. Provide means for drainage by valved connections with pipe plugs for water traps and with automatic air vents for air pockets. Automatic air vents shall be valved.
- E. Where horizontal pipes change size, eccentric fittings shall be used, to prevent the pocketing of air, except where branch pipes connect into mains, in domestic water piping systems and at water chilling unit connections.
- F. All welded elbows shall be long radius type.

- G. Make all joints smooth and unobstructed inside. Ream all pipe ends to remove burrs. Remove all obstructions and debris inside the piping systems prior to installation.
- H. Install unions or flanges at all equipment connections, control valves, and elsewhere as indicated on the Drawings. Flanges at water chilling units shall be positioned so that no more than a four (4) foot length of pipe and one (1) elbow shall be required to be removed for maintenance and cleaning of the condenser and evaporator vessels.
- I. Make welded joints on the piping system with continuous welds, without backing rings and with pipe ends beveled before welding. Gas cuts shall be true and free from burned metal. Before welding, welding surfaces shall be thoroughly cleaned. The piping shall be carefully aligned and no weld metal shall Project inside the pipe.
- J. Connections between dissimilar metal piping shall be made with dielectric insulating fittings.
- K. All piping shall be of the sizes indicated and shall be routed as indicated on the Drawings, or as required, to serve all equipment and systems.
- L. All piping materials, fabrication, erection, flanging, welding, tests, etc., shall be in accordance with American National Standard Code for Pressure Piping, current edition. Wire type "Short Arc" welding machines will not be acceptable for field welds, except where "shop procedures and methods" can be maintained for prefabrication of piping systems, such as the central plant piping, subject to the approval of the Engineer. Wire type "Short Arc" welding machines will be acceptable for shop fabricated piping. If in the opinion of the Engineer any "Short Arc" weld is found unsatisfactory, the use of the wire type short welding machine shall be discontinued for all remaining welding and rewelding the defective welds. The Engineer shall have unrestricted access, at all times during normal working hours, to the pipe fabrication facilities. The Subcontractor shall indicate in the piping submittals that all piping materials furnished for this Project are suitable for the service intended and comply with the requirements herein.
- M. All welders shall be certified by ANSI B31.1.0-1968 "Standard Qualification Welding Procedures, Welders and Welding Operators" or "Qualification Tests" in Section IX, ASME Boiler and Pressure Vessel Code. Furnish welder performance qualification test certificates for positions 2G, 5G or 6G made in strict compliance with the above codes. Welders shall be certified for the type of pipe material specified herein. All costs incident to procedures and welder's qualification tests shall be assumed by the Subcontractor. Two copies of the qualification test report and certification with welder's identification number, letter, etc., shall be submitted to the Engineer, via the Architect, for his file before any welding commences. Each weld shall bear the welder's identification mark permanently indented in the weld. Welding procedures shall also be in accordance with the requirements of the American Welding Society, current edition, where applicable.
- N. The Subcontractor utilizing a grooved piping system shall provide a letter to the Engineer and Architect stating that a Project Site training session of at least two (2) hours was conducted for this Project by the grooved fitting manufacturer for the Subcontractor's supervisory and installing personnel.

3.2 PIPE CLEANING

- A. The Subcontractor shall furnish all required pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to clean the chilled, condenser and heating hot water piping and sterilize the domestic water piping as herein specified. In addition, the Subcontractor shall permanently install necessary chemical injection fittings complete with stop valves and coupon racks, etc.
- B. Hydrostatic Testing: After each hydrostatic leak testing procedure is complete, drain the system until empty. The chilled, condenser and heating hot water piping systems shall be internally chemically treated and protected during and after the hydrostatic testing procedure. Liquid for each hydrostatic test of piping other than domestic water piping shall be water and Nalco 2572 or approved equal mixed to a ratio of fifty (50) gallons of Nalco 2572 to 10,000 gallons of water or a higher concentration if recommended by the chemical manufacturer. The process shall be monitored by the chemical treatment manufacturer and a written report issued to the Engineer and Owner two weeks after completion of the Subcontractor's hydrostatic testing. At least sixty (60) days prior to the start of hydrostatic leak testing a two (2) foot long length of the typical piping installed on the Project shall be sent by the Subcontractor to Nalco or another chemical manufacturer acceptable to the Owner to determine the composition of the internal pipe coating. Provide injection pumps,

water meters and coupon racks to control and monitor the concentration. After leak testing and a sufficient time period to allow the interior of the piping to be chemically coated to prevent rust formation, the piping shall be drained until empty. Liquid for hydrostatic testing of domestic water systems shall be clean domestic water. Refer to Section 23 05 93 titled "Testing, Balancing, and Adjusting".

- C. Pipe Cleaning and Flushing: The chilled water, heating hot water and condenser water piping shall be thoroughly cleaned and flushed as follows:
1. Cleaning shall not take place more than 14 days prior to system startup. The chemical manufacturer's representative shall be given 30 days notice prior to startup.
 2. Before the chemical cleaning procedure is begun, the Subcontractor shall install bypasses around water chilling units, air handling units, plate and frame heat exchangers, fan coil units, etc. in the chilled and condenser water systems and install a temporary skid mounted portable side stream filtering system. A single filtering system can be utilized and relocated to the system being cleaned. The filtering assembly shall have 6" flanged connections and multiple cartridge filters capable of at least 400 gpm, an integral Barco type flow venturi, and shall be pressure rated for the system to which it is connected. The filter cartridges shall be installed and changed out by the Subcontractor until the system is clean. The initial cartridges shall be twenty (20) microns, the intermediate set five (5) microns and the final set one (1) micron. The filtering assembly shall be removed by the Subcontractor when the piping systems are clean and accepted in writing by the Engineer and Owner.
 3. Refer to Section 23 25 00 for all pipe cleaning chemicals and compounds.
 4. The cleaning compound shall then be circulated in the system at a high flow rate for at least three (3) hours or the time period specified by the chemical manufacturer.
 5. The system shall then be drained until empty from its lowest point.
 6. Fill the system again with fresh water and flush thoroughly until clean water is obtained (maintain continuous blow down and makeup as required during flushing operation). A five (5) micron cartridge type strainer element at end of drain hose shall be utilized to confirm that discharge water is free of foreign material.
 7. The cleaning and flushing procedure shall be approved in writing by the chemical manufacturer. The chemical treatment manufacturer shall be Nalco or another chemical company acceptable, in writing, to the Owner. The chemical manufacturer's representative shall supervise and certify in writing the cleaning and flushing of the piping systems. The Subcontractor shall provide and install injection pumps, water meters and coupon racks to control and monitor the cleaning process. See Section 23 05 93 titled "Testing, Balancing and Adjusting".
 8. The Subcontractor shall provide pipe cleaning certification.
- D. Under no circumstances shall the Subcontractor permit the use of any portion of the domestic water system until it has been properly sterilized and certified same by the local water department or the authorities having jurisdiction.

3.3 FACTORY TESTING

- A. All pipe, valves, fittings and accessories shall be tested in accordance with the latest applicable industry standards.

3.4 FIELD TESTING

- A. Prior to execution of field testing, submit test procedures, recording forms, and test equipment cut sheets to Engineer for review. Refer to Section 23 00 20 titled "Scope of Work" for "Scheduling Procedures".
- B. Refer to Section 23 05 93 for additional testing requirements for pipe, valves, fittings and accessories.

END OF SECTION