SECTION 15050 – BASIC METHODS AND MATERIALS

1. GENERAL

1.1. Related Documents:

1.1.1. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this Section.

1.2. Scope:

1.2.1. This section includes requirements for items of mechanical equipment, materials and procedures which are common to more than one section of Division 15 and which are general in nature and use. This section applies to all sections of Division 15.

1.2.2. The requirements of Section 15010, Mechanical General Provisions, shall apply to all work specified under this section.

1.3. Codes:

1.3.1. All plumbing products, materials of construction, and joining methods shall be in compliance with State of Maryland regulations on the limit of weighted average lead content as set forth in the Annotated Code, and in the installation or repair of plumbing intended to dispense water for human consumption.

1.4. Submittals:

1.4.1. Submit shop drawings for all items of materials specified in this section in accordance with the General Requirements, Section 15010.

1.4.2. Manufacturer's product data shall include specifications, installation instructions and general recommendations for each type of material required. Include data substantiating that proposed materials comply with specified requirements for each type.

1.5. Tests and Adjustments:

1.5.1. The Contractor shall furnish labor, instruments, equipments, and materials required to perform tests prescribed in the sections describing the various systems.

1.5.2. Replace or repair defects found during inspection or test with new materials. Caulking of welded joints, screwed joints, cracks, or holes is not acceptable. Correct leaks in screwed fittings by remaking joints. In welded systems leaks in joints shall be cutout and rewelded. Repeat tests after defects have been eliminated.
1.5.3. Where reasonable doubt exists as to a system’s ability to comply with contract requirements, perform any reasonable test required by the Architect.

1.5.4. Make static pressure tests and prove to the satisfaction of the Architect that the piping is tight before pipes are concealed or insulated. Tests shall be provided as hereinafter specified.

1.5.5. Use test instruments for accuracy by an approved laboratory or by the instrument manufacturer and furnish certificates showing degree of accuracy to the Architect when requested. Make calibration histories for each instrument available for examination.

1.5.6. Where gauges, thermometers and other instruments which are to be left permanently installed are used for tests, do not install until just prior to the tests to avoid possible changes in calibration.

2. PRODUCTS

2.1. Hangers:

2.1.1. Refer to Section 15010, paragraph 2.2.

2.1.2. Hangers and accessories shall be Grinnel, Fee and Mason, Modern, National, or B-Line of the types specified in Section 15010.

2.1.3. It shall be the responsibility of the Contractor to provide an adequate pipe suspension system in accordance with recognized engineering practices, using standard, commercially accepted pipe hangers and suspension equipment.

2.1.4. The design of all hangers and support shall be in accordance with the provision of the current issue of MSS-SP-58 document developed as a standard by the Manufacturers’ Standardization Society.

2.1.5. Hangers for steel pipe, except as noted otherwise shall be spaced at least every ten (10') feet. Hangers for cast iron pipe shall be provided at each joint. Hangers for copper pipe shall be placed at least every eight (8') feet, except pipes 3/4 inch and smaller shall have hangers at six (6') foot intervals.

2.1.6. Where concentrated loads of valves, fittings and similar items occur, or if recommended by the piping manufacturer, closer hanger spacing will be necessary.

2.1.7. Generally, hangers shall be clevis type, standard weight.

2.1.8. Vibration hangers shall be provided as specified.

2.1.9. On insulated piping systems, provide Pipe Shields, Inc., Model CS-CW or approved equal hanger shields at each point of support. Diameter
of hanger shield shall match thickness of the insulation. In lieu of, provide wood dowel insert and minimum twenty gauge protection shield at each point of support. Diameter of insert and shield shall match thickness of the insulation and encompass 50% of insulation surface. On cold systems seal insert vapor tight with appropriate coating.

2.1.10. Diameter of hanger shield shall match thickness of the insulation.

2.1.11. Hangers in direct contact with copper piping systems shall be copper plated.

2.2. **Identification and Equipment Tags:**

2.2.1. All control devices, i.e. panels, switches, starters, push button stations, temperature controls etc., shall be clearly identified as to their function and the equipment controlled.

2.2.2. All equipment such as pumps, fans, filter housings, variable air volume terminal units, etc., shall be marked to clearly identify said equipment and space or duty they serve. All air terminal units and their corresponding thermostats shall be marked with sequential numbers to identify each terminal unit with its respective control thermostat.

2.2.3. Mechanical equipment herein specified shall be identified using engraved laminated black and white phenolic legend plates. Letters shall be minimum, 3/4" high white on surrounding black. Plates shall be mounted by means of sheet metal screws. Submit nameplate list to Architect for approval.

2.2.4. Mechanical and electrical equipment, i.e., air terminal units, valves, etc., concealed above ceiling shall be identified as to location using clear plastic self-adhesive tape with black lettering, applied to ceiling tile "T" bars. Submit nameplate list to Architect for approval.

2.2.5. Piping shall be identified with colored, pre-rolled, semirigid plastic labels as manufactured by Seton, Marking Services, Inc., or approved equal. Labels shall be Seton "set mark" system and shall be set around pipes with a field installed high strength cement around pipes with a field installed high strength cement compound applied along their longitudinal edge. Labels shall be placed around the piping or insulation every forty feet (40) and with one (1) label on each pipe in rooms smaller than fifteen feet (15). Medical gas and vacuum piping shall be labeled every twenty (20) feet. A label shall be placed at every major valve and at least six feet (6) from exit or entrance to an item of equipment. At Contractor's option, piping concealed above suspended ceilings only, may be identified by stenciling with black paint and taped color bands in accordance with the coding system herein specified.
2.2.5.1. Labels shall be provided in accordance with the following table with color coding and stencil designations as indicated:

### SIZE OF LEGEND LETTERS

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe (Inches)</th>
<th>Length of Color Field (Inches)</th>
<th>Size of Letters (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4” to 1-1/4”</td>
<td>8”</td>
<td>1/2”</td>
</tr>
<tr>
<td>1-1/2” to 2”</td>
<td>8”</td>
<td>3/4”</td>
</tr>
<tr>
<td>2-1/2” to 6”</td>
<td>12”</td>
<td>1-1/4”</td>
</tr>
<tr>
<td>8” to 10”</td>
<td>24”</td>
<td>2-1/2”</td>
</tr>
<tr>
<td>over 10”</td>
<td>32”</td>
<td>3-1/2”</td>
</tr>
</tbody>
</table>

2.2.5.2. Color coding and stencil designations shall be as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
<th>Stencil Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Cold Water</td>
<td>Green</td>
<td>Domestic Cold Water</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Yellow</td>
<td>Domestic Hot Water</td>
</tr>
<tr>
<td>Domestic Hot Water Recirculating</td>
<td>Yellow</td>
<td>Hot Water Recirculating</td>
</tr>
<tr>
<td>Sanitary</td>
<td>Brown</td>
<td>Sanitary Sewer</td>
</tr>
<tr>
<td>Storm Water</td>
<td>Brown</td>
<td>Storm Water</td>
</tr>
<tr>
<td>Vent</td>
<td>Brown</td>
<td>Sanitary Sewer</td>
</tr>
<tr>
<td>Condensate Drain</td>
<td>Brown</td>
<td>Drain Water</td>
</tr>
<tr>
<td>Chilled Water Supply</td>
<td>Blue</td>
<td>Chilled Water Supply</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>Blue</td>
<td>Chilled Water Return</td>
</tr>
<tr>
<td>Glycol Supply</td>
<td>Green</td>
<td>Glycol Supply</td>
</tr>
<tr>
<td>Glycol Return</td>
<td>Green</td>
<td>Glycol Return</td>
</tr>
<tr>
<td>Steam</td>
<td>Orange</td>
<td>Steam (Designate Pressure)</td>
</tr>
<tr>
<td>Steam Condensate</td>
<td>Orange</td>
<td>Steam Condensate</td>
</tr>
<tr>
<td>Hot Water Heating Supply</td>
<td>Yellow</td>
<td>Hot Water Heating Supply</td>
</tr>
<tr>
<td>Hot Water Heating Return</td>
<td>Yellow</td>
<td>Hot Water Heating Return</td>
</tr>
<tr>
<td>Oxygen</td>
<td>Green</td>
<td>Oxygen</td>
</tr>
<tr>
<td>Medical Air</td>
<td>Yellow</td>
<td>Medical Air</td>
</tr>
</tbody>
</table>
2.2.6. Ductwork shall be identified by stenciling. Stenciled lettering shall be minimum 3 inches high with adjacent direction of air flow arrows. Stenciled lettering shall be provided on all mains and principle duct branches. Mark each type of service every 30 feet with a marking of each shaft. Identify ductwork as follows:

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Handling Units</td>
<td>AHU-35</td>
</tr>
<tr>
<td>Return Systems</td>
<td>RF-35</td>
</tr>
<tr>
<td>Exhaust Systems</td>
<td>EF-5</td>
</tr>
</tbody>
</table>

2.2.7. All valves, except as specified below, shall be provided with colored plastic or brass valve tags with stamped-in numbers. Tags shall be secured to valve wheels with metal chain. Stop valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent, need not be so equipped. Care shall be exercised in selecting valve numbers to be prepared on tracing linen showing locations, details of arrangements, etc., of all service and control valves indicating identity and function. One black line print of each drawing shall be mounted under glass where directed. Valve tags shall be Seton or approved equal minimum 1-1/2" round tags with white characters describing system and valve designation. Submit valve number list for approval.

2.3. **Pipe, Fittings, and Joints:**

2.3.1. **General:**

2.3.1.1. Piping materials shall conform to state and local code requirements. Pressurized piping systems shall conform to American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) B31.9, “Code for Pressure Piping, Building Services Piping”. High-pressure piping shall conform to ANSI/ASME Section I, B31.1, “Code for Pressure Piping, Power Piping”.

2.3.1.2. Quality and weight of materials shall comply with requirements of applicable American Society of Testing Materials (ASTM), ANSI, ASME, and Cast Iron Soil Pipe Institute (CISPI) standards. ASTM number and wall thickness shall be indicated on each pipe length.
2.3.1.3. Provide pipe and fittings for piping systems as hereinafter specified. All references to codes shall apply to the latest year. All piping and fittings shall be made in America.

2.3.2. Pipe Materials:

2.3.2.1. Sanitary Drainage:

2.3.2.1.1. Underground sanitary drainage shall be cast iron soil pipe, service weight ASTM A74-98, fittings shall be cast iron service weight ASTM A74-98 fitting joints shall be premolded rubber gaskets, Tyler Pipe Industries, Ty-Seal Or Multiple Seal, polyvinyl chloride gaskets manufactured in accordance with ASTM-C-564.

2.3.2.1.2. Above ground sanitary drainage within the building shall be no-hub cast iron soil pipe, service weight, ASTM A888-98 fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Tyler no-hub coupling. CISPI 310-97.

2.3.2.2. Vent Piping:

2.3.2.2.1. Vent Piping shall be no-hub cast iron soil pipe, service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Tyler no-hub coupling.

2.3.2.3. Storm Water Drainage:

2.3.2.3.1. No-hub cast iron soil-pipe, service weight, fittings shall be no-hub cast iron, fitting joints shall be no-hub neoprene gasket and stainless steel corrugated shield, Tyler no-hub coupling.

2.3.2.4. Air Conditioning Condensate and Equipment Drainage:

2.3.2.4.1. Above ground drainage pipe shall be copper drainage tubing, DWV, ASTM B306 with wrought copper and bronze drainage fittings, ANSI B16-29 with soldered joints: Taramet Sterling "lead free" solder or equivalent.

2.3.2.5. Domestic Cold Water:
2.3.2.5.1. Domestic cold water above ground 2” and smaller shall be seamless copper water tube, ASTM B88, Type L hard tempered with wrought copper solder joint fittings, rated for 150 lbs. (water) ANSI B16.22 with soldered joints Taramet Sterling “lead free” solder or equivalent.

2.3.2.6. Domestic Hot Water and Hot Water Recirculation:

2.3.2.6.1. All sizes shall be seamless copper water tube, ASTM B88, Type L hard tempered with wrought copper solder joint fittings, 150 lbs. (water) ANSI B16.22 with soldered joints: Taramet Sterling "lead free" solder or equivalent. Galvanized steel pipe is not permitted.

2.3.2.7. Chilled Water and Glycol Supply and Return:

2.3.2.7.1. Piping 2-1/2” and larger shall be black steel, ASTM A53B ERW ANSI Schedule 40 with steel butt-welded fittings ANSI B16.9 using long turn ells, ANSI B16.5 weld neck or slip-on flanges & Bonney Forge Weldonets and Threadolets. Joints shall be welded in accordance with the Engineering Standards of the Mechanical Contractors Association of America Inc., Part VII, Standard Procedure Specifications Nos. 1 and 2. Piping 12” and above shall be standard weight. All fittings shall be “Made in America.”

2.3.2.7.2. Piping 2” and smaller shall be black steel, ASTM A53A ANSI Schedule 40 with black malleable iron 175 lbs., screwed fittings, ANSI B16.3. joints threaded in accordance with the American Standard for pipe threads, ANSI B2.1. Fittings shall be “Made in America.”

or

2.3.2.7.3. Seamless copper water tube, ASTM B88, Type L, hard tempered with wrought copper solder joint fittings 150 lbs., ANSI B16.22. Joints soldered with ASTM B32 tin-antimony 95-5 or Taramet Sterling “lead free” solder or equivalent.

2.3.2.8. Hot Water Heating Supply and Return:
2.3.2.8.1. Piping 2-1/2" and larger shall be black steel, ASTM A53B seamless ANSI Schedule 40 with steel butt-welded fittings ANSI B16.9 using long turn ells, ANSI B16.5 weld neck or slip-on flanges & Bonney Forge Weldolets and Threadolets. Joints shall be welded in accordance with the Engineering Standards of the Mechanical Contractors Association of America Inc., Part VII, Standard Procedure Specifications Nos. 1 and 2. Piping 12" and above shall be standard weight. Fittings shall be “Made in America.”

2.3.2.8.2. Piping 2" and smaller shall be black steel, ASTM A53A ANSI Schedule 40 with black malleable iron 175 lbs, screwed fittings, ANSI B16.3, joints threaded in accordance with the American Standard for pipe threads, ANSI B2.1. Fittings shall be “Made in America.”

2.3.2.8.3. Seamless copper water tube, ASTM B88, Type L, hard tempered with wrought copper solder joint fittings 150 lbs., ANSI B16.22. Joints soldered with ASTM B32 tin-antimony 95.5 or Taramet Sterling “lead free” solder or equivalent.

2.3.2.9. Steam Supply, Pressure Relief, and Vent Piping:

2.3.2.9.1. Piping 2" and smaller shall be black steel pipe, ASTM A53A ANSI Schedule 40 with cast iron 125 lbs., screwed fittings, ANSI B16.4, joints threaded in accordance with the American Standard for pipe threads, ANSI B2.1.

2.3.2.10. Steam Condensate Return Piping:

2.3.2.10.1. Piping 2" and smaller shall be black steel pipe, ASTM A53A ANSI Schedule 80 with wrought iron 250 lbs., screwed fittings, ANSI B16.4, joints threaded in accordance with the American Standard for pipe threads, ANSI B2.1.

2.3.2.11. Fire Protection Service:

2.3.2.11.1. Above ground pipe 2” and below - Black steel pipe, ASTM A53A, ANSI Schedule 40, assembled with black cast iron screwed
fittings one hundred seventy five pound (175 lb.) water ANSI B16.4, and threaded joints conforming to ANSI B2.1. At Contractor's option, pipe shall be assembled with UL listed and FM approved mechanically grooved couplings Victaulic Style 005.

2.3.2.11.2. At Contractor's option, pipe shall be assembled with mechanically grooved couplings Victaulic Style 005. Fittings shall be Victaulic FireLock™, ASTM-A-395 and ASTM-A-536. UL listed and FM approved for service to 300 psig with schedule 10 pipe.

2.3.2.12. Medical Gas and Vacuum Piping:

2.3.2.12.1. Piping shall be seamless Type L copper tubing. All solder joint fitting used for connecting copper tubing shall be wrought copper. All copper-to-copper joints shall be made using a copper-phosphorous brazing filler alloy (BCup Series) without flux. Dissimilar metals such as copper and brass shall be joined using an appropriate flux with either a copper-phosphorous (BCup Series) or a silver (BAg Series) brazing filler alloy. Tubing shall be joined by brazing or silver soldering, without flux, by a compound having a melting point exceeding 1,050oF. A low flow (0.5 scfm) nitrogen purge should be continuously conducted through the tubing during brazing to prevent the formation of copper oxide scale on inner walls.

2.4. **Valves:**

2.4.1. **General:**

2.4.1.1. Valves shall be provided where indicated on drawings and as herein specified.

2.4.1.2. Valves shall be placed in such a manner as to be easily accessible for handwheel operation and stuffing maintenance.

2.4.1.3. Valves in piping where shown and where listed herein:

2.4.1.3.1. To balance flows in heating, and chilled water piping.

2.4.1.3.2. To isolate all items of equipment.
2.4.1.3.3. To isolate motorized flow control valves.

2.4.1.3.4. To isolate branch lines and riser at mains.

2.4.1.4. Valve pipe connections shall be screw, solder, welded, flanged, or Victaulic as required to be consistent with other parts of the piping system.

2.4.1.5. Where piping or equipment may subsequently need to be removed, provide valves with bodies having integral flanges or full lugs drilled and tapped to hold valve in place so that downstream piping or equipment can be disconnected and replaced with blank-off plate while valve is still in service.

2.4.1.6. Valves over ten feet above standing level and above 4” in size shall have chain wheel with chain extending to within six feet of standing level. All wheel operated valves shall have an indicator to show the position of the disc or plug.

2.4.1.7. Install valves in accessible locations and adjust for smooth and easy operation.

2.4.1.8. Valves for equipment and controls shall be installed full size of pipe before reducing size to make connection.

2.4.1.9. Where there is no interference, shut-off valves shall be installed with handwheel down on horizontal runs of pipe to prevent accumulation of foreign matter in packer between seats at closing end of wedge.

2.4.2. Balancing Valves:

2.4.2.1. Provide balancing valves where indicated and required to balance water flow through the piping system. For pipe sizes 2-1/2” and larger provide separate balancing valve and flow meter fitting.

2.4.2.2. Balancing valve for system piping shall be DeZurik, Homestead or approved equal eccentric plug valve as follows: flanged 2-1/2” and larger, with Fluorinated Hydrocarbon filler in a PTFE U-ring (packing) and CIIR or EPDM plugs and Chloro-Isobutene Isoprene plug facing suitable for -20 to 250°F continuous operation. Valves used in chilled water applications may have packing and plug facing suitable for a maximum operating temperature of 180°F. Valves shall have lever actuators with adjustable memory stop. For 2” and smaller, provide combination balancing and flow fitting with screwed ends as manufactured by Nexus, Tour & Anderson, or approved equal.
2.4.3. Butterfly Valves - General HVAC Duty:

2.4.3.1. Butterfly valves shall be provided in chilled and hot water systems size 4" and larger.

2.4.3.2. Butterfly valves shall be Crane/Centerline, Nibco or DeZurik equal to DeZurik Model BGS resilient seated butterfly valve installed with welding neck companion flanges.

2.4.3.3. Butterfly valves shall be of the lug body style suitable for use with ANSI 125 or 150 pound flanges. Bodies shall be ductile iron, or cast iron. Valves shall be manufactured in accordance with MSS-SP67 rated at least 200 psi non-shock cold water working pressure. Bodies of all flangeless wafer valves shall have 4 flange bolt guides to center the body in the pipeline. Body to have 2" extended neck for insulating.

2.4.3.4. All valves shall have retained seat and shall provide bubble tight shutoff up to the full valve rating without the use of downstream flanges.

2.4.3.5. All valves shall be furnished with bronze self lubricated bearings. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion. Bearings shall be provided at the operator connection and at points immediately outboard of the seat.

2.4.3.6. Seats shall be of the reinforced resilient type. Seats shall also act as a body liner to prevent flow from contacting the body casting. Seats shall have flange sealing to provide a positive seal without use of flange gaskets.

2.4.3.7. Shafts shall be one piece and shall be of Type 416 stainless steel, and shall not have exposed stem-to-disc fasteners. Shaft diameter shall meet the 75B standard from AWWA specification C504-87 for butterfly valves. Shafts shall be finish ground to minimize bearing and shaft seal wear. Shafts of 12" and larger shall have non-adjustable thrust collar.

2.4.3.8. Discs shall be aluminum bronze, with EPDM rubber seat. The disc-to-shaft connections shall be Type 316 stainless steel. Pins, shaft and disc of all valves shall be individually machined and completely interchangeable.

2.4.3.9. Actuator for valves shall be lever type with locking trigger with notched quadrant. Sizes 8" and larger shall have weatherproof gear operators. All actuators shall have adjustable memory stops. All actuators manual or automatic shall be provided by the valve manufacturer.
2.4.3.10. Valves shall be lug-style and capable for use as isolation valves and recommended by the manufacturer for dead-end service at full pressure without the need for downstream flanges.

2.4.3.11. Each valve shall have a metal tag permanently affixed to the valve listing the following information:

2.4.3.11.1. Manufacturer.

2.4.3.11.2. Valve model/series designation.

2.4.3.11.3. Valve body material.

2.4.3.11.4. Disk material.

2.4.3.11.5. Seat material.

2.4.3.11.6. Certified pressure rating.

2.4.4. Ball Valves:

2.4.4.1. Ball valves shall be used in lieu of gate valves in all chilled water, hot water heating, and domestic water piping systems size 3” and smaller for shut-off service. Ball valves shall be Apollo, or approved equal.

2.4.4.2. The body and bonnet shall be ASTM B62 bronze. Ball shall be Type 316 stainless steel. Stem shall be stainless steel. Seats shall be TFE.

2.4.4.3. Stem shall be blowout proof and externally adjustable to compensate for wear. Valve shall be equipped with vinyl covered lever handle which shall indicate position of ball orifice and shall have stops for fully open and closed position. Construction shall be such that power actuator can be used. Ball opening shall be full pipe size.

2.4.4.4. Valve shall be suitable for flow in either direction and shall be rated 150 psig SWP and 600 psi non-shock WOG.

2.4.4.5. Valve shall be so constructed with two piece cast bronze bodies, full port design, with adjustable stem packing.

2.4.4.6. Ball valves used for balancing shall have adjustable memory stop. For use in insulated piping systems provide 2” extended handles of non-thermal conductive material.

2.4.5. Drain Valves:
2.4.5.1. Drain valves shall be ball valves with hose end connections and shall be provided at low points of all piping system and where indicated or required, 3/4" minimum. Provide Nibco Series 585-70-HC or approved equal. Valve shall be rated for 125 lbs.

2.4.6. Valve Schedule:

2.4.6.1. Unless otherwise specified, valves shall be Grinnell, Stockham, Crane, Jenkins, or Nibco equal to the Nibco figure numbers indicated herein:

2.4.6.2. Domestic Hot and Cold Water Systems:

Check - Solder end S-413

2.4.6.3. Hot Water Heating:

Ball - 2" and smaller
Check - 2-1/2" and larger Mueller No.105-MAP
Check - 2" and smaller T-413-B
Check - Solder end S-413-B

Check valves at pump discharge shall be in-line spring loaded or swing design with weight or lever and spring.

2.4.6.4. Steam Supply and Steam Condensate Return:

Gate - 2" and smaller T-124
Globe - 2" and smaller T-211-B

2.5. Pipe Specialties:

2.5.1. Manual Air Vents:

2.5.1.1. Manual air vents shall be key-operated type installed where indicated on the drawings or as required for proper venting of equipment. Vents at top of vent chambers or coils shall be 1/4" brass cocks, Crane #2190 H or approved equal.

2.5.2. Automatic Air Vents:

2.5.2.1. Automatic air vents on water systems shall be Spirotherm, Sarco, Bell, and Gossett, or Amtrol equal to Spirotherm air release valve, 150 psi, and 250° operating temperature. Provide shut-off valve on each vent. Vents above suspended ceilings shall have 1/4" soft copper drain line extended indirect to nearest floor drain, service sink or drain line.

2.5.3. Strainers:
2.5.3.1. Strainers shall be Mueller Steam Specialty Company, Inc., or approved equal, No. 351 for 2” and smaller and No. 758 for 2-1/2” and larger. Screens shall be stainless steel with 1/32” perforations for water. Provide valved blowdown connections on each strainer consisting of a gate valve set between two short nipples. Bush strainer outlet as required for 3/4” maximum connection. Provide a fine mesh start-up screen to be removed after system cleaning.

2.5.4. Flowmeter Fittings:

2.5.4.1. Flowmeter fittings shall be Barco or approved equal Venturi type, or Dieterich Annubar type, or approved equal, brass or cast steel construction suitable for 150 psig working pressure and 250 degrees F operating temperature and shall be equipped with brass quick-disconnect valves for connecting flowmeter. The fitting shall have a maximum head loss of one foot water gauge at design rate and shall have an accuracy of plus or minus 5 percent for water temperatures from 40 degrees F to 215 degrees F. Maximum meter reading shall be 50 inches water gauge.

2.5.5. Pressure Gauges:

2.5.5.1. Gauges shall be Trerice, Ashcroft, Weiss, Winters, Crosby or Marsh equal to Trerice No. 450 series, liquid filled, 4-1/2” diameter case, bottom connected for easy reading. Dial shall have black letters on white background.

2.5.5.2. Pressure gauges shall be suitable for field calibration.

2.5.5.3. Each gauge shall be mounted within six feet of the floor on background or pipe mounted. Submit gauge locations and scale ranges for approval.

2.5.5.4. Provide Apollo or approved equal 1/4” ball valve where "gauge cocks" are indicated or required.

2.5.5.5. Select gauge such that at normal service the gauge pointer is at the middle of the scale range.

2.5.6. Thermometers:

2.5.6.1. Thermometers shall be Moeller, Trerice, Weiss, Taylor, or approved equal. Thermometers shall be bi-metal type with adjustable angle, self-powered (no battery), 3/8” LCD digits display, Hi-impact ABS case, dual F&C switchable, temperature range -40°-300°F (-40°-150°C), accuracy +/- 1% or 1°, whichever is greater. Unit shall be complete with brass socket with extension necks for insulated pipes.
2.5.6.2. Thermometer (remote indicating type) shall be Weksler Series X, or approved equal, stainless steel casing, 4-1/2" dial, 0 degrees F to 120 degrees F reading, with Class 5A fully compensating capillary tubing (maximum length 25 feet), air temperature bulb and mounting bracket.

2.6. **Pipe Anchors:**

2.6.1. All pipe lines shall be anchored where specified herein, indicated on drawings and where required to prevent uncontrolled movement. Anchors shall be constructed of steel and plates, assembled by bolting or welding and secured to the building structure by means of clamps or welding. Structural members shall not be cut or drilled. Anchors shall prevent both axial and lateral movement of the lines. Anchor vertical pipes by means of clamps welded to pipe and secured to wall or floor construction. Submit details of anchors to Architect for approval.

2.6.2. Anchor piping adjacent to flexible pipe connectors to prevent connector from expanding against its restraining bolts and also to keep the pipe on both sides of the connector in alignment.

2.7. **Expansion (Water Systems):**

2.7.1. Where expansion joints are indicated or required, select joints with a traverse of 150 percent of the pipe expansion from the ambient 40 degrees F to the maximum system operating temperature.

2.7.2. All expansion joints shall be suitable for minimum operating pressure and temperature of 150 psi and 300 degrees F, respectively. Expansion joints 2" and larger shall have flanged ends, except when installed in copper pipe systems.

2.7.3. Expansion joints shall be as herein specified:

- 2.7.3.1. Flexible Ball Type - Barco Type N of Series 600.
- 2.7.3.2. Corrugated Type - Flexonics "Low-Corr" joints for pipes 3" and larger.
- Flexonics Model H or HB for pipes smaller than 3".
- 2.7.3.3. Slip Type - Flexonics "Slip Pakt" with anchor base.
- 2.7.3.4. Submit for approval manufacturer's shop drawings of each expansion joint provided depicting length of pipe, location of anchors and guides, calculated expansion offset and type of joint employed.

2.8. **Pipe Guides:**
2.8.1. Provide pipe guides where indicated on drawings or where required for proper installation of expansion loop. Limit use of guides with expansion loop to point shown or where required to prevent buckling of pipe whether indicated or not.

2.8.2. Do not use pipe guides as pipe supports.

2.8.3. Provide factory made cast semi-steel or other heavy fabricated steel consisting of bolted two-section outer cylinder and base with a two-section guiding spider welded or bolted tight to the pipe of sufficient size to clear pipe insulation and long enough to prevent over-travel of spider in cylinder. Furnish a guide sleeve of a length not less than the length of pipe expansion plus the spider length.

2.8.4. When installed in cooling systems, guides shall permit the application of thermal insulation.

2.9. Steam System Specialties:

2.9.1. Steam Traps:

2.9.1.1. Provide Sarco traps equal to the Sarco types indicated herein for all items of steam heating equipment. Traps shall be suitable for steam pressures encountered and shall have capacity to handle three times the condensate rating of the equipment served. Provide traps as herein specified:

2.9.1.1.1. Float and Thermostatic - Type FT & FTB Series, as applicable.

2.9.1.1.2. Traps adjacent to equipment requiring special finishes such as aluminum, brass, chromium, copper, nickel-alloy, or stainless steel, shall be brass bodies chromium plated.

2.9.1.2. Elements shall not be placed in traps until system has been cleaned.

2.9.1.3. Trap ratings shall be in accordance with the standards adopted by the Steam Heating Equipment Manufacturers Association providing for continuous elimination of air when the trap is operating at its maximum rating.

2.9.1.4. All traps, except steam line drip traps and traps used in conjunction with air heating units shall be based on the equipment's hourly condensate rate times a factor of five (5) for equipment controlled by modulating type valve. A factor of three (3) shall be used for equipment without modulating type control. Trap size shall be based on one of the above factors and the tables under the specific trap types, unless a
specific application requires a larger factor recommended by the trap manufacturer.

2.9.1.5. Traps shall be installed so as to permit gravity flow to the traps, and also away from the trap where modulating control valves are used. Traps weighing over 25 pounds shall be supported independent of piping using concrete piers of steel brackets for those near the floor, steel brackets for traps located adjacent to walls, and pipe hangers for ceiling locations.

2.9.1.6. When installing traps, proper provision must be made for expansion in both the steam and condensate lines to avoid stressing either piping or trap. Where trap locations are not at anchor points on the steam line, traps shall be bolted to brackets mounted from the steam line. Where pipe loop is not adequate to provide for expansion in the condensate return, properly sized expansion joints shall be installed together with proper guides.

2.9.2. Trap Applications:

2.9.2.1. Thermostatic traps, unless otherwise noted or shown on drawings, may be used for riser drips and horizontal branch equipment lines not over 15-feet in length.

2.9.3. Thermostatic Steam Traps:

2.9.3.1. Thermostatic traps shall be of the corrugated bellows, balanced pressure type, with a minimum of six corrugations on the bellow. The trap body shall be cast of forged brass designed for 125 psig steam working pressure. The corrugated bellows in traps for low pressure steam systems shall be special grade brass of phosphor bronze. Valves and seats of low pressure traps shall be of suitable non-corrosive metal and shall be removable. Trap maximum operating pressure shall be not less than 150 percent of the system operating pressure. Thermostatic traps shall comply with the applicable parts of Fed. Spec. WW-T-696. Trap capacities shall be as follows, based on 1/4 psi differential across trap:

<table>
<thead>
<tr>
<th>Trap Size</th>
<th>Operating Pressure</th>
<th>Capacity (#/Hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>15</td>
<td>279</td>
</tr>
</tbody>
</table>

2.9.3.3. The capacities in the above table are used on continuous condensate discharge temperatures at 10 degrees F below saturated steam condition.

2.9.4. Disc Diaphragm Traps:
2.9.4.1. In lieu of the bellows type thermostatic traps, Contractor may elect to use the disc diaphragm type thermostatic trap. Discs shall be constructed of phosphor bronze or stainless steel sheet and shall be provided with not less than six points of flexure. All joints shall be mechanically bonded and soldered, or joints may be heliarc welded, with or without mechanical bonding. Solder generally shall be silver solder. Soft solder in accordance with Fed. Spec. WW-T-696 with a tin content of not less than 60 percent, may be used on mechanically bonded joints for joint sealing purposes only on discs provided in traps installed on steam systems operating at less than 16 psig. Traps shall be fabricated with diaphragm center limit stops to prevent exceeding maximum design stroke by contraction. All trap elements shall be guaranteed for ten million cycles at maximum element stroke, at room ambient temperature, without failure.

2.9.5. Steam Pressure Reducing Valves:

2.9.5.1. Pressure regulators shall be Spence type ED for standard applications, type E5D for minimum pressure applications with external pilot operate, packless type, guaranteed for dead-end service. Internal trim shall be stainless steel, including diaphragms, stem, seats and disc.

2.9.5.2. Valves shall be designed so that it may be serviced in the line. Valve and seats shall be guaranteed against wire drawing. Springs in the path of flow are unacceptable.

2.9.5.3. Bodies shall be 250# iron construction. Pilot mountable either side with union fittings.

2.9.5.4. Valves shall be sized such that inlet velocities will not exceed 9000 feet per minute at full specified capacity and valve orifices shall be reduced in size as required to prevent valves from passing more than 120 percent of specified capacity under any condition.

2.10. Steam Expansion Joints:

2.10.1. Expansion joints shall be Advanced Thermal Systems Thermal Pak Model TP2, or approved equal, with integral internal and external guides and designed for the injection of self-lubricating packing under full line pressure. A (min.) 2” dia. Type A packing cylinder shall be welded in place and shall have internal acme threads to assure maximum evacuation of the injectable packing from the packing cylinder.

2.10.2. Traverse chamber and stuffing box shall be seamless steel A-53 Grade B pipe or equivalent tubing with circumferential weld attachments of the butt type only. Slip shall be machined from A-53
Grade B seamless pipe - schedule 80 to 16" size inclusive, and schedule 60 for sizes 18" to 24" inclusive. Slip shall be Corro-Cote Plus Plated - a duplex chrome plate consisting of 1 mil of Hard Chrome applied over 1 mil of Crack-Free Hard Chrome and certified by Permascope inspection per ASTM standard B-499. The stuffing box packing area in contact with the sliding slip shall be at least 15 times the expansion joints' nominal pipe size. Stuffing Box injectable packing shall be - Type “T” for operating temperatures to 550°F.

2.10.3. Each slip shall be factory pre-set for 1” movement in extension and the nominal traverse in compression unless otherwise directed. Prior to making the final connection of Expansion Joint to pipeline, it shall be the responsibility of the installer to verify that the correct amount of slip-precompression has been made to assure free movement of pipe from the installed pipe temperature to minimum and maximum temperature.

2.10.4. Factory produced primary and intermediate Guides shall be ATS Radial type Model HL, HLS, GA or ATS Fig. 101 low friction Graphite type for low profile systems. Primary and intermediate guide spacing shall be in accordance with manufacturers’ published recommendations.

2.10.5. Submittals for approval shall include the Manufacturers’ published Five Year Warranty and Service Guarantee.

2.11. Vibration Isolation:

2.11.1. General:

2.11.1.1. Mechanical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and required to minimize transmission of vibrations and structure-borne noise to building structure or spaces.

2.11.1.2. Select vibration isolating units for the lowest operating speed of equipment so designed that natural frequency of equipment and base mass is not less than 1.5 times the lowest operating frequency of the moving equipment but not a multiple or harmonic of the base frequency. Furnish vibration isolation producing a uniform loading and deflection even when equipment weight is not evenly distributed, and be stable during starting and stopping of equipment without excessive traverse and eccentric movement of equipment.

2.11.1.3. Concrete pads under the isolation units shall be reinforced. Use concrete having a minimum compressive strength of 2500 psi and structural reinforcing bars conforming at ASTM A-615 Grade 60.
2.11.1.4. The installed vibration isolation system for each floor or ceiling mounted item of equipment shall have a maximum lateral motion under equipment start up and shut down conditions of 1/4". Motions in excess shall be restrained by approved spring type mountings.

2.11.1.5. All electrical connections, drain connections, etc., made to equipment which rests on vibration isolators, shall be sufficiently flexible to permit the equipment to be properly isolated.

2.11.1.6. The type of isolation, base, and minimum static deflection shall be as required for each specific equipment application, but no case less than that specified herein when supported on a solid concrete structural slab having a thickness of not less than 4". If vibration isolators with a deflection greater than the minimum specified are required to meet the noise criteria for the adjacent spaces, suitable isolation systems shall be submitted. Should vibration isolators installed for the equipment prove inadequate to prevent transmission of equipment vibrations to the building structure or limit equipment vibration originated noises in the building spaces to acceptable levels, the isolators shall be replaced with units having the largest deflection that can be practicably installed.

2.11.1.7. Spring and combination rail and spring isolation supports where designated in the schedule are indicated for equipment structurally built or supported on a rigid structural steel frame suitable for these types of isolation. Where these types of isolation are not suitable for the equipment construction or operation, the equipment shall be mounted on a structural steel base as herein specified.

2.11.1.8. Equipment affected by wind pressure or with operating weight different from installed weight shall have built-in adjustable vertical stops to prevent rising of equipment when weight is removed. Equipment containing liquid such as chilled water refrigeration units shall have vertical stops.

2.11.1.9. Inertia bases shall consist of a steel reinforced concrete slab cast into a welded structural steel channel frame. Frame shall be fabricated of sufficient strength to prevent distortion of any type during construction, and when the equipment is in operation. Equipment anchor bolts with bottom plates and pipe sleeves shall be preset. One-half inch steel reinforcing bars shall be placed on 6" center both ways in a layer 1-1/2" above the bottom of the base; bars shall extend inside channel frame flanges not less than 1".
2.11.1.10. Where required due to equipment configuration, the inertia block construction shall change and the concrete thickness shall increase as necessary for the proper mounting of the equipment. The weight of the inertia base shall be equal to or greater than the weight of the equipment supported. Additional weight necessary to reduce vibration or motion caused by the equipment's unbalanced forces to less the 1/32" movement shall be provided when necessary.

2.11.1.11. Concrete sub-bases not less the 4" shall be provided for all floor mounted mechanical equipment under another Division. Sub-bases shall rest on a structural floor and shall be reinforced with steel rods and interconnected with floor. A minimum clearance of 2" shall be provided between sub-bases and all inertia blocks, steel bases, and steel saddles with equipment in operation.

2.11.1.12. Each electric motor shall be mounted on the same foundation as the driven machine. Piping connections including strainers at pumps shall be supported on the same foundation as the pumps.

2.11.1.13. All exterior vibration isolation shall be hot dip galvanized.

2.11.2. Vibration Isolation Equipment:

2.11.2.1. All isolation equipment shall be Mason Industries, Vibration Eliminator, Amber/Booth, or Korfund equal to the following Mason Industries products:

2.11.2.1.1. **Type III Mounting** - Spring mounting with limit stops. Mason Type SLR.

2.11.2.1.2. **Type IV Hanger** - combination spring and double deflection neoprene element. Mason Type 30N.

2.11.2.1.3. **Type V Hanger** - similar to Type IV with elevation holding device. Mason Type PC30N.

2.11.2.1.4. **Type VII Hose** - Flexible braided pipe connector. Mason Type FFLSS or approved equal, with control rods.

2.11.2.1.5. **Type XII Pad** - Neoprene cross ribbed or waffle pattern, 3/4" thick. Imprint durometer on material. Provide hot dipped galvanized steel bearing plates where necessary to spread loads. Mason Type Super W.
2.11.2.1.6. **Type XVI Pad** – All-directional seismic snubber. Mason Type Z-1011.

2.11.3. **Application of Isolation Equipment:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hangers within 50 ft. isolated equipment</td>
<td>V</td>
<td>1.50&quot;</td>
</tr>
<tr>
<td>First two hangers near non-isolated</td>
<td>IV</td>
<td>0.75&quot;</td>
</tr>
<tr>
<td>equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rooftop piping hangers from AHU dunnage</td>
<td>V</td>
<td>1.50&quot;</td>
</tr>
<tr>
<td>Rooftop piping on roof curbs</td>
<td>III</td>
<td>1.50&quot;</td>
</tr>
</tbody>
</table>

| Flexible Pump Connectors:                 | VII  | -----     |
| Flexible Chiller Connectors               | VII  | -----     |
| Chiller                                   | III  | 2.0"      |
| AHU                                       | XII  | 0.15"     |
| AHU Seismic Restraints                    | XVI  | -----     |

2.12. **Test Plugs:**

2.12.1. Pressure and temperature test plugs where indicated or required shall be 1/4" npt fittings, suitable to receive either a 1/8" OD temperature or pressure probe. Fittings shall be solid brass with Nardel valve core, fitted with a color coded marked cap with gasket. The entire assembly shall be rated at 1000 psig. Provide two (2) pressure gauge adapters and two (2) 5" stem thermometers, 0 to 220 degrees F and 20 to 130 degrees F range. Plugs shall be as manufactured by Peterson Equipment Company, Inc., Richardson, Texas or Sisco plugs.

2.13. **Electric Heat Tracing:**

2.13.1. Electric heat tracing shall be self-regulating type, consisting of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the cable to be crossed over itself without overheating, to be used directly on plastic or metal pipe, and to be cut to length in the field. The heat tracing shall be covered by a metallic braid grounding shield, and a radiation cross-linked modified polyolefin
dielectric overall jacket.

2.13.2. In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulating factor is defined as the percentage reduction, without thermostatic control, of the heater output going from 40°F pipe temperature operation to 150°F pipe temperature operation.

2.13.3. The heater shall operate on line voltage of 120 volts without the use of transformers.

2.13.4. Heat tracing shall be controlled by an ambient sensing thermostat set at 40°F.

2.13.5. Heat tracing shall be manufactured by Pentair, Thermon, Chromalox, or Heat Trace, Inc.

2.13.6. Digital heat trace controllers shall be Chromalox ITC1, (1) Circuit, or approved equal by Pentair, Thermon, or Heat Trace, Inc.

3. EXECUTION

3.1. Cleaning:

3.1.1. After completion of installation, thoroughly clean dirt, rust, loose scale, oils and grease, and other foreign matter from metal and insulated surfaces, painted or unpainted, specified under Division 15 of the specification.

3.1.2. Clean all systems piping thoroughly of grease, metal shavings, welding beads, or other refuse. Flush piping by use of portable pump or separate water supply to prevent damage to existing or new system pumps. Before cleaning closed systems, all air handling coils shall be isolated by closing inlet and outlet valves and opening the by-pass valves. The system shall be filled with sufficient detergent and dispersant added to remove all dirt, oil, and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. Bleeding shall continue until water runs clear and all detergent is removed. A sample of the water shall be tested and, if PH exceeds the PH of the make-up water, draining shall be resumed. After flushing, clean strainers of debris, open coils and close by-passes. Remove dirty water filters and install new water filters. Turn over replacement bag filters to Owner. Refill and vent water systems being sure to add water after venting to completely fill system.

3.2. Piping Installation:

3.2.1. Install piping without undue stress or strain in locations shown and run parallel to the lines of the building, except to grade them as specified in a neat and workmanlike manner using a minimum of fittings. Provide
such fittings, valves, and accessories as may be required to meet the conditions of the installation. Contractor shall inform himself fully regarding any peculiarities and limitations of space available for installation of material under each section of specifications. Install piping to suit necessities of clearance with ducts, conduits, structure, and other work, and so as not to interfere with any passages or doorways and allow sufficient head room at all places. Use proper reducing fittings for changing piping sizes.

3.2.2. Do not install piping through transformer vaults, elevator equipment rooms or other electrical or electronic equipment spaces. Do not route piping over electrical-distribution panels.

3.2.3. Cut pipes accurately to measurements established in the field in a neat and workmanlike manner without damage or without forcing or springing. Perform cutting by means of an approved type of mechanical cutter of the wheel type where practicable. Ream pipe after cutting to remove all burrs.

3.2.4. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Carefully investigate the architectural, structural, and existing conditions affecting the work, and arrange such work accordingly, providing such fittings, and accessories as may be required to meet such conditions.

3.2.5. Install unions and flanges where shown and on each side of all pieces of equipment and other similar items, and in such a manner that the unions of flanges can be readily disconnected. Do not place any union or flange in a location which will be inaccessible after completion of the project.

3.2.6. Unions in steel pipe 2-1/2" and smaller for water service, shall be 250 lb. malleable iron brass, seat type. Use 150 lb. forged steel flanges for piping 3" and larger. Gaskets shall be 1/8" thick rated for 150 psi service at 250 degrees F. Unions in copper pipe 2" and smaller shall be wrought copper with red bronze ring nut. Use 150 lb. ASME copper flanges for piping 2-1/2" and larger. Flanges and gaskets for use in steam and condensate systems shall be rated for system operating pressures.

3.2.7. Use dielectric unions or couplings at all junctions of copper or brass piping and fittings with ferrous material to prevent electrolysis and galvanic corrosion.

3.2.8. Joints between dissimilar piping material shall be made with appropriate adapters in accordance with the respective manufacturer’s printed instruction and recommendations.

3.2.9. Use reducing fittings, eccentric where required to prevent pocketing of air and water or both, to make changes in pipe sizes.
3.2.10. Grade pipe minimum 1” in 40 feet to low points, unless otherwise specified or indicated. Provide drain valves at all low points.

3.2.11. Automatic temperature control valves furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer’s supervision.

3.2.12. Install wells in chilled water, and hot water heating systems for automatic temperature control sensors. Exact locations and number of wells required shall be determined through coordination with the work required under Section “Automatic Temperature Control.”

3.2.13. All piping shall be so installed so that it will in no way be distorted or strained by expansion or contraction. Except as noted, all expansion and contraction shall be taken up by means of swing joints, loops, bends or long offsets. Swing joints made up with at least three fittings shall be provided in branches from mains to runouts. Size loops for the total pipe expansion without cold springing, but field cold spring one-half the pipe expansion corrected for ambient temperature.

3.2.14. Underground piping shall be installed in a continuous enclosure to protect the pipe from damage during backfilling. The enclosure shall be split or otherwise provide access at the joints during visual inspection and leak testing. Backfill shall be clean and compacted so as to protect and uniformly support the piping. A continuous tape or marker placed immediately above the enclosure shall clearly identify the pipeline by specific name. In addition, a continuous warning means shall be provided above the pipeline at approximately one-half the depth of bury. Where underground piping is installed through a wall sleeve, the ends of sleeve shall be sealed to prevent the entrance of ground water. Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit.

3.3. Workmanship:

3.3.1. Cut pipes accurately to measurements established at structure. Install pipes without springing or forcing.

3.3.2. Clear windows, doors, and other openings with all pipes and ductwork. Arrange pipes to permit expansion and contractions without misalignment or damage.

3.3.3. During construction all openings in piping and equipment shall be closed with caps or plugs to keep out all foreign matter indicated.

3.3.4. All piping in finished spaces shall be run concealed unless otherwise indicated.

3.4. Phasing:
3.4.1. The contractor shall schedule phasing to minimize the disruption of existing patient services. This phasing is essential to ensure a safe environment in patient care areas. Phasing shall include assurance for clean to dirty airflow, emergency procedures, criteria for interruption of protection, construction of roof surfaces, written notification of interruptions, and communication authority. Procedures must be developed for noise and vibration that will affect patients, and planned accordingly. The renovation areas shall be isolated from the occupied areas during construction using airtight barriers, and exhaust airflow shall be sufficient to maintain negative air pressure in the construction zone.

3.5. **Welding:**

3.5.1. See Section 15010, paragraph 3.7.

3.6. **Sleeves and Plates:**

3.6.1. See Section 15010, paragraph 2.4.

3.7. **Flow Meter Fittings:**

3.7.1. Locate and arrange piping, both upstream and downstream of fitting to conform to the manufacturer's published literature.

3.7.2. When flow is measured in horizontal pipe, locate the connection nipples at or slightly above the horizontal centerline of the pipe to minimize the entrance of gases and impurities.

3.7.3. Provide each fitting with an integral tab, or a metal tag or a stainless steel wire, extending outside the pipe covering, and stamp or print in a plainly visible position the manufacturer's name and address; the model number of the meter to which it is to be connected; the name, number or location of the equipment served; the specified rate of flow and the multiplier (including unity, where applicable) to be applied to the meter reading.

3.7.4. Provide fittings with shut-off valves and with quick connecting hose fittings for portable meters.

3.8. **Tests:**

3.8.1. The following tests shall be conducted by the Contractor and all piping shall be proven tight in the presence of the Architect or his representative. Notify Architect prior to tests. These tests shall be conducted before any insulation is installed and any insulation installed prior to test shall be removed. Provide all equipment and labor required. Tests shall be at least four hours in duration. Piping may be tested in sections as approved by the Architect. Tests shall be specified herein.
3.8.2. Domestic water piping shall be hydrostatically tested to 150 psig. All openings in the water piping shall be plugged throughout the system, or portion thereof, filled with water, and tested with a pump to a pressure of 150 psig.

3.8.3. Sterilization:

3.8.3.1. Domestic water system piping shall be disinfected after tests in accordance with State or District Health Department requirements. Before placing the systems in service, contractor shall engage a qualified service organization to sterilize the new water lines.

3.8.4. The sanitary, storm water, condensate drain and miscellaneous drain systems shall be hydrostatically tested. Tests shall be as required by code and as a minimum shall comprise the plugging of all openings in the line, filling the system (or portion thereof) with water until all joints are proven tight. Piping shall be tested with a minimum head of 10 feet of water.

3.8.5. All chilled water, hot water heating, steam and steam condensate (steel) piping shall be hydrostatically tested to 1-1/2 times the system working pressure or a minimum of 100 psig, whichever is greater.

3.8.6. Fire protection piping shall be tested as specified in Section 15500.

3.8.7. All pressure piping systems, unless otherwise specified herein, shall be filled with water and thoroughly flushed clean of foreign matter after erection and before connection of equipment.

3.8.8. Testing and certification of medical gas and vacuum systems shall be required for all new work and modifications to existing medical gas and vacuum piping as indicated on the documents. Testing and certification of medical gas and vacuum system shall be as follows:

3.8.8.1. The medical gas and vacuum systems, including all source equipment, valving, alarms and station outlets shall be evaluated and certified for mechanical and therapeutic function as defined in the National Fire Protection Assn. (NFPA) ii, Compressed Gas Assn. (CGA) and the AIA U.S. Department of Health and Human Services: "Guidelines for Construction and Equipment of Hospital and Medical Facilities," 2001 Edition, formerly: DHHS Publication No. (HRS-M-HF) 84-1. This testing shall be performed by an agency independent of the facility, contractor, or their suppliers. The Agency shall specialize in medical facilities and shall be able to demonstrate experience and expertise in medical gas and vacuum installations.

3.8.8.2. The Agency shall provide to the facility full documentation of the following:
3.8.8.3. That all medical gas and vacuum systems as constructed follow the guidelines of the NFPA 99, regarding the placement and applicability of valves, alarms, and source equipment. The Agency shall not be responsible for evaluation of Contractor's technique in such elements as routing and hangers except as per paragraphs 3.8.12.4, 3.8.12.5, 3.8.12.6, and 3.8.12.7 below.

3.8.8.4. That no cross connections exist in the pipeline as constructed. Documentation shall include examination of the outflow of each station outlet, following a mechanical cross connection procedure as specified by the NFPA 99 par. 4-5.1 1.2. Additionally, each system outflow shall be examined with an appropriate analyzer and the concentrations shall be documented. All medical gas and vacuum systems shall be included in the mechanical examination.

3.8.8.5. Where laboratory systems are tested as separate systems, cross connection tests will be performed to document their separation from medical systems as required by NFPA 99.

3.8.8.6. That all station outlets are delivering gas at a pressure and flow consistent with anticipated needs, as these shall be defined by responsible authorities within the facility, but in no case to be below CGA or NFPA guidelines.

3.8.8.7. That the pipeline is free of debris, including liquid.

3.8.8.8. That all station outlets are functional.

3.8.8.9. That delivered gas is as pure as required by applicable CGA/USP specifications for breathing gas. Samples shall be taken from such station outlets as shall be agreed by the facility and the agency. In no case shall the number of samplings be fewer than two (2), one from source and one from such station outlets as will provide the gas has traversed the greatest length of pipeline. Samples shall be evaluated against CGA/USP requirements for human use and compared to one another.

3.8.8.10. That all reserve source equipment and its control equipment is in place and is operational.

3.8.8.11. That all valves are functional. The control zones shall be documented without regard to plans. This documentation shall be compared to the as-built plans, and all discrepancies between the actual installation and the plans shall be reported to the facility.
3.8.8.12. That all alarms are functioning and are set in accordance with NFPA 99. The surveillance areas of each shall be documented and compared as in paragraph 3.8.12.11 above.

3.8.8.13. That medical air is dry. The examination shall consist of a dewpoint taken at source and most distant station outlet of each lateral branch. Temperatures and pressures affecting the dryness shall be documented.


3.8.8.15. The documentation shall be provided by an independent testing agency approved by the Engineer, and shall contain all of the above information as well as the certification. These documents shall become part of the permanent records of the facility. Certification shall be issued upon successful completion of all specified tests. The Contractor shall not be released from his contractual obligation until certification is obtained.

END OF SECTION