PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 230500 - Basic HVAC Materials and Methods, and other Sections in Division 23 specified herein.

1.2 SCOPE (NOTE TO EDITOR-REVISE SCOPE OF PIPE SYSTEMS AS NECESSARY)

A. All work to be furnished and installed under this section shall include, but not necessarily be limited to, the following:
   1. Pipe and Fittings
      a. Chilled water piping above grade
      b. Heating water piping above grade
      c. Low pressure steam piping above grade
      d. Medium pressure steam above grade
      e. Steam condensate above grade
      f. Temperature and Pressure relief
      g. Refrigerant piping
      h. Cold condensate drainage piping (refer to section 222113 Plumbing Piping)
   2. Valves
      a. HVAC Service Valves (125 psig max. working pressure)
      b. Check Valves
      c. Balancing Valves (125 psig working pressure)
      d. Combination HVAC terminal unit valve line sets
      e. Hydronic Service Pressure Reducing Valves
      f. Hydronic Service Pressure Relief Valves
      g. Steam Service Valves
      h. Steam Service Pressure Reducing Valves
      i. Steam Service Safety Valves
   3. Thermometers, gauges and accessories
   4. Piping specialties
      a. Pipe escutcheons
      b. Strainers
      c. Drip pans
      d. Air vent
      e. Dielectric unions and flanges
      f. Unions
      g. Flanges
      h. Pipe sleeves
      i. Sleeve seals
      j. Valve boxes
   5. Pipe coating
   6. Steam traps
   7. Expansion Compensators

B. In addition, provide the following:
   1. Furnish accessories and labor for flushing and cleaning HVAC piping.
   2. Install water treatment systems.
   3. Furnish material, accessories and labor for glycol antifreeze charging of new

HVAC piping.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Comply with all San Diego State University Campus Mechanical Standards For New Construction and Renovation Capital Projects Standards.

B. Division 01: General Requirements

C. Division 22: Plumbing

D. Division 23: Mechanical
1. Section 230500: Basic HVAC Materials and Methods
2. Section 230593: Testing, Adjusting and Balancing
3. Section 230700: HVAC Insulation
4. Section 232123: Pumps and Hydronic Specialties
5. Section 232500: HVAC Water Treatment
6. Section 238239: Heat Transfer

E. Underground Hydronic Piping
1. Provide all labor, material and equipment required to complete the mechanical underground piping work of the contract documents. Verify all existing utilities and exact locations prior to installation of new piping and provide all necessary trim and fittings for required connections. Coordinate with site work and civil engineering design for trench excavation, backfill, paving and cast in place concrete.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:
1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
3. Perform all tests required by governing authorities and as required under all Division 23 Sections. Provide written reports on all tests.
4. Electrical devices and wiring shall confirm to the 2013 standards of CEC; all devices shall be UL listed and so identified.
5. All HVAC work shall comply with the Americans with Disabilities Act (ADA).
6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

C. Product Control
1. Protection: Use all means necessary to protect materials before, during, and after installation and to protect the installed work and materials of all other trades.

2. The general arrangement and locations of piping are shown on the Drawings. Changes may be necessary to accommodate work. Should it be necessary to deviate from arrangement or location indicated in order to meet existing conditions or due to interference with work of other trades, such deviations as offsets, rises and drops in piping that may be necessary, whether shown or not, shall be made without extra expense. Accuracy of data given herein and on the Drawings is not guaranteed. The Drawings and Specifications are for assistance and guidance, and exact locations, distances, and elevations will be governed by actual site conditions.
3. All work shall be in accordance with the applicable codes listed in Division 01. No extra charge will be paid for furnishing items required by the regulations but not specified herein or shown on the Drawings. Should there be any direct conflict between the Drawings and/or Specifications and the above rules and regulations, the rules and regulations shall take precedence.
4. All work shall be completely coordinated, and all lines, grades, slopes and vertical and horizontal locations of pipes shall be exactly determined in the field and cleared with the Owner's Representative before the installation of these items is begun. No extra compensation shall be made for failure to observe this clause.
5. The Drawings and Specifications do not undertake to list every item that will be installed. When an item is necessary for the satisfactory operation of the system, it shall be furnished without extra cost. Work called for in the Specifications, but not on the Drawings, or vice versa, shall be done as though required by both. Lack of specific mention of any work necessary for proper completion of the work in the Specifications and/or Drawings, shall not lessen the Contractor's responsibility.
6. Obtain Owner's Representative's approval prior to rerouting of existing services. Refer to Division 01 sections for alterations, shutdown and temporary construction for existing services.
7. Pipe spaces provided in the design shall be utilized and the work shall be kept within the spaces established on the Drawings.
8. Manufacturers' directions shall be followed in all cases where manufacturers of articles used in this Contract furnish directions covering points not shown on the Drawings or specified herein. Manufacturers' directions do not take precedence over the Drawings and Specifications. Where manufacturers' directions are in conflict with the Drawings and Specifications, submit these conflicts to the Engineer and receive clarification before installing the work.
9. Do not permit or cause any work to be covered or enclosed until it has been inspected, tested, and approved. Should any of the work be enclosed or covered before inspection and test, Contractor shall, at his/her own expense, uncover the work; and, after it has been inspected, tested and approved, make all repairs with such materials as may be required. Restore all work to its original and proper condition.
10. Be responsible for damage to any of this work before acceptance. Securely cover all openings, both before and after setting into place, to prevent obstructions in the pipes and breakage.
11. Repair all damage to the premises occasioned by the work. All damage to any part of the premises caused by leaks or breaks in the pipe installed under this Section of the work for a period of one (1) year after date of final acceptance of the work, shall be repaired.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for all piping, valves and specialties indicating dimensions, valve CV, flow capacity, pressure setting, tolerances etc.

B. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, valve replacement, and spare parts lists. Include this data, product data, and shop drawings in operating and maintenance manuals.

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style number.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.All pipe, pipe fittings and valves shall be manufactured in North America. Alternatives may be acceptable, but must be submitted and approved by the Engineer prior to bidding.

OR

2. Upon request, the engineer shall be furnished certification by the manufacturer, stating samples representing each lot have been tested and inspected as indicated in governing ASTM specifications have been met. Certification shall be accompanied by test reports as prepared in accordance with relevant ASTM sections governing Test Methods and Inspection. Tension Tests reports shall include breaking load, machined diameter of the test bars, and calculated tensile strength. Certification shall include the legal name and address of the manufacturer.

B. Type M copper piping <u>is not acceptable</u> for any pressure water piping unless specifically noted otherwise.

C. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturers' names used herein, unless specifically noted that substitutes are not allowed.

D. Hydronic and Steam Piping Pressure Classifications:
1. Chilled Water, Heating Water and Condensate:
   a. "Normal Pressure" shall be working fluid pressure up to 50 psig.
   b. "Medium Pressure" shall be working fluid pressure up to 100 psig.
   c. "High Pressure "shall be working fluid pressure up to 200 psig.
2. Steam:
   a. "Low Pressure" shall be working steam pressure up to 20 psig.
   b. "Medium Pressure "shall be working steam pressure 20-80 psig.
   c. "High Pressure" shall be working steam pressure greater than 80 psig

2.2 PIPE AND FITTINGS

A. Chilled Water Piping: (Above grade)
1. Steel Pipe:
a. Pipe Material: ASTM A53 Grade B, Schedule 40 black steel up to 10" diameter. Standard weight black steel for 12" and larger.
b. Fittings:
c. Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded for pipe 2-inch and under; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding
d. Steel grooved end system: Painted, grooved end system, for applications to 300 psi.
e. Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 107 ("Installation Ready" stab-on design) and 07 (standard coupling), or flexible Style 177 ("Installation Ready" stab-on design and 77 (standard coupling), Tyco-Grinnell rigid Fig. 772 or flexible Fig 705 and 707, or Gruvlok FIG 7001 flexible or FIG 7401 rigid.
f. Rigid Type: Coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 an. Victaulic Style 107 or 07, Grinnell Fig 772, or Gruvlok FIG 7401.
g. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Victaulic Style 177, 077, or W77, Grinnell 705 and 707, or Gruvlok FIG 7001.
h. Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade "EHP" or Grade "E" EPDM or EHP.
i. Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.
j. All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.
k. Grooved manufacturer must be ISO 9001 certified.
2. Copper Tubing:
a. Pipe Material: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.
b. Fittings:
1) Copper system: ASME B16.23 cast brass or ANSI/ASME B16.22 wrought copper with the following connection methods.
a) Soldered or brazed: ASTM B32, solder, Grade 95TA.
I. 2" and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.
II. 2-1/2" and larger: Sil-Fos brazing or brazed and flanged.
b) With prior approval a grooved or pressed copper tubing connection system
I. Grooved copper tubing connection system: Victaulic CTS, Tyco-Grinnell, or Gruvlok for above grade joints.
i. Grooved couplings: Victaulic Style 607 (Quick Vic), Grinnell Fig. 672,

Gruvlok FIG 6400.

ii. Coupling gaskets shall be pressure responsive type, Grade “EHP” EPDM.

iii. Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.

iv. Grooved manufacturer must be ISO 9001 certified.

v. Flaring of copper tube to IPS dimensions is unacceptable.

II. Pressed Fitting: As an alternate to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller chilled water piping system for normal pressure systems. Pipe shall be ASTM A312, Schedule 10S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring or HNBR seals.

c) Joints: 2" and smaller, threaded or Vic Press 304™ (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld, grooved.

3. Stainless Steel: ASTM A312, Stainless Steel Type 304/304L, Schedule 10S, for above grade piping systems with operating pressures to a maximum of 300 psi.

B. Heating Water Piping (Above Grade):

1. Steel Pipe: ASTM A53 Grade B, Schedule 40 black steel up to 10” diameter, and Std. Wt. Black steel for 12” diameter and greater.

a. Fittings:

1) Steel normal pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel welding

2) Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges; ANSI B16.9, steel bevel welding.

3) Steel grooved end system (MECHANICAL ROOM ONLY): Painted, grooved end system, for applications to 230 deg. F and 300 psi.

a) Grooved joint couplings shall be ASTM A395 and A536 ductile iron. Victaulic rigid Style 07 or flexible Style 77.

I. Rigid Type: Coupling housings cast with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9. Victaulic Style 07.

II. Flexible Type: Use in locations where

vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings shall be placed in close proximity to the vibration source. Victaulic Style 77.

b) Gasket as recommended for the intended service by the manufacturer. Gaskets shall be pressure responsive synthetic rubber, Grade EPDM, for service up to 230 deg F.

c) Grooved fittings shall be ASTM A395 and A536 ductile iron; ASTM A234 forged steel; or fabricated from carbon steel pipe conforming to ASTM A53.

d) All grooved couplings, fittings, valves and specialties shall be the products of a single manufacturer.

e) Grooved manufacturer must be ISO 9001 certified.

b. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, ANSI B16.11 socket weld.

2. Copper: ASTM B88, Type K or Type L hard drawn copper water tube for normal pressure above grade.

a. Fittings:

1) Copper system: ANSI B16.22, wrought copper with the following connection methods.

a) Soldered or brazed:

I. 2” and smaller: Make connections using 95%-5% tin-antimony solder joints above grade and sil-fos brazing below grade.

II. 2-1/2” and larger: Sil-Fos brazing or brazed and flanged.

b) Grooved copper tubing connection system (MECHANICAL ROOM ONLY): Victaulic CTS, may be used for above grade joint. Used on normal pressure only.

I. Grooved couplings shall be ASTM A395 and A536 ductile iron, and must be of the angle bolt pad type. (Coupling coated with copper colored alkyd enamel.) Tongue and recess type couplings are unacceptable.

II. Coupling gaskets shall be pressure responsive FlushSeal® type, Grade EPDM.

III. Fittings shall be wrought copper per ANSI B16.22, or bronze sand castings per ANSI B16.18.

IV. Grooved manufacturer must be ISO 9001 certified.

V. Flaring of copper tube to IPS dimensions is unacceptable.

c) As an alternate with prior approval to soldered copper, threaded, or flanged steel, Vic Press 304™ pipe, couplings, and fittings may be used on the 2” and smaller heating water piping in mechanical room applications only. Pipe shall be ASTM A312,

Schedule 5S, Type 304/304L, certified for use with Vic Press 304™ products. Couplings and fittings shall be manufactured of precision cold drawn austenitic stainless steel, with EPDM O-ring seals for service up to 230 deg F.

d) With prior approval a pressed copper tubing connection system is acceptable for mechanical room application only.

C. Steam Piping:
1. Pipe: Acceptable alternatives are:
   a. ASTM A53 Grade B, Schedule 40 black steel for low and medium pressure (Up to 80 psig, steam working pressure); and ASTM A53 Grade B, Schedule 80 black steel for high pressure (greater than 80 psig steam working pressure).
2. Fittings:
   a. Steel low and medium pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged, Grade 2 flange bolts; ANSI B16.9, steel bevel welding
   b. Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges, Grade 5 flange bolts; ANSI B16.9, steel bevel weld bevel welding.
3. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

D. Steam Condensate Piping (Gravity and Pumped Pressure Condensate):
1. Steel (low, medium, and high pressure application):
   a. Pipe: ASTM A53 Grade B, Schedule 80 black steel.
   b. Fittings: Steel low-pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged; ANSI B16.9, steel bevel weld.
   c. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.
2. Copper (low pressure application):
   a. Pipe: ASTM B88, Type K
   b. Fittings: ANSI B16.22, wrought copper.
   c. Joints: Lead-free solder joints. Solder shall be lead-free nickel/silver bearing solder meeting ASTM B-32, ASTM B-828. Flux shall be water soluble and shall meet CDA standard test method 1.0 and ASTM B813-91.

E. Temperature and Pressure Relief Valve Discharge Piping:
1. Hydronic Water System (150 psig and 212 deg. F. maximum):
   a. Pipe: Type M or L copper ASTM B88
   b. Pipe: Schedule 40 black steel, ASTM A53 Grade B.
   c. Fittings: ANSI B16.22, wrought copper.
   d. Fittings: 150 lb. rating. ANSI B16.3, malleable iron threaded.
   e. Joints: ANSI B16.22, wrought copper, with 95%-5% tin-antimony solder joints.
   f. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI

B16.25bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

2. Steam Systems (low, medium, and high pressure applications):
   a. Pipe: Schedule 40 black steel, ASTM A-53 Grade B.
   b. Fittings: Steel low and medium pressure application: 150 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanged, Grade 2 flange bolts; ANSI B16.9, steelbevel welding. Steel high-pressure application: 300 lb. rating. ANSI B16.3, malleable iron threaded; ANSI B16.5, flanges, Grade 5 flange bolts; ANSI B16.9, steelbevel welding.
   c. Joints: 2" and smaller, threaded (except in the case of piping located in shafts which must be welded); 2-1/2" and larger, ANSI B16.25bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.

F. Refrigerant Piping
   1. Pipe: Acceptable alternatives are
      a. ASTM B88, Type K or Type L copper tubing
      b. AC/R pipe.
   2. Fittings: No joints below ground. For pipes below grade wrap with Scotch Wrap #51, ¼" thick, with 20% overlap.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

B. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of balancing valve or circuit setter. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable Manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):
   1. Gate or Butterfly: Crane, Bray, Hammond, Gruvlok, Milwaukee, Victaulic, Tyco-Grinnell, Keckley, or Nibco.
   2. Ball and Drain Valves: Apollo, Hammond, Milwaukee, Nibco, Victaulic, Tyco-Grinnell, Bray, Gruvlok, or Watts.
   3. Check: US Valve, Metraflex, DeZurik, Victaulic, Milwaukee, Mueller, Apco, Cla-Val or American Wheatley Products.
   4. Lubricated Natural Gas Service Plug Valves: Homestead, Resun, or Rockwell.
   5. Hydronic System Pressure Reducing Valves: Cash-Acme, Cla-Val, Watts, or Wilkins.
   6. Steam System Pressure Reducing Valves: Sarco, Fischer, Hoffman, or Spence.
   7. Hydronic Pressure Relief Valves: Cash-Acme, Cla-Val, Watts, or Wilkins.
   8. Steam System Pressure Relief Valves: Sarco, Fischer, Spence, or Lonergan-Kunkle.

9. Hydronic Balancing valves and Circuit Setters: Pro Hydronic Specialties, Griswold (Venturi with characterized ball valve only), Wheatley (Y-globe type only), Armstrong, Nibco (globe style), Victaulic/Tour & Anderson, Gruvlok, Oventrop, or Tyco-Grinnell.

E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators:
1. Provide standard hand wheel for gate valves.
2. Provide 90 degree lever operator for ball valves.
3. Provide 90 degree lever operator for lubricated natural gas plug valves. Exterior located natural gas plug valves shall be provided with removable manual wrench handle, one wrench for each 10 valves.
4. Provide 90 degree locking lever operator for butterfly valves up through 5” size. For 6” size and greater, provide gear operator and handwheel.
5. Provide valve stem extension for lever-operated valves on insulated piping, so handle will clear insulation.
6. For valves sizes 2-1/2” and larger, located more than 8 feet from floor in equipment room areas, provide chain operated sheaves. Provide chain and extend down to 5ft above floor and hook clips on chain arranged to clear walking aisles.

G. Valve Features:
1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
2. Bypass: On valves 6" and larger comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving. Provide a 3-valve bypass, minimum 1" size, to consist of two threaded shut-off valves and a plugged drain valve.
3. Drain: Comply with MSS SP-45, and provide ¾” threaded pipe end with cap on chain.
4. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
5. Grooved: Valves shall be joined using grooved joint couplings of the same manufacturer. Copper tubing valve grooved ends shall be copper tubing sized.
6. Vic Press 304™: Valves complete with Vic Press 304™ ends.
7. Threaded: Valve ends complying with ANSI B2.1.
8. Solder-Joint: Valve ends complying with ANSI B16.18.
9. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.4 HVAC SERVICE VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Ball Valves, 2” and Smaller:
1. 2-piece brass body, 600 psi rating, stainless steel or chrome plated brass ball, Teflon seat, brass or stainless steel stem, steel handle, full port. Threaded steel ends for iron pipe and soldered ends for copper pipe. Threaded steel pipe: Milwaukee #BA-100 or equal. Soldered copper pipe: Milwaukee #BA-150 or equal.
2. 2-piece stainless steel body, 300 psi maximum operating pressure, ASTM A-312 compliant, Vic-Press Schedule 10S ends for Type 304 stainless steel

pipe, brass body, chromes plated brass ball, brass stem, PTFE seats, steel handle, full port. Victaulic Series 589 or equal.

B. Butterfly Valves, 2-1/2" and Larger:
1. 2-1/2" through 48", lug type, MSS SP-67 compliant, ductile iron body, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Disc may be stainless steel, bronze, nickel-plated ductile iron or aluminum bronze. Mount stem in horizontal position. Milwaukee model ML323E or equal.
2. 2-1/2" through 12" grooved end type, MSS SP-67 compliant, ASTM A395 and A536 compliant, ductile iron body, stainless steel stem, and memory stop control. Lever handle thru 5" size and worm gear operator for 6" and larger. Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Victaulic Vic®-300 MasterSeal, Tyco Grinnell Model B302, Gruvlok FIG 7700 Series.
3. 14" through 24" grooved end type, MSS SP-67 compliant, ASTM A395 and A536 compliant, ductile iron body, EPDM seal, stainless steel stem, with gear operator. Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Victaulic Vic®-300 AGS (300 psi maximum pressure.), Tyco-Grinnell Model B308, Gruvlok FIG 7700 series.
4. 2-1/2" through 6" copper tube dimensioned grooved end type, cast brass body, EPDM seal, stainless steel stem, memory stop control, lever handle thru 5" size and worm gear operator for 6". Disc may be nickel coated ductile iron, aluminum bronze or stainless steel. Mount stem in horizontal position. Victaulic Series 608N, Tyco-Grinnell Model B680, or Gruvlok BFV.

C. Check Valves:
1. Bronze Silent Check Valves – Up to 1-1/2":
   a. Class 125, MSS SP-80, ASTM B62, ASTM B16 and ASTM , bronze body, threaded ends, bronze spring, Buna disk ring, and silent closing. Milwaukee #548B/548T or equal.
2. Globe Style Silent Check Valves – 2" and Larger:
   a. Class 125, MSS SP-125, ASTM A126 class B cast iron body, ASTM B584 bronze seat and plug, stainless steel spring, bronze bushing, stainless screw. ANSI B16.1 flange rating to 190 psi up to 12" and 135 psi above 12". Cla-Val Series 581, Apco Series 600, Metraflex Series CVO900 or equal.
3. Wafer Style Silent Check Valves – 2" and Larger:
   a. Class 125, MSS SP-125, ASTM A126 class B cast iron body, ASTM B584 bronze seat and disc, stainless steel spring, bronze bushing, stainless screw. ANSI B16.1 flange rating to 190 psi up to 12" and 135 psi above 12". Milwaukee Series 8800, American Wheatley Dual Disc Series, or US Valve Series 09.
4. Grooved Style Silent Check Valves – 2" to 12":
   a. ASTM A536 ductile iron body, single stainless steel disc, EPDM disc coating, brass or stainless steel shaft, stainless steel spring, stainless steel plug. Sizes 2" to 3" rated for 365 psi working pressure and sizes 4" to 12" rated for 300 psi working pressure. Victaulic Series 716H/716, Gruvlok Series 7800, Grinnell Series 590 or equal.
   b. Venturi style check valve with flow measuring taps across the valve. ASTM A536 ductile iron body, single stainless steel disc, EPDM disc coating, brass or stainless steel shaft, stainless steel spring,

stainless steel plug. Sizes 2” to 3” rated for 365 psi working pressure and sizes 4” to 12” rated for 300 psi working pressure. Victaulic Series 779 or approved equal.

D. Drain Valves:
1. Threaded or soldered ends, Class 125, ASSE 1005, bronze body, screw-in bonnet, rising stem, composition disc, 3/4" hose outlet.
2. Threaded or soldered ends, Class 600, bronze body, 2-piece ball valve, ¾" hose outlet with cap and chain. Milwaukee #BA-100/150H.

2.5 STEAM SERVICE VALVES: MAXIMUM 120 PSIG STEAM SYSTEM PRESSURE

A. Gate Valves:
1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61, threaded ends, cast bronze body, bronze union bonnet, bronze wedge, rising stem, bronze packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #1153 or equal.
2. 2-1/2” and Larger: Class 200, 250 lb. SWP, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, OS&Y, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2894A or equal.

B. Globe Valves:
1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61, threaded ends, cast bronze body, bronze bonnet, bronze disc, bronze packing gland, non-asbestos packing and aluminum or malleable iron hand-wheel. Milwaukee #570 or equal.
2. 2-1/2" through 6”: Class 200, 250 lb. SWP, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, OS&Y, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel. Milwaukee #F-2983-M or equal.

C. Check Valves:
1. 2" and Smaller: Class 200, 200 lb. SWP, MSS SP-80, ASTM B61 and ASTM B16, cast bronze body, threaded ends, screwed cap, swing type, bronze disc. Milwaukee #508.
2. 2-1/2" and Larger: 250 lb. SWP, MSS SP-71, ASTM A126 Class B cast iron body, bolted cap, swing type, bronze disc with bronze face rings. Milwaukee #F-2970.

2.6 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure <u>Independent</u> Water Flow in Variable Flow Systems:
1. 1/2" and Larger: Construction and attachment style as required by piping system. Internal working parts and removable flow cartridge shall be stainless steel DZR Brass, polyphenylsufone orifice with an elastomeric diaphragm. Valves shall be factory set and shall automatically limit the flow to specified capacities with 10% +/- accuracy over the entire operating pressure differential. Quick disconnect valves shall be extended to outside of insulation. Pro Hydronics Specialties, Griswold, Victaulic, Oventrop, Hays Fluid Controls.

2.7 TERMINAL UNIT ASSEMBLIES – COIL KITS

A. General: As an alternative to built-up valve and connection assemblies for terminal units, a complete kit consisting of valves, strainer, balancing, and flexible hose connection may be provided. Pro Hydronic Specialties, Victaulic Koil Kit Series 799 or 79V, Hays Fluid Controls, or equal by others.

2.8 BRANCH CIRCUIT DIFFERENTIAL PRESSURE CONTROL VALVES

A. Self powered control valves designed to maintain constant differential pressure for branch circuits and consisting of a differential control, single pressure temperature port, and dead end service shutoff. Shall be capable of stabilizing pressure ranges of 1.5 to 8.7 psi in 3/4" to 1" valves, 2.9 to 11.6 psi in 1-1/4" -2" valves, or 51 psi for 2-1/2" through 4" valves.

B. Bonnet shall be manufactured of copper alloy, O-rings, seat seal, and membrane to be EPDM.

C. T/A 793/794 used in conjunction with Victaulic T/A balancing valves

2.9 PRESSURE INDEPENDENT TEMPERATURE CONTROL VALVES (COIL CONTROL VALVES)

A. Modulating control valves shall be pressure independent characterized two-way actuated flow control valves. The flow rate through the valve shall not vary more than + or - 15% due to system pressure fluctuations across the valve in the selected operating range.

B. Electronic valves at all variable air volume terminals, constant volume terminals, fan powered terminals, and zone reheat coils with valve connections of 1" (18 gpm) or less in size may utilize floating point control. All air handler coils shall utilize proportional control electronic valves.

C. The rangeability of the valve shall be 90:1 (minimum).

D. The valve bodies shall be of cast brass and rated for 200 PSI working pressure (minimum). All internal parts shall be stainless steel, teflon, brass, bronze, or polyphenylsufone orifice with an elastomeric diaphragm. The valves shall be serviceable without removing them from the piping system. Valve flow characteristics shall be able to be changed without removing the valve from the piping system.

E. Balancing valves shall not be required where these control valves are installed. Flow performance curves shall be provided with each valve

F. The actuator shall modulate the control valve from 0 to 100% design flow. The actuator shall be directly coupled to the valve at the factory.

G. Pressure/temperature ports (Pete's Plugs) shall be installed at the factory in each valve larger than 1” or be integral to the valve. Two ports shall be used to measure inlet and outlet pressure to the valve.

H. Manufacturer: Honeywell VRN, Belimo PICCV, Hays Fluid Controls, Victaulic TCP Series, Danfoss AB-QM, Griswold PIC-V, MVP, or PIM models, Oventrop Cocon Q or Flow Control Industries DeltaPValve. Valves shall be provided by controls

provider and installed by piping.

2.10 HYDRONIC SYSTEM' PRESSURE REDUCING VALVES

A. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tappings and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and fall-off at inlet and outlet pressure indicated.
   1. 25-75 psig range: Watts #U5 series.
   2. 10-25 psig range: Watts #N256
   3. Provide with asbestos-free insulating cover, with silicone treated fiberglass cover, 1” insulation, and Velcro fasteners. Suitable for temperatures up to 550 deg. F.
   4. Spence #Series E or equal.

2.11 HYDRONIC SYSTEM PRESSURE RELIEF VALVES

A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Watts #740 Series.

B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting (or pressure setting as indicated on construction documents), and so stamped. Size as required. Watts #100XL, 40XL, 140, N240, or 340 Series.

2.12 HYDRONIC SYSTEM REDUCED PRESSURE BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved. Coordinate with plumbing system for provision of domestic water to reduced pressure backflow prevention to protect domestic water system from connection to hydronic piping systems.

B. Reduced Pressure Backflow Preventer
   1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-QT-S-HW valve with #909AG air gap fitting.
   2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-S-OSY valve with #909AG air gap fitting.

2.13 STEAM PRESSURE REDUCING VALVES

A. The pressure regulator shall be of the pilot-actuated diaphragm operated type. The main valve shall be single seated with hardened stainless steel trim: the regulator body shall be cast iron or steel. The pilot shall be bolted directly to the regulator

body. The regulator shall be capable of dead-end shut-off.

1. Size 1/2”-2”, NPT ends, cast iron, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
2. Size 2-1/2” and greater, ANSI 250 lb flanged ends, 250 psig maximum operating pressure, 450 deg. F. maximum temperature.
3. Spring shall be selected to provide outlet pressure as indicated in equipment schedules or on construction documents.

2.14 STEAM SYSTEM SAFETY VALVES

A. Size 1/2”-1-1/4”. ASME sections I and VIII for steam service. Safety valve shall be fitted with enclosed spring and external lifting lever. Valve shall be rated up to 250 psi and 450 deg. F. steam. Shall be furnished with manufacturer’s standard connections and valve body of cast brass with bronze Teflon internals.

1. NPT inlet and outlet
2. Provide relief setting as per equipment schedules or indicated on construction documents.
3. Inlet pressure as per equipment schedules or indicated on construction documents.
4. Flow capacity as per equipment schedules or indicated on construction documents.
5. Provide with manufacturer drip pan elbow.
6. Provide manufacture data on capacity steam flow, with 90% rating at 10% over pressure, as part of valve submittal
7. Spence Series #31, 41 and 41A, or equal.

B. Size 1-1/2” and above. ASME sections I and VIII for steam service. Safety valve shall be fitted with enclosed spring and external lifting lever. Valve shall be rated up to 250 psi and 450 deg. F. steam. Shall be furnished with manufacturer’s standard connections and valve body of cast iron with bronze internals.

1. ANSI 250 lb. Fanged end inlet and outlet.
2. Provide relief pressure setting as per equipment schedules or indicated on construction documents.
3. Inlet pressure as per equipment schedules or indicated on construction documents.
4. Flow capacity as per equipment schedules or indicated on construction documents.
5. Provide with manufacturer drip pan elbow.
6. Provide manufacture data on capacity steam flow, with 90% rating at 10% over-pressure, as part of valve submittal
7. Spence Series #31, 41 and 41A, or equal.

2.15 THERMOMETERS AND GAUGES

A. General:

1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
2. No mercury shall be used in thermometers due to hazardous material classification.
3. Acceptable Manufacturers: Weklser, Ashcroft, Trerice, Marshalltown, WIKA or US Gauge.

B. Thermometers:

1. Bi-Metal Type: Provide bi-metal glass thermometers of materials,

capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.

a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
d. Stem: Stainless steel, adjustable angle socket, length to suit installation.

2. Glass Thermometer: Provide adjustable angle 9” thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
   a. Case: Aluminum or Valox
   b. Temperature Sensitive Gage Liquid: Organic non-toxic. No mercury permitted.
   c. Scale: Aluminum painted white with black markings.
   d. Connection: 1/2” NPT with thermowell, 1-1/4” UNF swivel nut without thermowell.
3. Photovoltaic Cell Powered LCD Thermometer
   a. Case: ABS Plastic
   b. Accuracy: 1% of full scale
   c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celcius.
   d. Connection: 3/4” NPT with thermowell 1-1/4” UNF swivel nut without thermowell.
4. Range: Conform to the following:
   a. Hot Water: 20°F - 240°F with 2°F scale divisions.
   b. Cold Water: -40°F - 160°F with 2°F scale divisions.

C. Thermometer Test Wells:
1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature/Pressure Gauge Connector Test Plugs (Pete’s Plugs):
1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200° F (93° C). Construct of brass or stainless steel, equip with 1/2” NPT fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8” O.D. probe assembly from dial type insertion thermometer or pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
4. Connector: Brass with ¼" male NPT.
5. Scale: White coated aluminum, with permanently etched markings.

6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

F. Pressure Gauge Cocks:
1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock shall be 1/4-1/2” threaded end, 2-piece bronze body ball valve. Milwaukee #BA-100.
2. Siphon: 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end.
3. Snubber: 1/4" brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

2.16 PIPING SPECIALTIES

A. General:
1. Provide factory fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Pipe Escutcheons:
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Low Pressure Y-Type Pipeline Strainers:
1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations at 233 0.045" perforations per square inch.
2. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Spirax Sarco, Keckley, Wheatley or Mueller.
3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with 3/4” drain valve. Spirax Sarco, Keckley, Wheatley or Mueller.
4. Grooved Ends, 2-1/2” and Larger: Ductile iron body, bolted screen strainer with off center blowdown fitted with 3/4” drain valve. Victaulic style 730/731/732, Tyco-Grinnell Fig. S853 and S55, Gruvlok FIG 7260/758G, or approved equal.
5. Strainers for steam service shall be installed in horizontal position, so as not to trap condensate.

D. Basket Strainers:
   1. Provide strainers full line size of connecting piping, with ends matching piping system materials.
   2. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
   3. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
   4. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   5. CWP Rating: 125 psig.
   6. Manufacturers: Spirax Sarco, Keckley, Wheatley or Mueller.

E. Drip Pans:
   1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection.

F. Steam Safety Valve Drip-Pan Elbows:
   1. Provide pre-manufactured drip pan elbows specially designed for steam pressure safety valve discharge, sized to match corresponding steam safety valve discharge size.
   2. Sarco, Armstrong, Hoffman, Spence, Kunckle, or approved equal.

G. Air Vent with Valves:
   1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A minimum 3/8 inch type "L" copper tubing drain line shall be run to floor sink, floor drain or other approved drain receptacle to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Provide Hoffman #79 or equal by Amtrol, Watts, or Dole.

H. Dielectric Waterways:
   1. To effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
   2. Steel to copper, with thermoplastic dielectric lining.
   3. 250 psig rated pressure at 210 deg. F.
   4. Connection: screwed, grooved, sweat, or flanged to match pipe.
   5. Victaulic style 47, Gruvlok FIG 7088/7089 or approved equal.

I. Dielectric Flanges: Provide dielectric flanges and dielectric bolt sleeves for flanged transitions between dissimilar metal piping. Watts Series 3100 or approved equal.

J. Unions:
   1. Unions shall be of type specified in following schedule:
      a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
      b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
      c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
      d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass,

ground joint, brass to brass seat, with threaded ends.

e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.

f. Where grooved joint piping systems are utilized, unions are not required. Grooved joint couplings shall serve as unions.

g. Manufacturer: EPCO, Mueller, Stanley G. Flagg, Victaulic, Tyco-Grinnell, or Watts.

K. Flanges:

1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
3. Type of pipe and corresponding flanges as follows:
   a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
   b. Stainless Steel Pipe, Class 150 stainless steel flange adapter with carbon steel back-up flange and Vic Press 304™ end.
   c. Welded Steel Pipe, 150 lb. black forged steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.
   d. Grooved Steel Pipe, Class 150, ASTM A395 and A536 ductile iron flange adapter, with pressure responsive synthetic rubber gasket. Victaulic Style 741, Tyco-Grinnell Fig. 71, or Gruvlok FIG 7401.

L. Flange Gaskets:

1. Type: full faced or flat ring to suit flange facings.
2. Shall conform to ASTM F-104
3. Minimum thickness: 1/16”
4. Flange gaskets for medium and high pressure steam service shall be provided with metallic rim.
5. Manufacturer: Garlock style 3200, or approved equal.

M. Pipe Sleeves:

1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum ½ inch annular clearance around pipe.
3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6", 14 gauge.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1” above finished floor.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane

clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

9. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydro Preseal, or equal.
   b. Outer Sleeves: EPDM attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.
   c. Water Stop Mid-body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve.

N. Sleeve Seals:
1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.
3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

O. Watertight Sleeve-Seal Systems
1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydroflame Sleeve, or equal.
   b. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
   c. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
   d. Retain subparagraph below if fire resistance rating is required.
   e. Provide a comparable fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.
2. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.
   a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE; Hydroflame CMD Metal

Deck Device, or equal.

b. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.

c. Includes a cone attached to the base for extending the device through the metal deck and a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.

d. Retain subparagraph below if fire resistance rating is required.

e. Provide a comparable fire-resistance rated assembly when tested according to ASTM E 814 or ANSI/UL 1479.

2.17 VALVE BOXES:

A. Concrete body, cast iron cover with vandal resistant screws, extensions as required to extend full depth to valve. Valve box cover lettering shall correspond to the valve service, "Water", "Gas", etc. Christy #G8 or equal.

2.18 STEAM TRAPS

A. Provide steam traps of size, flow capacity, and type as indicated on plans. Manufacturer: Armstrong, Spirax Sarco, Hoffman, or approved equal.

B. Where size or type is not indicated, provide trap of size and type as recommended by trap manufacturer to meet the scheduled equipment capacity or anticipated flow for the application.

1. Traps shall be sized with minimum 2:1 factor of safety for drip traps on mains.
2. Traps shall be sized with minimum 3:1 factor of safety for end of main traps, heat exchanger and coil traps, or ahead of pressure reducing valves.

C. Drip traps on steam headers or mains are to be inverted bucket (IB) type or Thermodynamic type.

D. Traps on shell and tube type heat exchangers are to be inverted bucket large vent (IBLV) type or float & thermostatic (F&T) type.

E. Traps on air unit heating coils are to be IBLV or F&T.

F. Traps on radiation or pipe coils are to be IBLV, F&T, or thermostatic.

G. Provide gate valves upstream and downstream of trap and inlet and outlet unions for servicing.

H. Provide strainer upstream of trap and check valve downstream of trap.

I. Provide bypass piping and normally-closed bypass globe valve one pipe size smaller than trap line size at each steam trap.

2.19 EXPANSION COMPENSATORS AND FLEXIBLE PIPING CONNECTIONS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be

installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ANSI B31.1 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop, Unisource V-SF21 Style, or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal. Provide steel supports to prevent sagging is required.

E. Three grooved joint flexible type couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Victaulic Style 177 or 77, Tyco Grinnell Fig. 705 and 707 couplings, or Gruvlok FIG 7401.

F. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS, Unisource V-BF11 Style, or approved equal. Provide steel supports to prevent sagging is required.

G. Flexible Rubber Connectors (Pump Connections): Concentric spool type expansion joint, single or double arch. Chlorobutyl tube and cover, meeting ASTM specification D2000 Grade 2AA610AB, L13. The body shall be reinforced with rectangular body rings and a minimum of six bias plies of polyester fabric. A hypolon coating shall be applied completely and uniformly to the cover. All expansion joints shall be rated 190 PSI/26 inch vacuum at 250° F for sizes up to and including 12 inch.

1. For heating hot water service and critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 400° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturer shall provide documentation utilizing oven aged and cold flexibility tests to verify elastomer capability. Each batch of compound manufactured shall be tested to verify it conforms to the ASTM specifications listed below. Garlock #204HP. No known equals.

	CHLOROBUTYL	VITON
Specific Gravity	ASTMD 792	ASTMD 792
Durometer Shore A	ASTMD 2240	ASTMD 2240
Tensile	ASTMD 412	ASTMD 412

Elongation	ASTMD 412	ASTMD 412

	POLYESTER	FIBERGLASS/KEVLAR
Thread Count	ASTMD 3775	ASTM 1910
Gauge	ASTMD 1777	ASTMD 1777
Weight	ASTMD 3776	ASTM 1910
Breaking Strength	ASTMD 1682	ASTMD 1682

2. For chilled water, condenser water, and non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26 inch vacuum at 250° F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or equal.
3. Three grooved joint flexible type couplings may be used in lieu of flexible connectors on steel pipe for vibration attenuation and stress relief. Grooved joint couplings shall be placed in close proximity to the vibration source. For services up to 250°F. Victaulic Style 177 or 77 Or Gruvlok FIG 7401.

H. Expansion Joints for Grooved Piping: For piping systems fabricated from grooved pipe and couplings, use one of the following methods for expansion compensation:
1. Combination Couplings and Nipples: Provide expansion joints constructed of grooved short pipe nipples and flexible couplings, designed by manufacturer to suit intended service. Provide removable ties to hold joint compressed or expanded during piping fabrication, depending on application. Total joint end movement is dependent on the number of couplings/nipples in the joint. Select couplings and gasket materials to match balance of piping system. Victaulic Series 155 or Gruvlok FIG 7240.
2. Slip-Type Expansion Joints: Provide slip-type expansion joints constructed of carbon steel pipe and couplings, designed by manufacturer to suit intended service. Joint shall be gasketed expansion joint, with grooved ends. Slide section coated with PTFE modified PPS (Polyphenylene Sulfide) coating. Joint suitable for axial end movement up to 3”. Victaulic Style 150. Select couplings and gasket material to match balance of piping system.
3. Three flexible couplings: Use three flexible couplings (Victaulic 177, 75 or 77, Tyco-Grinnell Fig. 705 and 707, or Gruvlok FIG 7401) for the first three connections in close proximity to a pump or chiller to eliminate flexible rubber connectors.

I. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or equal.

J. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints. Expansion loops in IPS steel and roll grooved copper tubing systems shall be accommodated with loops or bends consisting of (8) Victaulic or Gruvlok couplings, (4) 90 degree elbows, and (3) grooved end pipe spools provided in water systems up to 250 deg F in accordance with recommendations for expansion compensation.

2.20 TRACER WIRE PIPE LOCATING WIRE AND MARKER

A. Pipe Locating Wire: Bare AWG No. 10, soft drawn, single strand copper wire.

B. Provide at least six mil PVC electrical tape insulation around wire where adjacent to metal pipe, valves, and in all valve boxes.

C. Pipe marker shall be internal with locating wire color coded for use with different utility pipe systems, and marked with the utility tape every 24 inches. Provide 4 mil thick, 4"inch wide polyethylene marker.

2.21 PIPE COATING

A. All exposed above ground steel and copper pipe and fittings in corrosive air environments shall be covered with one of the following methods:
1. Twice Wrap 20 Mill Scotch Wrap PVC No. 51, 50% overlap.
2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mill Scotch Wrap No. 51.

2.22 SUPPORTS AND ANCHORS (SEE SECTION 230500)

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal or otherwise irregular work unless so indicated on Drawings or approved by Architect.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturer’s directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.

B. The cooperative work not included in the Mechanical Division related to the general construction work is as follows:
1. All formed concrete work
2. Framed openings in masonry and other Architectural and Structural elements

3. Wood grounds and nailing strips in masonry and concrete

C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

3.5 PIPE SIZES TO EQUIPMENT

A. General: Pipe sizes indicated on drawings shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1 inch clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

D. Cleaning: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

3.7 SLOPING, AIR VENTING, AND DRAINING:

1. Chilled, heating, and condensate water:
   a. Slope all piping to allow for drainage at low points. Slope shall not exceed 1%. Provide drain valves and hose adapters at all low points in piping.
   b. Connect all water branch piping to the bottom or side of their respective mains. Where connection must be made to the top of the main piping, make provision for venting of air.
   c. Provide manual or automatic vents at all high points in water piping and where shown on the drawings.
2. Steam:
   a. Slope steam piping as specified and as indicated, true to line and grade, and free of traps and air pockets downward a minimum of 1” per 40 feet of run in the direction of flow and maximum 1% slope.
   b. Where horizontal piping must be reduced in size, use eccentric reducers that allow continuing a uniform pitch along the bottom of the piping (in downward pitched systems). Avoid concentric reducers in horizontal piping to avoid potential water hammer.
   c. Takeoffs from steam mains are to be taken from the top of the main preferably at a 45 degree angle.
   d. Where branch takeoffs are less than 10 feet in length, the branch line is to be pitched back towards main at 1% slope.

3.8 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Steam Condensate, and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

B. Water Piping (chilled and heating piping): Clean systems with chemicals specified in Section 232500 HVAC Water Treatment. Follow the method provided below or a method recommended by the suppliers of the chemicals specified in Section 232500.

1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and similar deleterious substances without damage to any system component. Provide temporary piping or hoses to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any components which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris-carrying velocity of 2.5 to 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and contractor’s booster pumps. Flush until clean as approved by the Owner, Architect or Engineer.
2. Cleaning: Using products specified in Section 232500, circulate systems at normal temperature to remove adhering organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and similar substances

not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Before cleaning isolate equipment which is “clean” and where dead-end debris accumulation must not occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body using the velocity of this throttling action. Flush for not less than one hour.

3.9 WATER TREATMENT EQUIPMENT AND SYSTEMS

A. Install water treatment equipment and provide water treatment for systems as designated in Section 232500 HVAC Water Treatment.

B. Close and fill systems as soon as possible after final flushing to minimize corrosion.

3.10 WELDING

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other approved test procedures using methodology and procedures covered in the ASME Boiler and Pressure Vessel Code, Section IX, "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators". Installation shall conform to ANSI 31.1 "Power Piping". Welders shall be tested and certified for all positions.

3.11 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM. B-32, in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or

corrosive flux shall not be present at the jobsite.

1. Manufacturers:
   a. Solder: JW Harris "Bridgit" or Englehard "Silvabrite 100".
   b. Flux: Laco "Flux-Rite 90", MW Dunton "Nokorode CDA Flux", Hercules "Fluid Action Solder Flux".

E. Braze copper tube and fitting socket or extrude joints (T-drill) with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

F. Piping shall be capped during construction to prevent entry of foreign material.

G. Grooved Joints:
   1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall meet AWWA C-606 requirements.
   2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.
   3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   4. Grooved coupling manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically inspect the product installation. Contractor shall remove and replace any improperly installed products.

H. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0°F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or un-fused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Re-fabricate to comply with requirements.
   6. With engineering pre-approval stub-in saddle taps may be acceptable for branch connections where the branch size is less than 50% of the main size and where branch sizes are 2”, or smaller, in diameter.

I. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

J. Cast-Iron Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

K. Adhesive Bonded Joints:
1. All joints installed or constructed in the field shall be assembled by employees of the contractor who have been trained and certified to the bonding procedure specification provided by the pipe manufacturer. This specification shall meet or exceed the requirements of ASME B31.3, Section A328.2.1. The pipe manufacturer or their authorized representative shall train the contractor's employees in the proper joining and assembly procedures required for the project including hand-on participation by the contractor's employees in accordance with the manufacturer's specification.

3.12 VALVES

A. General: Except as otherwise indicated, comply with the following requirements.
1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping, strainers and other equipment. Locate valves so as to be accessible and so that separate support can be provided as necessary.
2. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
3. Install butterfly valves with stems mounted horizontally.
4. All valves mounted higher than 10 feet above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 5 feet above floor.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:
1. Copper Pipe, 2-1/2" and Smaller: One of the following, at installer's option:
a. Soldered-joint valves
b. Grooved-joint valves
2. Copper Pipe, 2-1/2" and Larger: Grooved-joint valves.
3. Steel Pipe, 2" and Smaller: Threaded joint valves.
4. Steel Pipe, sizes 2-1/2" and larger: One of the following, at installer's option:
a. Flanged valves
b. Lug valves
c. Grooved-end valves

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, globe, ball, plug, circuit setter, glove, and butterfly valves to comply with ASME B31.9.

G. Check Valves: Install in vertical or horizontal a minimum of three (3) pipe diameters

downstream of pump outlet.

H. Wafer Style Silent Check Valve: Install between two (2) flanges and use full size bolts to assure center alignment.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with "Mechanical Identification" section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

M. Install so handles are readily available. Locate valves and valve handles for appropriate maintenance access.

N. Gasket and O Ring Material: Valve manufacturer is responsible for submittals. Provide gasket and O ring material best suited for the both piping systems.

3.13 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
   1. At inlet and outlet of heat exchangers

3.14 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1” minimum annular clear space between piping/insulated piping and concrete slabs and walls.
   1. Retain subparagraph below when cast-in-place watertight sleeve seals are required.
   2. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.
   3. Retain subparagraph below if applicable.
   4. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2” above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
4. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.15 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Position cast-in-place water tight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.
1. Install cast-in-place watertight sleeves for pipes NPS 6 (DN 150) and smaller in diameter.
2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve.

3.16 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in

relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.17 EXPANSION COMPENSATORS

A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

3.18 EXCAVATION AND BACKFILL

A. Underground piping shall be installed in stable, open trenchwork. Trench excavations shall be a minimum of 16 inch wide, true to line and grade. Contractor shall exercise all due shoring and safety procedures. No stones larger than 1 inch may be present in the trench to a minimum depth of 4 inch below the trench bottom. The trench shall be free of job site debris, and free of corrosive media. Pipe crown shall be not less than 36 inch below the finished ground surface for metallic pipe, and 40 inch for non-metallic pipe, unless otherwise indicated on the drawings or directed by the Architect. Trenches shall be kept free of excess moisture, and shall be kept open for only a short a time as necessary for installation, testing and inspection. Dispose of surplus excavation and seepage water as directed by the Architect.

B. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12 inch above the pipe crown with thin layers of unwashed sand, dampened but not puddled, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6 inch and tamped by mechanical tampers to a minimum 90% Standard Proctor Density, in accordance with ASTM D-1557-58T. Trenches shall be backfilled to a minimum depth of 36 inch prior to being wheel loaded. Replace to their original condition all turf, plants, concrete, asphalt, or other improvements which constitute landscaping, traffic areas or other improved areas which become disturbed by excavation. In graded and undeveloped areas, in addition to procedures specified above, backfill trenches with crown 8 inch above the surrounding surface.

C. Excavated and backfill in soils of unstable nature shall be provided as directed by Architect.

3.19 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e. "Rough-in" "Top-out" and final.

B. Inspection - Below Grade: All piping installed below grade shall be inspected <u>prior</u> to burial by the Architect, the Owner's Representative or the Engineer. Provide photographs of underground piping in Operation and Maintenance Manuals including location and depth of pipes. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be buried without approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection - Above Grade: All piping installed above grade shall be inspected upon completion and prior to finish of walls and ceilings by the Architect, the Owner's Representative or the Engineer. Contractor must notify Architect no less than 24 working hours prior to inspection time. Should the piping be hidden within the structure prior to inspection approval the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.20 PAINTING (SEE SECTION 230500)

3.21 IDENTIFICATION MARKERS (SEE SECTION 230500)

3.22 WATER ANALYSIS AND TREATMENT

A. Upon completion of systems installation, cleaning, and filling, engage a qualified water treatment firm, acceptable to the Architect and Engineer. The water treatment firm shall perform a chemical analysis on each system listed hereinafter, and shall submit to the Engineer a report, including the following:
1. Analysis of heating water, chilled water, and condenser water systems
2. Initial treatment of each system
3. Recommendations regarding subsequent, periodic, or continuous treatment on each system

B. Contractor is to furnish and install initial treatment.

C. For all systems except steam and condenser water, contractor is to provide for periodic testing at 6 months and 12 months after startup and shall provide all recommended treatment for full first year of system operation. For steam and condenser water systems provide monthly testing and report.

3.23 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The systems may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. "Tolerance" shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be the minimum test pressure listed below or the listed test pressure below or 50 psig more than operating pressure, whichever is greater. Do not exceed the maximum pressure rating of the piping.

SYSTEM	TEST MEDIUM	TEST PRESSURE (MINIMUM)	TOLERANCE – TEST PERIOD

SYSTEM	TEST MEDIUM	TEST PRESSURE (MINIMUM)	TOLERANCE – TEST PERIOD
Chilled Water	Water	100 psig	None - 8 hours
Heating Water	Water	100 psig	None - 8 hours
Steam	Air	200 psig	None – 8 hours
Condensate	Water	150 psig	None – 8 hours
Refrigerant Piping	Air	200 psig	None – 8 hours

D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, and air vents for proper performance. Test all air vent points to ensure that all air has been vented.

END OF SECTION