SECTION 22 11 10
PLUMBING PIPING AND ACCESSORIES

PART 1 – GENERAL

1.01 WORK INCLUDED

A. The work of this Section shall include, but is not limited to, the following:

1. Piping
2. Fittings
3. Jointing Materials
4. Unions and Couplings
5. Mechanically Coupled Pipe
6. Heat Tracing
7. Welding and Jointing Procedures
8. Cleaning of Piping Systems
9. Testing of Piping Systems

1.02 RELATED DOCUMENTS

A. Section 21 13 19 – Fire Protection Systems

B. Section 21 20 00 – Fire Suppression Systems

C. Section 22 05 01 – Plumbing General Provisions23 09

D. Section 22 05 16 – Expansion Compensation for Plumbing

E. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

F. Section 22 05 48 – Vibration Isolation and Seismic Restraints for Plumbing

G. Section 22 05 53 – Systems Identification for Plumbing

H. Section 22 07 19 – Insulation for Plumbing

I. Section 22 11 00 – Domestic Water Systems

J. Section 22 11 23 – Plumbing Pumps

K. Section 22 13 00 – Drainage Systems

L. Section 22 33 00 – Domestic Water Heating Systems

M. Section 22 63 13 – Natural Gas Systems

1.03 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

A. ANSI – American National Standards Institute

1. ANSI/ASME B1.20.1 – 2013: Pipe Threads, General Purpose (Inch)
2. ANSI/ASME B1.20.2M – 2006: Pipe Threads 60-deg., General Purpose(Inch)
3. ANSI/ASME B31.1 – 2012: Power Piping

B. ASME – American Society of Mechanical Engineers

1. ASME Standard for Boiler and Pressure Vessel Code – 2013

    a. ASME BPVC – Section IX – Welding and Brazing Qualifications

2. ASME B16.1 – 2010: Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250
3. ASME B16.3 – 2011: Malleable Iron Threaded Fittings, Classes 150 and 300
4. ASME B16.4 – 2011: Gray Iron Threaded Fittings, Classes 125 and 250
5. ASME B16.5 – 2009: Pipe Flanges and Flanged Fittings, NPS½ through NPS 24 (Metric/Inch Standard)
6. ASME B16.18 – 2012: Cast Copper Alloy Solder Joint Pressure Fittings
7. ASME B16.21 – 2011: Nonmetallic Flat Gaskets for Pipe Flanges
8. ASME B16.22 – 2013: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
9. ASME B16.24 – 2011: Cast Copper Alloy Pipe Flanges and Flanged Fittings, Classes 150, 300, 400, 600, 900, 1500 and 2500
10. ASME B16.26 – 2013: Cast Copper Alloy Fittings for Flared Copper Tubes
11. ASME B16.34 – 2013: Valves – Flanged, Threaded and Welding End
12. ASME B18.2.1 – 2012: Square and Hex Bolts and Screws (Inch Series)
13. ASME B31.9 – 2011: Building Services Piping

C. ASTM – American Society of Testing and Materials

1. ASTM A53/A53M – 2012: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
2. ASTM A105/A105M – 2013: Standard Specification for Carbon Steel Forgings for Piping Applications
3. ASTM A106/A 106M – 2013: Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
4. ASTM A120 – 1984: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized), Welded and Seamless for Ordinary Uses
5. ASTM A153/A153M – 2005 Revised 2009: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. ASTM A181/A181M – 2013: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
7. ASTM A182 – 2012: Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
8. ASTM A183 – 2003 Revised 2009: Standard Specification for Carbon Steel Track Bolts and Nuts
9. ASTM A312 – 2011: Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
10. ASTM A376 – 2013: Standard Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service
11. ASTM A403 – 2011: Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
12. ASTM A536 – 1984 Revised 2009: Standard Specification for Ductile Iron Castings

13. ASTM A674 – 2010: Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
14. ASTM B32 – 2008: Standard Specification for Solder Metal
15. ASTM B43 – 2009: Standard Specification for Seamless Red Brass Pipe, Standard Sizes
16. ASTM B62 – 2009: Standard Specification for Composition Bronze or Ounce Metal Castings
17. ASTM B88 – 2009: Standard Specification for Seamless Copper Water Tube
18. ASTM B633 – 2013: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
19. ASTM B813 – 2010: Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
20. ASTM B828 – 2002 Revised 2010: Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy tube and Fittings
21. ASTM D1330 – 2004 Revised 2010: Standard Specification for Rubber Sheet Gaskets
22. ASTM D1785 – 2012: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
23. ASTM D2104 – 2003: Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40
24. ASTM D2464 – 2013: Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
25. ASTM D2466 – 2013: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
26. ASTM D2467 – 2013: Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
27. ASTM D2609 – 2002 Revised 2008: Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
28. ASTM D2657 – 2007: Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
29. ASTM D2846 – 2009: Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
30. ASTM D3261 – 2012: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
31. ASTM F1290 – 1998 Revised 2011: Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings

D. AWS – American Welding Society

1. AWS A5.8/A5.8M – 2011: Specification for Filler Metals for Brazing and Braze Welding
2. AWS B2.1/B2.1M – 2009: Specification for Welding Procedure and Performance Qualification
3. AWS C3.4M/C3.4 – 2007: Specification for Torch Brazing
4. AWS D10.12M/D10.12 – 2000: Guide for Welding Mild Steel Pipe

E. AWWA – American Water Works Association

1. AWWA C104/A21.4 – 2013: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. AWWA C105/A21.5 – 2010: Polyethylene Encasement for Ductile-Iron Pipe Systems
3. AWWA C106/A21.6 – 2000: Cast-Iron Pipe Centrifugally Cast in Metal Molds

4. AWWA C111/A21.11 – 2012: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

F. ISO – International Organization for Standardization

1. ISO 9001, 4th Edition – 2008: Quality Management System Requirements

G. UL – Underwriters Laboratories Inc.

H. International Building Code

I. International Plumbing Code

J. Local Codes and Standards

1.04 QUALITY ASSURANCE

A. Comply with the applicable provisions and recommendations of the standards and codes listed in Paragraph 1.03 and the requirements of the listed related documents.

B. Welding materials and labor to conform to ASME Code and applicable state Labor Regulations.

C. All welders shall be certified by ANSI/ASME B31.1 “Power Piping” or “Qualification Tests” in Section IX of the ASME Boiler and Pressure Vessel Code: Welding and Brazing Qualifications.

D. Each length of pipe, fitting, trap, fixture or device used in any piping system shall be stamped or indelibly marked with type, weight, quality and manufacturer’s name or mark.

1.05 SUBMITTALS

A. Submit the following for review:

1. Product Data: Submit manufacturer’s latest information on construction details, rated capacity data, operating characteristics and installation data.

2. Submit, for all equipment provided under this Section, dimensions, accessories, required clearances, electrical requirements and wiring diagrams specific to this project that clearly differentiates between manufacturer-installed and field-installed wiring and location and size of all required field connections.
3. Submit manufacturer’s installation instructions, operation data, start-up instructions, maintenance data, parts list and controls specific to this project, accessories and maintenance data.
4. Submit schedule indicating the ANSI, ASME, ASTM, AWWA Standard Specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
5. Submit shop drawings indicating anchoring details, anchor points, guide details, etc.
6. Submit manufacturer’s data for strainers and fittings.
7. Submit dimensioned drawings locating pipe penetrations through walls, slabs and other structural elements, anchor and guide locations, etc.
8. Submit pipe expansion and flexibility calculations.

9. Submit test reports on all systems tested. Tests required by Authorities Having Jurisdiction over the work shall be submitted on appropriate forms to the satisfaction of such authorities.

B. Heat Tracing: Equipment sizes, locations, performance data, installation details, wiring diagrams and controls. Manufacturer's latest published data for materials, equipment and installation.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Strainers:

1. Y-type and Basket: Mueller Steam Specialty, Muessco, Spirax-Sarco, Bailey Div. of CMB Industries, Zurn Industries, Victaulic Company (all grooved end strainers)
2. Tee Type Grooved End: Victaulic Company (all grooved end strainers)
3. Basket Type: Viking

B. Welding Fittings: Hackney, Bonney Forge Foundry (Weld-o-lets), Weldbend

C. Mechanical Couplings and Fittings: Victaulic Company, Anvil International Gruvlok

D. Stainless Steel Pressed Fittings: Victaulic Company, Viega

E. Dielectric Fittings:

1. Unions: Watts, Perfection, Central Plastics, EPCO, Zurn, Hart
2. Insulating Flanges: Watts, Capital, Central Plastics, EPCO, Walter Vallett Co., V-Line
3. Flange Kits: Calpico, Central Plastics, Advanced Plastics
4. Couplings: Calpico, Lochinvar
5. Nipples: Perfection, Sioux Chief, Victaulic Company

F. Flange Gaskets: John Crane, Garlock, Manville, Goodrich

G. Heat Tracing: Raychem Type XL, Thermon Type FLX, Nelson Electric Type LT

H. Cleaning of Piping Systems: Use chemicals as recommended by the water treatment specialist engaged under Section 23 25 00: Water Treatment

I. Testing of Piping Systems: American Gas and Chemicals "Leak-Tee", Cosgille Scientific "Sho Gas", Flamort Chemical "Detect-A-Leak", Highside Chemicals "Leak Finder Foam"

J. Plastic Pipe Fittings: J-M Ring Tight

2.02 PREESURE PIPING AND FITTINGS

A. Pressure piping shall conform to requirements of ANSI/ASME B31.1 Power Piping. Pressure ratings herein are steam, unless specifically designated as "WOG" (Water, Oil or Gas) or "WWP" (Water Working Pressure).

B. Black Steel, Threaded, 2 inches and smaller: Schedule 40, ASTM A120 or ASTM A53/

A53M:

1. Cast iron banded fittings, ASME B16.4, 125 pound class.
2. Malleable iron, ASME B16.3, 150 pound class.

C. Galvanized Steel, Threaded: Schedule 40, ASTM A120 or ASTM A53/A 53M:

1. Fittings: Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1½ pipe diameters:

   a. Threaded, galvanized malleable iron fittings and ground-joint unions, ASME B16.3, 150 pounds per square inch class, 2 inches and smaller.
   b. Cast iron flanges and flanged fittings ASME B16.1 125 pounds per square inch class, at values and piping specialties 2½ inches and larger.

D. Copper Tubing: ASTM B88:

1. Wrought copper, solder joint fittings, ASME B16.22, in sizes available with AWS A5.8/A5.8M or ASTM B32 filler metals per Article 2.4, C.
2. Cast bronze solder-joint fittings, ASME B16.18, only in sizes not available in wrought copper.
3. Cast bronze, threaded, ground-joint unions, ASME B16.18, 2 inches and smaller.
4. Cast bronze, flanged unions, ASME B16.24, 150 pounds per square inch class, 2½ inches and larger.
5. Copper tubing flared fittings: Bronze castings for flared type joints, ASME B16.26.

6. Medical gas piping shall be especially cleaned, dehydrated and capped in accordance with NFPA 99.
7. Grooved end copper fittings conforming to ASME B16.18 and ASME B16.22, and couplings conforming to ASTM A536. Copper tubing dimensioned. Flaring of tube or fitting ends is not permitted.

E. Brass:

1. Standard weight and red brass pipe, 85 percent copper, 15 percent zinc, ASTM B43.
2. 125 pounds per square inch threaded brass fittings, ASME B16.15.

F. Cast Iron, Mechanical – Joints:

1. AWWA C104/A21.4, AWWA C106/A21.6.
2. 150 pounds per square inch class.
3. Centrifugally cast, coated, cement lined.
4. Mechanical-joints, AWWA C111/A21.11.

G. Cast Iron, Flanged: AWWA C104/A21.4, AWWA C106/A21.6, 150 psi class:

1. Centrifugally cast, coated, cement lined.
2. Cast iron flanges and flanged fittings, ASME B16.1, 125 pounds per square inch class.
3. Flanges integrally cast for long straight pipe runs.
4. Flanges may be threaded in areas requiring many fittings. Where field joints require close dimensional tolerance for make-up length of piping.

H. Plastic: Pipe and fittings shall carry the National Sanitation Foundation Seal:

1. Threaded: Schedule 80.
2. Non-threaded except as noted: Schedule 40.
3. Unplasticized chlorinated polyvinyl chloride Type 1 (CPVC): ASTM D2846.
4. Unplasticized polyvinyl chloride Type 1 (PVC) bell-end: AWWA C900.
5. Unplasticized polyvinyl chloride Type 1 (PVC) Schedule 40 and 80: ASTM D1785.
6. Polyethylene (PE) Schedule 40: ASTM D2104.
7. Fittings:

a. Unplasticized Polyvinyl chloride Type 1 (PVC) pressure type:

1) Socket type:

a) ASTM D2466, Schedule 40.
b) ASTM D2467, Schedule 80.

2) Threaded type: ASTM D2464, Schedule 80.
3) With National Sanitation Foundation Seal.

b. Polyethylene (PE):

4) Insert type: ASTM D2609.
5) Butt fusion type: ASTM D3261.

I. Stainless Steel:

1. 2-inch and smaller: ASTM A312 or ASTM A376, Schedule 40, seamless stainless steel, type 304 pipe with ASTM A182, Grade F304, 3000-pound socket-weld fittings.
2. 2½-inch and larger: ASTM A312 or ASTM A376, Schedule 40, seamless stainless steel, Type 304 pipe with ASTM A403, Grade WP304, butt-weld fittings.
3. Use 3000-pound socket-weld, stainless steel ground joint unions.
4. Use ASTM A182, Grade F304, 150-pound flanges with $^{1}/_{16}$-inch raised face, serrated face finish and weld neck pattern.

2.03 JOINING MATERIALS

A. Flange gaskets shall be rated ASME B16.21, non-metallic, flat, asbestos-free full faced or flat ring type to suit flange facings. Selected from one of the following materials:

1. General service, water, air, natural gas: $^{1}/_{16}$-inch thick, non-asbestos. Crane Style 333, or approved equal.
2. PVC piping applications: ⅛-inch thick, Durometer 65 to 75; Goodrich “Koroseal”, Grade 116 polyvinyl chloride, or approved equal.
3. Hot water: Red rubber, ASTM D1330, $^{1}/_{16}$-inch thick; Crane Style 555, or approved equal.
4. Gaskets shall be coated with thread lubricant when being installed.

B. Pipe threads shall be ANSI/ASME B1.20.1.

C. Flange bolts and nuts shall be rated ASME B18.2.1, carbon steel.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer.

E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

1. 100 percent lead free, silver bearing solders; equivalent to:

a. “Silverflo” by Canfield
b. “Bridget” by Harris Products Group

2. 95 percent tin and 5 percent antimony composition.

F. Brazing Filler Metals:

1. General Duty: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys; unless otherwise indicated, equivalent to:

a. “Stay-Silv 15” by Harris Products Group
b. “Sil Can 15” by Canfield

G. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.04 UNIONS

A. Steel Piping 2 inches and smaller: ASME B16.3 malleable iron unions with brass seats. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 pounds square inch, ground joint.

B. Steel Piping 2½ inches and larger: ASTM A181/A 181M or ASTM A105/A 105M, Grade 1 hot forged steel flanges of threaded, welding neck, or slip-on pattern and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2½ inches may be used as required for connecting to equipment and piping specialties. Use raised face flanges ASME B16.5 for mating with other raised face flanges on equipment with flat ring or full-face gaskets. Use ASME B16.1 flat face flanges with full-face gaskets for mating with other flat face flanges on equipment. Gasket material to be non-asbestos and suitable for pressures and temperatures of the piping system.

C. Copper Piping: Nibco No. 633.

2.05 DIELECTRIC FITTINGS

A. Unions:

1. 1¼ inches and smaller: EPCO Model FX, or approved equal:

a. 250 pounds per square inch WOG
b. Provide standard gaskets for plumbing
c. Female pipe thread by solder end connections, non-asbestos gaskets, having a minimum pressure rating of 250 psig at not less than the design operating temperature of the fluid being conveyed
d. Clearflow dielectric waterways

2. 1½ inches and larger: EPCO Model X, or approved equal:

a. Brass half-union, ASME B16.1, 175 pounds per square inch WOG
b. Clearflow dielectric waterways
c. Steel weld neck by copper solder joint end connections, non-asbestos gaskets, having a minimum pressure rating of 125 psig at not less than the design operating temperature of the fluid being conveyed

B. Insulating Flanges:

1. Dielectric-Flange Kits: Provide companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
2. Provide separate companion flanges and steel bolts and nuts, 150 or 300 psig minimum working pressure where required to suit system pressures.
3. 2 inches and smaller: Walter Vallett Company, V line, or approved equal.
4. 2½ inches and larger: Brass half-union, ASME B16.1, 175 pounds per square inch WOG; EPCO Model X, or approved equal.

C. Couplings: Provide galvanized-steel coupling with inert and non-corrosive, thermoplastic lining, threaded ends and 300-psig minimum working pressure at 225 degrees F.

D. Nipples: Provide electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 degrees F.

2.06 MECHANICALLY COUPLED GROOVED END PIPING SYSTEM

A. Provide mechanically coupled grooved end fittings and pipe similar to Victaulic roll grooved products manufactured under ISO 9001 certification.

B. The following services may use mechanical grooved pipe connections within the building in mechanical spaces and above accessible ceilings, and in other locations as approved by the Engineer. Mechanical shafts and chases are not considered accessible.

1. Domestic cold water

C. Piping Components:

1. Grooved couplings shall consist of two pieces of ductile or malleable iron housings. Coupling gaskets shall be a synthetic rubber gasket with a central cavity pressure responsive design. Coupling bolts and nuts shall be heat-treated carbon steel, trackhead conforming to physical properties of ASTM A183. Use Style 77 couplings for all joints within 10 feet of riser connections. Grooved fittings, couplings, valves and gaskets must be manufactured under ISO 9001.
2. Reducing couplings are not acceptable.
3. Make full size branch connections for piping 2½ inches and larger with manufactured grooved end tees. Branch connections for less than full size shall be made with hole cut products. Style 920 or Style 921 branch connections with locating collar engaging into hole or Style 72 outlet coupling used to joint grooved pipe and to create a branch connection. Provide gaskets for branch connection using Grade “E” EPDM Compound with working temperature of minus 30 degrees F to plus 230 degrees F. Gaskets must be ISO 9001 certified. Gaskets shall be provided by the same manufacturer that provides the coupling housing.

4. Provide flanges for all connections to flanged components as follows:

   a. Style 741 (2 inches or larger) for connection to ANSI Class 125 and 150 flanged components
   b. Style 743 (2 through 12 inches) for connection to ANSI Class 300 flanged components

5. Provide full-flow cast fittings, manufactured under ISO 9001 with grooves to accept grooved end couplings as recommended by the manufacturer:

   a. Standard Fittings: Cast or ductile iron conforming to ASTM A536 (Grade 65-45-12), painted with a rust-inhibiting modified vinyl alkyd enamel or hot-dip galvanized to ASTM A153/A 153M or zinc electroplated to ASTM B633, as required
   b. Standard Steel Elbow Fittings (14-24 inches): Forged steel conforming to ASTM A106/A106M, Grade B (0.375 inch wall) painted with rust-inhibiting modified vinyl alkyd enamel or hot-dip galvanized to ASTM A153/A153M

   c. Standard Segmentally Welded Fittings: Factory fabricated, by fitting manufacturer, of carbon and steel pipe as follows:
      6) ¾ to 4 inches conforming to ASTM A53/A 53M, Type F;
      7) 5 to 6 inches Schedule 30 conforming to ASTM A53/A 53M, Type E or S, Grade B;
      8) 8 to 12 inches Schedule 30 conforming to ASTM A53/A 53M, Type E or S, Grade B, painted with rust-inhibiting modified vinyl alkyd enamel or hot-dip galvanized ASTM A153/A 153M, as required.

   d. Mechanical-Tee: Style 920 fittings with ductile or malleable iron housings may be used for up to 2-inch outlet size.

2.07 STRAINERS

A. Provide threaded ends up to 2-inch size, flanged or grooved end 2½-inch and larger.

B. Body:

1. Up to 150 pounds per square inch – Y-type: Ductile or cast iron body; bolted, coupled or threaded screen retainer tapped for a blow-off valve; threaded body in sizes through 2-inch and rated at not less than 175 psi WOG; flanged or grooved end body in sizes over 2-inch and rated at not less than 125 psi WOG at 230 degrees F. Cast iron body with clamped cover, tapped for a blow-off valve; 125 psig flanged body for 2½-inch and larger.
2. Up to 150 pounds per square inch – Basket type: Cast iron body with clamped cover; body tapped for a blow-off valve; 125 psig flanged body for 2½-inch and larger.
3. Over 150 pounds per square inch – Y type: Ductile or cast iron or cast steel body; stainless steel screens; bolted, coupled or threaded screen retainer tapped for a blow-off valve; threaded or socket weld body in sizes through 2-inch and rated at not less than 300 psi WOG at 150 degrees F; flanged, grooved end or butt weld body in sizes over 2-inch and rated at not less than 300 psi WOG at 150 degrees F.

C. Strainer screen shall be Type 316 stainless steel or monel, reinforced, with free area not

less than 2½ times inlet area.

1. Perforations:

a. Water:

9) Up to 2-inch: 1/32 inches
10) 2½-inch to 8 inch: ⅛ inches
11) 10-inch and larger: 5/32 inches

2. Magnets:

a. Water strainers:

12) All 8-inch and larger
13) Each pump suction

b. Provide continuous magnetic field around entire circumference of screen.
c. Removable cast Alnico No. 5 channel magnets or approved baskets constructed of magnetic alloy.
d. Secure magnets with stainless steel retaining lugs and threaded rods.

D. Y-Type:

1. Threaded: Faced cap, straight thread and gasket; Muessco No. 11M, or approved equal
2. Flanged: Bolted cover; Muessco No. 751 or No. 752, or approved equal

E. Basket Type: Bolted cover, bottom drain connection.

1. Up to 6-inch: Provide cast iron or steel body with bolted cover, stainless steel ball valve and integral mechanism to permit servicing without interrupting flow; Muessco 792FD, or approved equal.
2. 8-inch and larger: Diverting type, cast iron body with stainless steel basket and integral mechanism to permit servicing without interrupting flow; Zurn Series 570, or approved equal.

F. Grooved End Type: Wye type grooved joint for vertical or horizontal installation with blow-off plug.

2.08 HEAT TRACING

A. Heat tracing cable shall consist of two (2) 16 AWG tinned copper bus wires, embedded in parallel, in a self-regulating semi-conductive core that varies its power output to respond to temperature along its length.

B. Heater to be capable of being crossed over itself without overheating and of being cut to length in the field.

C. Cover cable with a cross-linked modified polyolefin dielectric jacket. Protect cable with a tinned copper braid. Cable shall be approved for use without ground fault protection of the electric branch circuit.

D. Heat tracing cable shall operate on line voltage of **[277] [208] [230] [120]** volts without the use of transformers.

E. Manufacturer shall provide power connection, end seals, splice and tee kits for a complete Underwriters Laboratories listed system. Heat tracing cable shall be sized using manufacturer's standard procedure and shall maintain fluid within pipe at 40 degrees F when outside temperature is minus 10 degrees F.

F. Provide a line voltage thermostat for on-off control of heat tracing cable by sensing ambient temperature at the traced pipe and turn heat tracing on when outside temperature is below 35 degrees F and turn the heat tracing off when outside temperature is above 35 degrees F.

G. Provide and install manufacturer's recommended glass cloth adhesive tape and "Electrically Heat-Traced Pipe" labels at maximum of 30-foot centers.

H. Each circuit shall be protected with a 30 milliamp ground-fault protection device.

I. Required output rating is in watts per foot at 50 degrees F, based on 1-inch fiberglass insulation on metal piping. Minimum Ambient minus 10 degrees F.

1. 4-inch pipe or less: 5 watts per foot
2. 6-inch pipe: 8 watts per foot
3. 8- and 10-inch pipe: 2 strips at 5 watts per foot each
4. 12- and 14-inch pipe: 2 strips at 8 watts per foot each
5. 16- to 24-inch pipe: 3 strips at 8 watts per foot each

2.09 UNDERGROUND PIPE WRAPE

A. Use a flexible polymer film with a coal tar and synthetic elastomeric coating of 36 mil thickness and dielectric strength exceeding 12 kilovolts. Use a compatible primer below the polymer film.

PART 3 – EXECUTION

3.01 APPLICATION

A. In addition to applicable portions of the PART 3, refer to the following specification sections for installation, testing and cleaning requirements for specific piping systems identified in these sections.

1. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
2. Section 22 11 00 – Domestic Water Systems
3. Section 22 11 30 – Reclaimed Water Systems
4. Section 22 13 00 – Drainage Systems
5. Section 22 62 00 – Vacuum Systems
6. Section 22 63 13 – Natural Gas Systems
7. Section 22 63 14 – Nitrogen Systems
8. Section 22 63 15 – Laboratory Gas Cylinder Systems
9. Section 22 64 13 – Propane Gas Systems
10. Section 22 67 00 – Pure Water Systems

3.02 INSTALLATION

A. General:

1. Except as otherwise indicated, protect piping as specified below:

    a. Allowance for thermal expansion and contraction shall be provided for piping passing through a wall, floor, ceiling or partition by wrapping with an approved tape or pipe insulation, and by installing through an appropriately sized sleeve to allow for thermal movement.
    b. No ashes, cinders, refuse, stones, boulders or other materials that can damage or break the piping or promote corrosive action shall be used in backfilling any trench or excavation in which piping is installed.

2. Install piping at indicated slope free of sags, bends, and kinks. Install components having pressure rating equal to or greater than system operating pressure. Support all piping per Section 22 05 29 – Supports, Hangers, Anchors and Sleeves for Plumbing.
3. Brace all piping per Section 22 05 48 – Vibration Isolation and Seismic Restraints for Plumbing.
4. Clean off scale, rust and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.
5. Install (at traps, instruments, etc., and wherever else directed) approved unions, to permit easy connection and disconnection.
6. Use main sized saddle type branch connections for directly connecting branch lines to main piping lines in steel piping if main is at least one pipe size larger than the branch for up to 6-inch main and if main is at least two pipe sizes larger than branch for 8-inch and larger main. Do not project branch pipes inside the main pipe.
7. Cap all openings in pipes during progress of the work.
8. Do not connect bottom of pipe risers until riser is complete. Rod or tap to clear loose material before making bottom connection.
9. Correct leaks in piping immediately using new materials. Leak-sealing compounds or peening is not permitted.
10. Install drains throughout the systems to permit complete drainage.
11. Not acceptable: mitered ells, bullhead tees, notched tees, bushings on threaded piping.
12. Do not allow any other subcontractor (electrical, telephone company, BMS, elevator, etc.) to electrically ground to any plumbing system.
13. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Encase underground piping with polyethylene film according to ASTM A674 or AWWA C105/A21.5.

B. Arrangement:

1. Except for large scale details, piping is diagrammatically indicated. Install generally as shown.
2. Do not scale the Drawings for exact location of piping.
3. Install piping to best suit field conditions and coordinate with other trades.
4. Piping arrangement: Arrange piping along walls in horizontal groups in an organized, orderly, well executed manner. Each group shall be in one plane if possible. Maintain required slope.
5. Do not sleeve structural members without consent of Architect.
6. Maintain 1-inch clearance from adjacent work, including insulation, except as noted or approved.
7. Install piping concealed above as high as possible above ceilings or in walls unless

otherwise indicated. Install all piping parallel to building walls and ceilings and at heights that do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

C. Expansion, Contraction and Bending:

1. Install piping with provisions for expansion and contraction **[and seismic movement]**. Provide expansion loops, swing joints, anchors and/or expansion joints **[and seismic joints]** where indicated or otherwise required so that piping may expand and contract **[and allow seismic movement]** without damage to itself, equipment, or building.
2. Do not spring or force piping during installation.
3. Do not bend piping without use of pipe bending machine.
4. Refer to Section 22 05 16 – Expansion Compensation for Plumbing.

D. Sloping, Air Venting and Draining:

1. Slope piping as indicated, true to line and grade, and free of traps and air pockets.
2. Unless otherwise indicated, slope piping in direction of flow as follows:

Service	**Inclination in Direction of Flow**	**Slope**
Storm Sewer	Down	**[⅛] [¼] [½]** inch per foot
Sanitary Sewer:		
3 inch and smaller	Down	¼ inch per foot
4 to 6 inch	Down	⅛ inch per foot
8 inch and larger	Down	1/16 inch per foot

3. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
4. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
5. Reducers:

    a. Eccentric:
    14) Between water piping and pump suction, top side flat

    b. Concentric:
    15) In vertical piping
    16) May be used as increasers in horizontal piping

6. Provide drain valves and hose adapters at all low points in piping.
7. Provide drain valves for float type controllers.
8. Provide manual air vents at all high points in water piping:

a. ¼-inch copper tube
b. Discharge vented water into nearest janitor's sink or floor drain
c. If no fixture is near provide 180-degree bend to discharge into portable container

E. Strainers:

1. Install at following locations:

a. Ahead of pump suctions
b. Ahead of control and regulating valves
c. Elsewhere as indicated on the Drawings

2. In water service, up to 250 degrees F maximum; and compressed air:

a. Install globe valve for blow-off with full outlet size and same pressure rating as piping system.
b. Hose-end fittings are acceptable for water service only.

F. Piping Specialties:

1. Locate thermometers and gauges to permit observation by personnel standing on floor.
2. Provide instrument cocks at pressure gauges.

G. Copper:

1. Crimping of copper tubing prohibited.
2. Isolate copper pipe and tubing from contact with ferrous materials.
3. For branch drops and rises to plumbing fixtures, anchor branch to wall with drop-ear ell or tee.
4. Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

H. Coatings: Reapply mastic coating on buried piping, after installation, to surfaces from which coating has been removed or scraped.

I. Care of Floors:

1. Do not set pipe vises or threading machines on unprotected concrete floors.
2. Cover floor when making plumbing connections to avoid staining floors with oil, white or red lead or other substances. Bear cost of removing any stains.

J. Heat Trace Cable:

1. Provide heat trace cable for piping systems, where indicated on the Drawings.
2. Install cable and components per manufacturer's instructions.
3. Apply "Electric Traced" labels to heat trace cables covered in insulation.

3.03 SYSTEMS INSTALLATION

A. Underground Pipe Wrap:

1. Provide for all underground metallic piping that is not encased in a non-metallic conduit and for underground metallic gas conduit.
2. Remove all dirt and other foreign material from exterior of pipe. Apply primer as recommended by the manufacturer.
3. Use a spiral wrap process for applying tape to the pipe. Repair any breaks in the tape coating caused by the installation process.

B. Underground Piping:

1. Install piping where indicated and according to manufacturer's instructions.
2. Install closures at points of field joints between straight units or fabricated fittings by welding them centrally over conduit ends between such adjacent units.
3. After welding, conduct a 25 psig air pressure test on the outer casing and examine for leaks with a soap solution.
4. Repair any leaks and re-test until the system is airtight at 25 psig air pressure for a two-hour period.
5. Clean closures of all welding slag, burned coating, mud, etc. by wire brushing.
6. Finish coat in accordance with the system manufacturer's instructions, using materials supplied. Final outside coating to be subjected to a spark test and be capable of maintaining dielectric strength at 5,000 volts.
7. Contractor shall furnish all necessary equipment and labor to perform the spark test and the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc., and complete the tests to the satisfaction of the Architect.

C. Heat Trace Cable:

1. Cable shall be secured to piping with cable ties or fiberglass tape.
2. Install heater cable linearly along the pipe's lower quadrants after pipe has been successfully pressure tested.
3. Wrap extra cable around fittings and valves as required to offset heat loss at these areas.

3.04 PIPE JOINTING

A. Fittings:

1. Provide standard, manufactured fittings in all cases.
2. Prohibited fittings:

    a. Field fabricated
    b. Bushings on pressure piping
    c. Clamp-on branch connections

3. Dielectric separation:

    a. Provide insulating couplings or dielectric fittings at all connections or metal-to-metal contact of ferrous materials to non-ferrous materials.
    b. Locations shall be accessible. Coordinate with General Contractor.

4. Branch connections, steel piping:

    a. Equal to main and to two pipe sizes smaller: weld tees, same weight as piping.
    b. Three or more pipe sizes smaller than main, but 2½ inches and larger: Bonney Weld-o-lets.
    c. To two inches and smaller: Bonney Weld-o-lets, Thread-o-lets, threaded Nip-o-lets, or steel couplings.

B. Unions: Provide unions or flanges to render all items in systems easily removable, including:

1. Valves
2. Piping specialties
3. Both sides of pumps and equipment
4. Where indicated on the Drawings

C. Pipe Ends: Perform pipe cutting and end preparation to result in clean ends with full inside diameter. Grind and ream ends of pipe and tube and remove burrs to restore full inside diameter.

D. Nipples: Provide extra heavy pipe for nipples where unthreaded portion is less than 1½ inches long. Close nipples not permitted.

E. Threaded Joints: Ream threaded pipe ends to remove burrs and restore full inside diameter. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Apply appropriate tape or thread compound to external pipe threads (except where dryseal threading is specified).
3. Align threads at point of assembly.
4. Tighten joint with wrench and back-up wrench as required.
5. Damaged threads: Do not use pipe or pipe fittings having threads that are corroded or damaged.
6. Sealed with sealant compounds or teflon tape. Hard setting pipe thread cement or caulking shall not be allowed.
7. Sealant compounds: John Crane or Rector Seal:

    a. General service: John Crane JC-40
    b. Chemicals and corrosive service piping: John Crane JC-30

F. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. When required, use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.

G. Mechanical Joints: Grooved copper tube and grooved-tube fitting joints shall be assembled with coupling, gasket, lubricant, and bolts per coupling and fitting manufacturer's standard written procedure. Grooved ends on copper and copper alloy tube shall be roll-formed only using the appropriate roll-groove tool to construct a groove meeting the coupling and fitting manufacturer's written specifications. Cut grooving methods shall not be used on copper

and copper alloy tube.

H. Flared tube Joints: Flared copper tube joints shall be made by the appropriate use of cast copper alloy fittings conforming to ASME B16.26. Flared ends of copper tube shall be of the 45-degree flare type and shall only be made with a flaring tool designed specifically for that purpose. Copper alloy tube shall be reamed to remove burrs and restore full inside diameter prior to forming the flared end.

I. Welded Joints:

1. Where required, peen and wheel-grind welds.
2. Ends of pipe may be burned for welding:

    a. Grind, bevel and remove scale between welding joint.
    b. Ragged edges with metal beads, poor alignment or other inferior work shall be rejected.
    c. Preparation of pipe ends: For wall thickness up to $^{3}/_{16}$-inch, ends shall be finished square or with 37½-degree bevel with a $^{1}/_{16}$ inch band; for wall thickness $^{3}/_{16}$-inch to ¾-inch inclusive, ends shall be machined or ground to have a 37½-degree bevel with a $^{1}/_{16}$-inch band per latest edition of ANSI/ASME B31.1.

3. Perform welding with oxyacetylene or electric arc process.
4. Welding shall be from outside only on pipe configurations.
5. Tack welds shall be of same quality as required in the completed weld and shall be visually examined for defects before applying any complete passes. The ends (starts and stops) of the tacks shall blend in smoothly with the base metal so that subsequent passes can be applied without interruption.
6. Inspection: Visual inspection shall be done by the welder after each pass.
7. Inspection Criteria: Cracks, cold laps, open porosity and tungsten inclusions shall not be allowed. If the above occurs, the weldment shall be removed and rewelded per this specification. Weld beads shall be applied in such a manner that they are smooth into adjacent beads and the base metal with no areas, such as crevices, undercuts, or overlaps, that would weaken the structure or prevent adequate penetration of subsequent weld passes. Undercut of the final pass, which reduces the initial material thickness, shall be repaired by additional welding.
8. Repair: All materials welded using this procedure or which fall within the requirements of this procedure may also be repair-welded using this procedure.

J. Grooved End Joints:

1. Pipe Preparation: The pipe ends must be clean from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The dimensions must be according to the standard roll groove specifications as recommended by the manufacturer. Cut grooves are not acceptable.
2. Pipe Preparation Plain End: Black pipe must be thoroughly cleaned down to bare metal for one-inch from the pipe end to receive mechanically coupled fittings; removed pipe coatings, mill scale, rust and raised weld beads.
3. Tighten all nuts to assure firm metal contact of the coupling pads.
4. Groove width depth and outside diameter must conform to the standard groove specifications in the latest “Field Assembly and Installation Instruction Pocket Handbook”.
5. Before assembly of couplings, lightly coat pipe ends and outside of gasket with

cup grease or graphite paste to facilitate installation.
6. Support branch pipes independently to eliminate stress on coupled joint.
7. Determine that gasket material and lubricant are compatible with service of pipe.
8. Hammer welds to remove slag and weld beads.

K. Soldered and Brazed Joints: Construct soldered joints per ASTM B828. Construct brazed joints per AWS C3.4M/C3.4.

1. Install solder-joint to male-thread adapters, or solder-joint to male-thread unions meeting the requirements of ASME B16.18 or ASME B16.22, adjacent to each threaded valve and threaded equipment connection in a copper tube system.
2. Install ASME B16.24 cast copper alloy pipe flanges adjacent to each flanged valve and flanged equipment connection in a copper tube system.
3. Provide brazing for refrigerant piping system using AWS A5.8/A5.8M, BAg-1 with 15 percent silver, 80 percent copper and 5 percent phosphorous.
4. Provide solder joint for building domestic cold water and domestic hot water supply and return systems.
5. Clean surfaces to be jointed of oil, grease, rusts and oxides.

    a. Remove grease from fittings by washing in solution of $^{1}/_{16}$ sodium carbonate and three gallons hot water.
    b. Clean socket of fitting and end of pipe thoroughly with emery cloth to remove rust and oxides. After cleaning and before assembly or heating, apply Handy or Aircosil flux to joint surface and spread evenly.

6. Any joints showing evidence of overheating, cracking, poor penetration, or other defects of fit-up or workmanship shall be replaced as directed by the Architect at the Contractor's expense.

L. Plastic Piping, General:

1. Threaded joints only at terminal connections or when specifically approved.
2. Threaded joints only on Schedule 80 pipe or with socket-threaded adapters.
3. Teflon joint thread tape.
4. Approved adapters for connections to metallic piping.
5. Heat-Fusion Joints: Make polyolefin pressure-piping joints according to ASTM D2657.
6. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F1290.
7. Fiberglass Piping Joints: Make joints with piping manufacturer's bonded adhesive.
8. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.05 CHEMICAL CLEANING

A. General:

1. During construction:

    a. Keep openings in piping closed to prevent entrance of foreign matter.
    b. Clean pipe, fittings and valves internally.
    c. Hammer welds to remove slag and weld beads.

2. After completion of pressure testing, chemically clean internally each domestic water piping system.
3. Proceed with chemical cleanout within four (4) hours of completion of pressure testing.

B. Domestic Water Systems:

1. Upon start-up, flush and then fill with clean water, and vent as required.
2. Install temporary filter bags in domestic system strainers at all pumps during start-up. Replace as often as necessary until they are relatively clean after 48 hours of service from last change.

C. Disinfect water systems. For requirements, refer to Section 22 11 00 – Domestic Water Systems. Protect against damage from freeze-up or discharge of water.

3.06 FIELD QUALITY CONTROL

A. General:

1. Any deviation from the cleaning, installation, testing, and certification requirements herein shall be approved in writing by the Architect.
2. All materials and workmanship shall be subject to inspection and examination by the Architect at any place where fabrication or erection occurs.
3. The Architect reserves the right to reject all or any part of the system that does not conform to the requirements herein. Rejected materials or equipment shall be returned at the Contractor's expense for re-cleaning and certification.
4. The Architect reserves the right to remove random samples of the installed work sufficient to establish the quality of materials and workmanship. If such samples indicate materials and workmanship do not meet the contract specification, the Contractor shall be required to replace or re-clean the installed work at no expense to the Owner. The Owner shall reimburse the Contractor on a time and materials basis for such work if the system proves to be installed to specification.
5. All testing shall be done in the presence of the Owner's Representative.
6. Upon completion of this work, all systems shall be adjusted for use. Should any piece of apparatus or any material or work fail in any of the required pressure tests, it shall be immediately removed any replaced by new materials. The defective portion of the work shall be replaced by new materials. The defective portion of the work shall be replaced by the Contractor in the presence of the Owner at no expense to the Owner.
7. Test gauges shall be installed and test medium source connections shall be made to convenient process connections. After completion of testing, the gauges and source connection shall be removed and the specified process attachments replaced.
8. Any leaks found shall be repaired in the following manner:

    a. Welded joint – Grind out defect and re-weld.
    b. Brazed and/or Soldered joint – Cut out and re-braze/solder.
    c. Plastic joint – Remove/re-weld.
    d. Threaded joint – Taken apart and re-do (do not use compound).

B. Test Preparation:

1. Clean new piping internally by flushing with water before the application of

pressure tests, and before the performance of disinfection procedures as specified in Section 22 11 00.

2. Block off and isolate circulating pumps, plumbing fixtures and heat exchangers during the preliminary flushing and draining process.
3. Thoroughly flush piping with water under pressure, clear of foreign matter, and then drain before proceeding with pressure testing. Blow down accumulations of grit, dirt and sediment at each strainer and each low point in the piping systems.
4. Leaks and Defects:

    a. Repair or replace as directed.
    b. Repair damage caused by test failure without additional cost.
    c. Re-test repaired and/or damaged systems until tests are accomplished successfully.

5. Refer to other sections and divisions for tests to plumbing systems and other special piping systems.
6. Notify Architect in writing one week before test.
7. Maintain a log book of all pressure tests showing dates, personnel performing test, test observer and test results.
8. Furnish written report and certification that tests have been satisfactorily completed.

C. Pressure Tests:

1. Less than 100 pounds per square inch operating pressure: Test hydrostatically to 150 pounds per square inch.
2. Over 100 psi operating pressure:

    a. Test hydrostatically to 1½ times operating pressure.
    b. Never exceed test pressure ASME B16.1 basis.

3. With system valves capped and pressure apparatus disconnected, a 4-hour duration pressure test shall exhibit:

    a. No pressure change (zero).
    b. Compensate for temperature change.

4. For air tests, gradually increase the pressure to not more than one half of the test pressure; then increase the pressure in steps of approximately one-tenth of the test pressure until the required test pressure is reached. Examine all joints and connections with a soap bubble solution or equivalent method. The piping system exclusive of possible localized instances at pump or valve packing shall show no evidence of leaking.
5. Heat Tracing: After initial installation, and before and after installing the thermal insulation, subject heat tracing to testing using a 2500-volt DC megaohm meter (megger). Minimum insulation resistance shall be between 20 to 1000 megaohms regardless of length. Consult manufacturer if conditions test outside this range; if necessary, new heat tracing and insulation shall be installed to meet test criteria, at no cost to Owner.
6. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed

b. Procedures, materials, and gases used
c. Test methods used
d. Results of tests

END OF SECTION 22 11 10