SECTION 40 05 13

PIPELINES, LIQUID PROCESS PIPING
10/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2009) Standard for Gray Iron Pipe Flanges and Flanged Fittings; Classes 25, 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.3	(2006) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2009) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2007) Standard for Factory-Made Wrought Buttwelding Fittings
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B18.2.2	(1987; R 2005) Standard for Square and Hex Nuts
ASME B31.1	(2007) Power Piping
ASME B31.3	(2006) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 48	(2003; R 2008) Gray Iron Castings
ASTM A 105/A 105M	(2009) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 106/A 106M	(2008) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

ASTM A 125	(1996; R 2007) Standard Specification for Steel Springs, Helical, Heat-Treated
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 182/A 182M	(2009) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature
ASTM A 183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 193/A 193M	(2009) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and other Special Purpose ApplicationService
ASTM A 194/A 194M	(2009) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A 197/A 197M	(2000; R 2006) Cupola Malleable Iron
ASTM A 234/A 234M	(2007) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 240/A 240M	(2007e1) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A 269	(2008) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A 276	(2008) Standard Specification for Stainless Steel Bars and Shapes
ASTM A 307	(2007) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2009) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A 320/A 320M	(2008) Alloy/Steel and Stainless Steel Bolting Materials for Low-Temperature Service
ASTM A 351/A 351M	(2006) Standard Specification for Castings, Austenitic, Austenitic-Ferritic

	(Duplex), for Pressure-Containing Parts
ASTM A 380	(2006) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A 403/A 403M	(2007) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A 47/A 47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A 479/A 479M	(2008) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 525	(2005) Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A 536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 564/A 564M	(2004) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A 743/A 743M	(2006) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM A 744	(2006) Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
ASTM A 780	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 790	(2009) Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe
ASTM A 923	(2008) Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic/Ferritic Stainless Steels.
ASTM B 462	(2006) Specification for Forged or Rolled UNS N06030, N06022, N06035, N06200, N06059, N06686, N08020, N08024, N08026, N08367, N10276, N10665, N10675, N10629,

	N08031, N06045, N06025, & R20033 Alloy Pipe Flanges, Forged Fitting, & Valves & Parts for Corrosive High Temperature Service
ASTM B 464	(2005) Standard Specification for Welded UNS N08020, N08024, and N08026 Alloy Pipe
ASTM B 474	(2003) Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe
ASTM B 61	(2008) Standard Specification for Steam or Valve Bronze Castings
ASTM B 62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM D 1330	(2004) Rubber Sheet Gaskets
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2004; E 2006) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(2007) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(2008) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996; R 2002) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3139	(1998; R 2005) Joints for Plastic Pressure

	Pipes Using Flexible Elastomeric Seals
ASTM D 3222	(2005) Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
ASTM D 3308	(2006) PTFE Resin Skived Tape
ASTM D 3350	(2008) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3839	(2008) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3892	(1993; R 2009) Packaging/Packing of Plastics
ASTM D 429	(2008) Rubber Property-Adhesion to Rigid Substrates
ASTM F 402	(2005) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 437	(2009) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 439	(2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F 441/F 441M	(2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F 493	(2004) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F 656	(2008) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 2620	(2009) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F 1290	(1998a; R 2004) Electrofusion Joining Polyolefin Pipe and Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2008) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C512	(2007) Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
AWWA C104/A21.4	(2008) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2005) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2007) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2009) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C207	(2007) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C213	(2007) Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C219	(2006) Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2006) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2001) Resilient-Seated Gate Valves for Water Supply Service
AWWA C510	(2007) Standard for Double Check Valve Backflow Prevention Assembly
AWWA C511	(2007) Standard for Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C540	(2002) Power-Actuating Devices for Valves and Slide Gates
AWWA C550	(2005; Errata 2005) Protective Interior Coatings for Valves and Hydrants

AWWA C606	(2006) Grooved and Shouldered Joints
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C800	(2005) Underground Service Line Valves and Fittings
AWWA C900	(2007) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C905	(1997) Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14 In. Through 48 In. (350 mm through 1,200 mm)
AWWA C906	(2007) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In., (1,600 mm) for Water Distribution and Transmission
AWWA M11	(2004) Manual: Steel Pipe: A Guide for Design and Installation; Fourth Edition
AWWA M55	(2006) PE Pipe - Design and Installation

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2008) Structural Welding Code - Steel

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2006) Thrust Restraint Design for Ductile Iron Pipe

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-43	(2008) Standard for Wrought and Fabricated Butt-Welding Fittings for Low Pressure Corrosion Resistant Applications
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-89	(2003) Pipe Hangers and Supports - Fabrication and Installation Practices
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves

MSS SP-110	(1996) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 704	(2007) Identification of the Hazards of Materials for Emergency Response

NSF INTERNATIONAL (NSF)

NSF 61	(2008) Drinking Water System Components - Health Effects

PLASTICS PIPE INSTITUTE (PPI)

PPI TR-21	(2001) Thermal Expansion and Contraction in Plastic Piping Systems
PPI TR-33	(2006) Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	(2008) Occupational Safety and Health Standards

1.2 UNIT PRICES

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications and the contract payment schedules. No payment will be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 31 00 00 EARTHWORK.

1.2.1 Measurement

The length of pipelines, for which payment will be made, shall be determined by measuring along the centerlines of the various piping systems and sizes as furnished and installed. Pipe shall be measured from the center of fitting to center of fitting and from center of main header to end of pipe. No deduction shall be made for the space occupied by valves or fittings.

1.2.2 Payment

Payment will be made at the price per linear foot listed in the bid form for the various types and sizes of piping, and will be full compensation for all pipes, joints, fittings and specialties, complete in place. Payment for valves and other appurtenances will be made at the respective contract unit price for each item complete in place. Payment will include the furnishing of all testing, plant, labor, and material and incidentals

necessary to complete the work, as specified and as shown in contract documents.

1.2.2.1 Connections to Existing Piping

Connections to existing piping systems where new fittings in the existing line are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the removal and replacement of the existing pipe as necessary.

1.2.2.2 Connections to Existing Equipment

Connections to existing equipment where new fittings for the existing equipment are required will be paid for according to the contract prices for such connection. The price will be considered as full compensation for material and labor required for the installation of new fittings or the removal and replacement of existing fittings, as necessary.

1.3 SYSTEM DESCRIPTION

This specification covers the requirements for above and below grade liquid process pipe, pipe supports, fittings, equipment and accessories located both inside and outside of treatment plants.

1.3.1 Design Requirements

Support systems shall be selected and designed in accordance with MSS SP-58, MSS SP-69, and MSS SP-89 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility. The structural design, selection, fabrication and erection of piping support system components shall satisfy the seismic requirements in accordance with UFC 3-310-04 SEISMIC DESIGN FOR BUILDINGS and Section 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, accounting for a maximum ambient air temperature of 105 degrees F and a minimum ambient air temperature of 22 degrees F. Use the seismic design criteria as noted in Structural Construction Notes on Drawings.

1.3.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.3.2.1 Buried Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.3.2.2 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors

such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Coordinate submittals with Section 40 17 26.00, Welding Pressure Piping. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pipe and Equipment; G

Equipment shop drawings and support system detail drawings and the associated pipe support structural calculations showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system, as directed by the Contracting Officer.

Cable System; G

An as-built location map for the cable leak detection system in double containment piping systems indicating the as installed system configuration and sensing string layout. Marks in feet along the length of the cable shall be provided as references to locate leaks.

SD-03 Product Data

Qualifications; G

A statement certifying that the Contractor has the specified experience.

Welders; G

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc.

Certificate of qualification for persons to be fusing HDPE pipe.

Waste Water Disposal; G

The method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests.

Assistance and Training; G

A signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

Delivery, Storage and Handling; G

Material safety data sheets.

Materials (General); G

Manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream.

Installation; G

The manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation.

Pipe Schedule; G

A list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system.

Valve Schedule; G

Operator Schedule; G

A list of valve materials, pressure ratings, valve operator's materials, air supply pressure, electrical service, location, source of supply, and reference identification as indicated in the contract drawings. A list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly.

SD-06 Test Reports

Double Containment Piping System; G

Manufacturer's engineering end load calculations for anchors in double containment piping systems.

Pipe Leakage Tests; G

Hydrostatic Tests; G

Pneumatic Tests; G

Double Containment Piping Leak Detection System; G

Valve Testing; G

Disinfection; G

Copies of all field test reports within 24 hours of the completion of the test.

SD-07 Certificates

PLASTIC PIPING SYSTEM

Documentation certifying that the manufacturer of each thermoplastic piping system is listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

Plastic Pipe Installation

A statement signed by the plastic pipe manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project.

SD-10 Operation and Maintenance Data

Piping and Appurtenances; G

Six copies each of operation and maintenance manuals in indexed booklet form. Operation manuals shall detail the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and shall include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. Maintenance manuals shall list routine maintenance procedures and troubleshooting guides for the equipment, and shall include piping layout and valve locations.

1.5 QUALIFICATIONS

1.5.1 Contractor

Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.5.2 Double Containment Piping System Manufacturer

The Double Containment Piping System manufacturer shall have at least 10 years of installation experience with leak detection/location sensor cable technology.

1.5.3 High-Density Polyethylene (HDPE) Pipe and Fittings

1. Pipe Manufacturer: Listed with Plastic Pipe Institute.

2. Persons fusing HDPE pipe shall be certified under 49 CFR § 192.285 have minimum of 2 year(s) of experience with fusing HDPE pipe and shall have received a minimum of 20 hours of training for fusing HDPE pipe from pipe supplier or fusing equipment supplier.

1.5.4 Welders

The welding of pressure piping systems shall be in accordance with qualifying procedures using performance qualified welders and operators. Procedures and welders shall be qualified in accordance with Section 40 17 26.00 20 WELDING PRESSURE PIPING. Structural members shall be welded in accordance with Section 05 05 23 WELDING, STRUCTURAL.

1.6 GENERAL JOB REQUIREMENTS

Piping materials and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Piping materials, appurtenances and equipment supplied as part of this contract shall be new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems are indicated by service in the contract drawings.

1.6.1 Components

Piping equipment and appurtenances shall be new products of equal material and ratings as the connecting pipe.

1.6.2 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacturing of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Nominal sizes for standardized products shall be used. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.6.3 Identification and Tagging

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall be marked in accordance with MSS SP-25 and shall bear an identification tag securely attached using stainless steel wire. Identification tags shall be 1.375 inch minimum diameter, made of stamped stainless steel. Indentations shall be black for reading clarity. The service, valve identification number shown on the contract drawings, the manufacturer's name, and the valve model number shall be displayed.

1.7 DELIVERY, STORAGE AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in

conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D 3892.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Existing Conditions

The Contractor shall be responsible for the verification of existing piping and penetrations. Prior to ordering materials, the Contractor shall expose all existing pipes which are to be connected to new pipelines. The Contractor shall verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

1.8.2 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.9 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, the Contractor shall have on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. The Contractor shall verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

1.10 MAINTENANCE

1.10.1 Service

Services for automatic valve and double containment leak sensor cable systems shall be provided by a manufacturer's representative who is experienced in the installation, adjustment and operation of the equipment specified. The representative shall inspect the installation, and supervise the adjustment and testing of the equipment.

PART 2 PRODUCTS

2.1 MATERIALS (GENERAL)

Materials for various services shall be in accordance with Piping Schedule on Drawings. Pipe fittings shall be compatible with the applicable pipe materials.

2.2 DUCTILE IRON PIPING SYSTEM

2.2.1 Ductile Iron Pipe

Ductile iron pipe for pressure service shall have a design and wall thickness conforming to AWWA C151/A21.51 for buried pipe and AWWA C115/A21.15 for exposed pipe using grooved end and flanged joints. Ductile iron pipe shall have a double thickness-Type V cement lining with seal coat conforming to AWWA C104/A21.4.

2.2.2 Ductile Iron Joints

Joints shall have a working pressure rating for liquids equal to the pressure rating of the connected pipe. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.2.2.1 Mechanical Joints

Mechanical joints shall conform to AWWA C110/A21.10 and AWWA C111/A21.11. Gaskets, glands, bolts and nuts shall be furnished in sufficient quantity for the complete assembly of each mechanical joint. Glands shall be ductile iron with an asphaltic coating, anchor type, wedge action, with breakoff tightening bolts. Thrust rated to 250 psi minimum. Rated operating deflection not less than 2-1/2 degrees. UL and FMG approved. Gaskets shall be EPDM. For grooved shoulder piping, self-centering gasketed couplings designed to mechanically engage piping and lock in a positive watertight couple shall be used. Housings shall be composed of malleable iron, ASTM A 47/A 47M or ductile iron, ASTM A 536 and gaskets of molded synthetic rubber, halogenated isobutylene isoprene conforming to ASTM D 2000 and AWWA C606. Bolts and nuts shall be per the manufacturer's standard.

2.2.2.2 Push-on Joints

Push-on type joints shall conform to AWWA C111/A21.11. Each push-on joint shall be supplied complete with gasket and lubricant. Gaskets shall be compatible with joint design and comprised of EPDM. Lubricant shall be specifically formulated for use with push-on joints and shall be non-toxic, odorless, tasteless and shall not support bacteria growth.

2.2.2.3 Restrained Joints

Restrained joints shall conform to AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall not be not less than 1/2 degree for 42-inch and larger pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted.

2.2.2.4 Flanged Joints

Flanged joints shall conform to AWWA C110/A21.10 and shall be flat face. Gaskets, bolts, washers and nuts shall be provided with flanged joints in sufficient quantity for the complete assembly of each joint. Bolts and nuts shall be ASTM A 307 Grade A carbon steel hex head bolts and ASTM A 563, Grade A carbon steel hex head nuts. Bolts shall be provided with washers

of the same material as the bolts. Gaskets shall be 1/8 inch-thick, red rubber (SBR) hardness 80 (Shore A), rated to 180 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D 1330, Grades 1 and 2. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.

2.2.3 Ductile Iron Fittings

Fittings shall be gray iron or ductile iron and shall be rated for 250 psig service. Fittings shall be lined and coated the same as the pipe.

2.2.4 Corrosion Control

Exposed Ductile Iron pipe shall be coated in accordance with Specification Section 09 90 00.00 40, PAINTING AND COATING. Buried ductile iron piping shall be coated with the manufacturer's standard asphaltic coating, approximately 1 mil thick, applied to the outside of pipe and fittings. Buried pipe shall be provided with polyethylene encasement in accordance with AWWA C105/A21.5.

2.3 CARBON STEEL PIPING SYSTEM

2.3.1 Carbon Steel Pipe

2.3.1.1 General Service

Carbon steel pipe shall meet the requirements of ASTM A 106/A 106M, Grade B seamless or ASTM A 53/A 53M, Grade B Type E or S; Type F not permitted, Schedule 40 for sizes 10 and smaller, Schedule 30 for sizes 12 inches through 16 inches, Schedule 20 for sizes 18 inches through 24 inches unless noted otherwise in the Pipe Schedule or the Drawings.

2.3.2 Carbon Steel Joints

Carbon steel piping shall be joined by threaded or flanged joints at valves and equipment for pipe sizes 2 inches and smaller and butt-welded or flanged at valves and equipment, or grooved ends as indicated on the Drawings meeting the requirements of AWWA C606 for pipe sizes 2-1/2 inches and larger. Where mechanical type couplings are indicated on the Drawings, the ends of pipe shall be shoulder banded with Type D collared ends of the identical materials of construction as that of the pipe using double fillet welds per AWWA C606. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.3.3 Carbon Steel Fittings

Fittings shall be cast malleable iron, carbon steel, or heat-treated low-carbon steel. Where cast fittings are not available, segmental welded steel fittings, ASTM A 53/A 53M, Grade B, meeting the requirements shall be fabricated. Unless otherwise indicated, wall thickness schedule shall be standard weight, or shall match the wall thickness of the pipe, whichever is greater. Fittings 2 inches and smaller shall be threaded. Fittings 2-1/2 inches and larger shall be welded, unless otherwise indicated on the Drawings.

2.3.3.1 Threaded Fittings

Threaded fittings shall be 150 or 300 pound malleable iron, ASTM A 197/A 197M or ASTM A 47/A 47M, dimensions in accordance with ASME B16.3. Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308 shall be used for lubricant /sealant, unless otherwise indicated.

2.3.3.2 Welding Fittings

Wrought carbon steel butt-welding, ASTM A 234/A 234M, Grade WPB meeting the requirements of ASME B16.9. Minimum fitting wall thickness to match adjoining pipe; long radius elbows required, unless shown otherwise.

2.3.3.3 Grooved End Fittings

Grooved end fittings 2 inches and smaller shall be malleable iron, ASTM A 47/A 47M or ductile iron ASTM A 536. Grooved end fittings 2-1/2 inches and larger shall be malleable iron, ASTM A 47/A 47M, ductile iron ASTM A 536, forged steel ASTM A 234/A 234M, or factory fabricated from ASTM A 53/A 53M pipe. Grooved ends to accept couplings without field preparation.

2.3.3.4 Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. Flanges 2 inches and smaller shall be forged carbon steel, ASTM A 105/A 105M, Grade II, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, flat face. Flanges 2-1/2 inches and larger shall be flat face, forged carbon steel, ASTM A 105/A 105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, flat face. Use weld neck flanges when abutting butt-weld fittings. Bolting shall be ASTM A 307, Grade A hex head bolts and ASTM A 563, Grade A hex head nuts. Flanged joints in sumps, wet wells, and submerged and wetted installations shall be Type 316 stainless steel ASTM A 320/A 320M, Grade B8M hex head bolts and ASTM A 194/A 194M, Grade 8M hex nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets for water, steam and air services shall be 1/16-inch thick, compressed inorganic fiber with nitrile binder, rated to 700 degrees F and 1,000 psi and shall be NSF 61 approved. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.

2.3.3.5 Unions

Unions 2 inches and smaller shall be threaded malleable iron, ASTM A 197/A 197M or ASTM A 47/A 47M, 150 or 300-pound WOG, meeting the requirements of ASME B16.3.

2.3.3.6 Couplings

Couplings 2-1/2 inches and larger shall be grooved end, rigid joint malleable iron, ASTM A 47/A 47M or ductile iron, ASTM A 536. Gaskets shall be EPDM per ASTM D 2000 for water and oil-free air to 230 degree F, nitrile for oil vapor in air and oil services to 180 degrees F and NSF 61 approved for potable water service. Bolting shall be carbon steel, ASTM A 183 bolts and nuts, 110,000 psi minimum tensile strength.

2.3.4 Carbon Steel Coatings

Carbon steel piping components shall be lined and coated in accordance with Section 09 90 00.00 40, PAINTING AND COATING, and the Piping Schedule. Coatings and finishes shall be 100 percent holiday free.

2.4 STAINLESS STEEL PIPING SYSTEM

2.4.1 General

The surface of all stainless steel products shall be free of tool marks, arc strikes, gouges, scratches and foreign material contamination. The surface finish of all stainless steel surfaces shall be of a high quality and as a minimum, equal to the hot rolled condition specified by the material specification. All stainless steel welds, heated areas of stainless steel plates or shapes, and heat affected zones of stainless steel welds shall be cleaned, descaled and passivated per ASTM A 380 Standard Practice for Cleaing Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems after welding to prevent corrosion rates in excess of unwelded and unheated stainless steel base material.

Passivation is the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of stainless steel by means of a chemical dissolution, by a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself.

2.4.2 Austenitic Stainless Steel

2.4.2.1 Austenitic Stainless Steel Pipe

Stainless steel pipe shall meet the requirements of ASTM A 312/A 312M, Type 316L seamless annealed, pickled and passivated, Schedule 40S for sizes 12 inches and smaller. For sizes larger than 12 inches minimum pipe wall thickness shall be 0.375 inches, unless noted otherwise in the Pipe Schedule or the Drawings.

2.4.2.2 Austenitic Stainless Steel Tubing

Stainless steel tubing shall meet the requirements of ASTM A 269 Type 316L seamless, soft annealed, with 0.083-inch wall thickness minimum.

2.4.2.3 Austenitic Stainless Steel Joints

Stainless steel piping shall be joined by threaded or flanged joints at valves and equipment for pipe sizes 3/4 inches and smaller and socket weld or flanged at valves and equipment, or as shown for pipe sizes 1 inch and 1-1/2 inches and butt-welded or flanged at valves and equipment, or grooved ends as indicated on the Drawings meeting the requirements of AWWA C606 for pipe sizes 2 inches and larger. Where mechanical type couplings are indicated on the Drawings, the ends of pipe shall be shoulder banded with Type D collared ends of the identical materials of construction as that of the pipe using double fillet welds per AWWA C606. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.4.2.4 Austenitic Stainless Steel Threaded Fittings

Threaded fittings shall be forged austenitic stainless steel, ASTM A 182/A 182M, Grade 316L, 3,000-pound WOG. 100 percent virgin Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308, designed for stainless steel pipe shall be used for lubricant /sealant, unless otherwise indicated.

2.4.2.5 Austenitic Stainless Steel Socket Weld Fittings

Socket welded fittings shall be forged austenitic stainless steel, ASTM A 182/A 182M, Grade 316L, 2,000-pound WOG.

2.4.2.6 Austenitic Stainless Steel Welding Fittings

Welding fittings shall be butt-welded austenitic stainless steel, ASTM A 403/A 403M, Grade WP316L conforming to ASME B16.9 and MSS SP-43, annealed, pickled and passivated. Fitting wall thickness to match adjoining pipe; long radius elbows required, unless shown otherwise.

2.4.2.7 Austenitic Stainless Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. Flanges shall be forged austenitic stainless steel, ASTM A 182/A 182M Rev C Grade F316L, Class 150 or Class 300, slip-on welding neck, flat face, ASME B16.5. Bolting shall be Type 316 stainless steel, ASTM A 193/A 193M, Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be 1/16-inch thick virgin Teflon or inorganic filled Teflon full face type for flat face flanges and shall be NSF 61 approved for potable water applications. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.

2.4.2.8 Austenitic Compression Fittings for Tubing

Compression fittings shall be of ASTM A 479/A 479M 316L stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum 250 psig. Threads shall be straight conforming to ASME B1.1.

2.4.2.9 Couplings

Couplings 2 inches and larger shall be grooved end, rigid joint, Type 316 stainless steel, ASTM A 351/A 351M, ASTM A 743/A 743M, and ASTM A 744. Gaskets shall be EDPM per ASTM D 2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 108 degrees F and SNF 61 approved for potable water service. Bolting shall be stainless steel, ASTM A 193/A 193M, Grade B8M Type 316. Nuts shall be stainless steel, ASTM A 194/A 194M, Grade B8M, Type 316, Class 2, special anti-galling coating. Couplings shall be pressure rated for the maximum pressure indicated in the Piping Schedule.

2.4.3 Superaustenitic Stainless Steel

2.4.3.1 Superaustenitic Stainless Steel Pipe

Piping 3 inches and smaller, Schedule 40S, ASTM B 464 seamless or automatically welded, or ASTM B 474 (Alloy 20), electric fusion welded.

2.4.3.2 Alloy 20 Joints

Socket welded or flanged at equipment as required or shown.

2.4.3.3 Alloy 20 Fittings

Fittings 3 inches and smaller socket-weld, forged Alloy 20, 3,000-pound WOG, same schedule as pipe, conforming to ASTM B 462.

2.4.3.4 Alloy 20 Flanged Fittings

Flanges shall be forged Alloy 20, ASTM B 462, flat face, Class 150, ASME B16.5, socket-weld type. Bolting shall be Type 316 stainless steel, ASTM A 193/A 193M Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be 1/16-inch thick virgin Teflon or inorganic-filled Teflon. Thread lubricant shall be Teflon tape.

2.4.4 Duplex Stainless Steel

2.4.4.1 Duplex Stainless Steel Pipe

Duplex stainless steel pipe shall meet the requirements of ASTM A 790, Grade S31803 (Alloy 2205) seamless, pickled and passivated, Schedule 10S for sizes 2-1/2 inches, and larger, unless noted otherwise in the Pipe Schedule or the Drawings.

2.4.4.2 Duplex Stainless Steel Joints

Duplex stainless piping shall be joined by threaded or flanged joints at valves and equipment for pipe sizes 3/4 inches and smaller and socket weld or flanged at valves and equipment, or as shown for pipe sizes 1 inch and 1-1/2 inches and butt-welded or flanged at valves and equipment, or grooved ends as indicated on the Drawings meeting the requirements of AWWA C606 for sizes 2 inches and larger. Where mechanical type couplings are indicated on the Drawings, the ends of pipe shall be shoulder banded with Type D collared ends of the identical materials of construction as that of the pipe using double fillet welds per AWWA C606. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.4.4.3 Duplex Stainless Steel Socket Weld Fittings

Socket welded fittings shall be forged duplex stainless steel, ASTM A 182/A 182M, Grade F51 (S31803), 2,000 - pound WOG.

2.4.4.4 Duplex Stainless Steel Welding Fittings

Welding fittings shall be butt-welded duplex stainless steel, ASTM A 182/A 182M, Grade F51 (S31803) conforming to ASME B16.9, annealed, pickled and passivated. Fitting wall thickness to match adjoining pipe; long radius elbows required, unless shown otherwise.

2.4.4.5 Duplex Stainless Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. Flanges shall be forged duplex

stainless steel, ASTM A 182/A 182M, Grade (S31803), Class 150 or Class 300, slip-on welding neck, flat face, ASME B16.5. Bolting shall be Type 316 stainless steel, ASTM A 193/A 193M, Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same materials as the bolts. Gaskets shall be 1/16-inch thick virgin Teflon or inorganic filled Teflon full face type for flat face flanges and shall be NSF 61 approved for potable water applications. Blind flanges shall be gasketed coveing the entire inside face with the gasket cemented to the blind flange.

2.4.4.6 Metallurgical Quality Assurance

Fabrication practices involving heating and welding of duplex stainless steel shall be carefully controlled to avoid adverse effects on mechanical properties or corrosion resistance. Heat treatment will generally be required after fabrication to ensure proper metallurgical conditions are maintained. Conduct testing to verify the absence of unfavorable intermetallic phases as required and in accordance with ASTM A 923.

2.4.4.7 Couplings

Couplings 2 inches and larger shall be grooved end, rigid joint, Type 316 stainless steel, ASTM A 351/A 351M, ASTM A 743/A 743M, and ASTM A 744. Gaskets shall be EDPM per ASTM D 2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 108 degrees F and SNF 61 approved for potable water service. Bolting shall be stainless steel, ASTM A 193/A 193M, Grade B8M Type 316. Nuts shall be stainless steel, ASTM A 194/A 194M, Grade B8M, Type 316, Class 2, special anti-galling coating. Couplings shall be pressure rated for the maximum pressure indicated in the Piping Schedule.

2.4.5 Super Duplex Stainless Steel

2.4.5.1 Super Duplex Stainless Steel Pipe

Super duplex stainless steel pipe shall meet the requirements of ASTM A 790, Grade S32750 (Alloy 2507) seamless, pickled and passivated, Schedule 10S for sizes 2-1/2 inches, and larger, unless noted otherwise in the Pipe Schedule or the Drawings.

2.4.5.2 Super Duplex Stainless Steel Joints

Super duplex stainless piping shall be joined by threaded or flanged joints at valves and equipment for pipe sizes 3/4 inches and smaller and socket weld or flanged at valves and equipment, or as shown for pipe sizes 1 inch and 1-1/2 inches and butt-welded or flanged at valves and equipment, or grooved ends as indicated on the Drawings meeting the requirements of AWWA C606 for sizes 2 inches and larger. Where mechanical type couplings are indicated on the Drawings, the ends of pipe shall be shoulder banded with Type D collared ends of the identical materials of construction as that of the pipe using double fillet welds per AWWA C606. Where pipe 12-inch and smaller is furnished in standard schedule thicknesses, and where the wall thickness equals or exceeds the coupling manufacturer's minimum wall thickness, the pipe ends may be grooved. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.4.5.3 Super Duplex Stainless Steel Socket Weld Fittings

Socket welded fittings shall be forged super duplex stainless steel,

ASTM A 182/A 182M, Grade F33 (S32750), 2,000 - pound WOG.

2.4.5.4 Super Duplex Stainless Steel Welding Fittings

Welding fittings shall be butt-welded super duplex stainless steel, ASTM A 182/A 182M, Grade F53 (S32750) conforming to ASME B16.9 and MSS SP-43, annealed, pickled and passivated. Fitting wall thickness to match adjoining pipe; long radius elbows required, unless shown otherwise.

2.4.5.5 Super Duplex Stainless Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. Flanges shall be forged super duplex stainless steel, ASTM A 182/A 182M, Grade F53 (S32750), Class 150 or Class 300, slip-on welding neck, flat face, ASME B16.5. Bolting shall be Type 316 stainless steel, ASTM A 193/A 193M, Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same materials as the bolts. Gaskets shall be 1/16-inch thick virgin Teflon or inorganic filled Teflon full face type for flat face flanges and shall be NSF 61 approved for potable water applications. Blind flanges shall be gasketed coveing the entire inside face with the gasket cemented to the blind flange.

2.4.5.6 Couplings

Couplings 2 inches and larger shall be grooved end, rigid joint, Type 316 stainless steel, ASTM A 351/A 351M, ASTM A 743/A 743M, and ASTM A 744. Gaskets shall be EDPM per ASTM D 2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 108 degrees F and SNF 61 approved for potable water service. Bolting shall be stainless steel, ASTM A 193/A 193M, Grade B8M Type 316. Nuts shall be stainless steel, ASTM A 194/A 194M, Grade B8M, Type 316, Class 2, special anti-galling coating. Couplings shall be pressure rated for the maximum pressure indicated in the Piping Schedule.

2.4.5.7 Metallurgical Quality Assurance

Fabrication practices involving heating and welding of super duplex stainless steel shall be carefully controlled to avoid adverse effects on mechanical properties or corrosion resistance. Heat treatment will generally be required after fabrication to ensure proper metallurgical conditions are maintained. Conduct testing to verify the absence of unfavorable intermetallic phases as required and in accordance with ASTM A 923.

2.5 PLASTIC PIPING SYSTEM

2.5.1 PVC Pipe

PVC pipe 1/2 inch through 18 inches above grade, Type I, Grade I or Class 1254-B conforming to ASTM D 1784 and ASTM D 1785, pipe shall be Schedule 80. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. PVC pipe 4 inches through 12 inches buried, AWWA C900 DR-14. PVC pipe 14 inches through 36 inches buried, AWWA C905 DR-18.

2.5.2 PVC Joints

Solvent socket-weld, flanged, or integral-bell gasketed joints except where connection to unions, valves and equipment with threaded connections that

may require future disassembly. Connections at those points shall be threaded and back-welded. Integral-bell gasketed joints shall meet the same pressure capacity as the pipe and conform to the requirements of ASTM D 3139.

2.5.3 PVC Fittings

Schedule 80 PVC as specified for the pipe, ASTM D 2466 and ASTM D 2467 for socket welded type and Schedule 80 ASTM D 2464 for threaded type. Fittings shall be manufactured with titanium oxide for ultraviolet protection. All C900 and C905

2.5.3.1 PVC Joints

Integral-bell gasketed joints shall meet the same pressure capacity as the pipe and conform to the requirements of ASTM D 3139.

2.5.3.2 Flanged Fittings

Flanges and flanged fittings shall be Class 125, one piece, molded hub type PVC flat face flange conforming to ASME B16.1. Bolting shall be Type 316 stainless steel Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full faced 1/8-inch thick ethylene propylene (EPR) rubber in accordance with ASME B16.21.

2.5.4 PVC Solvent

Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D 2564 and primer that meets or exceeds requirements of ASTM F 656 and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF for use with potable water.

2.5.5 Plastic Pipe Coatings

Coat plastic pipe in accordance with Specification Section 09 90 00.00 40, PAINTING AND COATING.

2.6 CHLORINATED POLYVINYL CHLORIDE (CPVC)

2.6.1 CPVC Pipe

Schedule 80 CPVC, Type IV, Grade I or Class 23447-B conforming to ASTM D 1784 and ASTM F 441/F 441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection.

2.6.2 CPVC Joints

Solvent socket-weld, or flanged except where connection to unions, valves, and equipment may require future disassembly. Connections to these points shall be threaded and back-welded.

2.6.3 CPVC Fittings

Schedule 80 CPVC conforming to the requirements of ASTM F 439 for socket

welded type and Schedule 80 ASTM F 437 for threaded type. Fittings shall be manufactured with titanium oxide for ultraviolet protection.

2.6.3.1 Push-on Joints

Integral-bell gasketed joints shall meet the same pressure capacity as the pipe and conform to the requirements of ASTM D 3139.

2.6.3.2 Flanged Fittings

Flanges and flanged fittings shall be Class 125, one piece, molded hub type CPVC flat face flange conforming to ASME B16.1. Bolting shall be Type 316 stainless steel Grade B8M hex head bolts and ASTM A 194/A 194M Grade 8M hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full faced 1/8-inch thick ethylene propylene (EPR) rubber in accordance with ASME B16.21.

2.6.4 Solvent Cement

Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM F 493 and primer that meets or exceeds requirements of ASTM F 656 and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted. Solvent cement and primer shall be listed by NSF for use with potable water.

2.6.5 CPVC Pipe Coatings

Coat plastic pipe in accordance with Specification Section 09 90 00.00 40, PAINTING AND COATING.

2.7 HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

a. Pipe and Fittings:

1. Conform to requirements of AWWA C906.

2. In compliance with NSF 61.

3. Resin:

a) Polyethylene resin shall meet or exceed requirements of ASTM D 3350 for PE 3408 material. Pressure rating shall be based on hydrostatic design stress of 800 psi at 73.4 degrees F.

b) Polyethylene resin shall meet or exceed requirements of ASTM D 3350 for PE 4710 material with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.

4. Pressure Rating: 160 psi and nominal SDR of 11.

5. Outside Diameter Basis: DIOD in accordance with ASTM F 714 and AWWA C906.

6. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the

fusion process.

7. Fittings:

a) Sizes 6 Inches and Smaller: Molded and fabricated from polyethylene pipe.

b) Sizes 8 Inches and Larger: Use thermal butt-fusion.

c) Polyethylene fittings shall have same or higher pressure rating as pipe.

b. Backup Rings:

1. Convoluted for Flanged Connections:

a) ASTM A 240/A 240M, Type 316 stainless steel.

b) Complete with one-piece, molded polyethylene flange adapters.

c) Flanged Connections: Same or greater pressure rating as pipe.

2. Ductile Iron: shop coated in accordance with requirements in Section 09 90 00.00 40, Painting and Coating.

c. Gaskets: Material, size, and thickness shall be as recommended by pipe or flange manufacturer, and in accordance with PPI Technical Note 38.

d. Joints: Thermal butt-fusion or electrofusion, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly.

e. Bolts, Nuts, Washers:

1. Type 316 stainless steel, ASTM A193/A193M, Grade B8 hex head bolts; and ASTM A 194/A 194M, Grade 8 hex head nuts.

2. Bolts: Fabricated in accordance with ASME B18.2.2 and provided with washers of same material as bolts.

f. Wall Anchor:

1. Material: Same as HDPE pipe.

2. Internal Diameter: Equal to adjacent pipe.

3. Shear Strength: Equal to or greater than tensile strength of adjacent
pipe.

4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.

g. Electrofusion Flex Restraint:

1. Material: HDPE.

2. Method of Attachment: Electrofusion.

3. Designed for restraining movement of HDPE pipe.

4. Manufacturers:

a) Central Plastics Company.

b) ISCO Industries.

h. Products that restrain HDPE pipe with wedges, machined serrations, or clamps are not acceptable.

2.8 DOUBLE CONTAINMENT PIPING SYSTEM

Double containment piping systems shall conform to the requirements of ASME B31.3.

2.8.1 Primary (Carrier) Pipe

PVC primary, or carrier, pipe of the double containment piping system shall be Schedule 80 and manufactured from a Class 12454-B PVC resin, according to ASTM D 1784. Joints shall be solvent-welded socket type.

Stainless steel primary, or carrier, pipe of the double containment piping system shall be ASTM A 312/A 312M, Schedule 40S, Type 316L. Joints shall be socket or butt welded.

Alloy 20 primary, or carrier, pipe of the double containment piping system shall be Schedule 40S, ASTM B 464 seamless, or automatically welded, or ASTM B 474, electric fusion welded.

The piping shall be free of flanges and other joints that are not compatible with the secondary piping installation. The piping shall be equipped with expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction, which shall be coordinated with the secondary piping.

2.8.2 Secondary (Containment) Pipe

The secondary, or containment, pipe of the double containment piping system shall be ASTM D 1784 clear PVC, Schedule 40. The secondary piping shall be resistant to weathering, impacts, and ambient temperature variations. The piping shall be equipped with expansion joints, expansion loops, offsets, or direction changes as necessary to counter thermal expansion and contraction. Equipment for addressing thermal movement shall be coordinated with the primary piping. The secondary piping shall be drainable and dryable, and capable of being tested using air pressure. The secondary piping system shall be continuous and equipped with drains at all low points and vents at all high points. Pressurized secondary piping systems shall be equipped with pressure relief devices. Drains, vents and pressure relief devices shall be provided as specified elsewhere in this Section. The piping shall be designed to allow pulling of the leak detection cable into the containment pipe both during and after piping installation. Minimum annular clearance shall be 0.75 inch. Containment pull ports shall be located a maximum of 492 feet apart for straight runs and reduced by 148 feet for every 90 degree change in direction. Containment pipe joints shall be Flo Safe-G fittings or approved equal.

2.8.3 Connections and Fittings For Double Containment System

All fittings shall be factory manufactured of material compatible with the process fluids and associated piping. All secondary contained fittings shall be of unitized construction with the carrier and containment integrally anchored together to prevent the movement of the carrier relative to the containment within the fitting. Anchors shall be of sufficient thickness to withstand the maximum possible end loads that will be generated by the carrier pipe during the life of the system. Elbows must be anchored on both ends. Tees must be anchored on both the run and the branch.

2.8.3.1 Fitting Pressure Rating

Pressure rating of connections and fittings shall be greater than or equal to the design pressure of the system with a minimum safety factor of two.

2.8.3.2 End Seals

End seals and other subassemblies shall be designed and factory prefabricated to prevent the ingress of moisture into the system. Subassemblies shall be designed to allow for complete draining of the secondary containment.

2.8.4 Leak Detection

The leak detection system shall be a cable detection system. The leak detection system shall be equipped with an electronic monitoring and control unit.

2.8.4.1 Leak Detection Monitoring Unit

A complete cable-type leak detection and location system consisting of a microprocessor based monitoring unit, sensor cable, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing strings for leaks, shorts, breaks and probe activation shall be furnished. If any of these conditions should occur at any point along the cable, an alarm shall sound, type of condition shall be clearly identified and the location clearly displayed. The system shall monitor the interstitial space of double contained piping.

a. Enclosure. The monitoring unit shall be enclosed in a NEMA 250 Type 12 enclosure with a viewing window for mounting outdoors. Ability to locate a leak shall not depend on battery backed up functions. In the event of power failure, system conditions and parameters shall be stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power. An on-off switch shall be provided in the panel for servicing.

b. Relay Outputs. The system shall provide relays for remote indication of an alarm condition. The relays shall provide indication that no alarm conditions exist, an alarm condition exists but has not yet been acknowledged, and an alarm condition exists and has been acknowledged. Communications shall be available via RS-232 and ASCII communication protocols to allow central point monitoring and control via a remote computer.

c. Storage Memory. The system shall record significant events in

permanent memory. A minimum of 100 events shall be stored. When the memory becomes full, the recorded events shall be deleted from memory in sequential order beginning with the oldest event. Each recorded event shall include the time and date that the event occurred. Archives shall be retrievable through RS-232 and ASCII communication protocols.

d. Status Indication. The system shall continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string.

e. Security. The system shall have assignable password security. The system shall not permit unauthorized modifications to the sensing string to be made without causing an alarm condition.

2.8.4.2 Cable System

The sensor cable, connectors, probes and jumpers shall be supplied by the manufacturer of the monitoring unit. The cable sensing principle shall provide for continuous monitoring while short lengths of the cable are in contact with liquids, without altering the system's sensitivity and/or accuracy. The cable system shall be a conductance or impedance type system.

a. Requirements. The leak detection system shall locate the point of origin of the first liquid leak within 0.1 percent of the sensor string length. The system shall identify the type of alarm as well as the location. The system shall be able to monitor (detect and locate) with up to 98.4 feet of wetted cable without significant inaccuracy in location. The system shall be capable of monitoring up to 1,970 feet of cable per sensor string from a single monitoring unit. The system shall be capable of monitoring (detecting and locating) for multiple leaks or additional liquid on the sensor cable.

b. Detection Capabilities. The system shall be capable of detecting all liquids, including, but not limited to aqueous, hydrocarbon, and conductive and nonconductive liquids. The sensitivity of the system shall be field adjustable to increase or decrease the amount of wetted cable needed to cause an alarm from several inches to feet. The system shall be capable of identifying the location of breaks and shorts on the cable. When either of these faults occur, an alarm shall sound and a display visible on the front of the monitoring unit shall clearly indicate the type of fault and display the location of the fault.

c. Materials. The sensor cables shall be suitable for use with the monitoring unit. The sensor cables shall be of coaxial construction consisting of an insulated copper center conductor, a suitable spacer material, and an outer braid. Center conductors shall be not less than twenty AWG for mechanical strength. Cables shall be capable of field installation of connectors by trained technicians. The cable shall be available in bulk spools. All cables shall be field repairable by trained technicians.

2.8.4.3 Sensing Probes

Sensing probes for the leak detection system shall be pH probes conductivity probes liquid level switches specific ion probes as required for liquid and location to be monitored.

2.8.4.4 Visual Leak Detection System

All low points of the secondary piping system shall be equipped with sample valves.

2.8.5 Supports

Supports shall be designed and supplied for the conveyance and containment piping to prevent distortion of the pipes and strain on joints and fittings. Supports shall be designed by the double containment piping system manufacturer. No field fabricated supports will be allowed. The manufacturer shall design and fabricate the system taking into account pressure and temperature requirements when placing the pipe supports. Double supports shall be required throughout the system to minimize stresses due to point loading.

2.9 ISOLATION JOINTS AND COUPLINGS

2.9.1 Insulating Flanges, Couplings and Unions

Materials shall be in accordance with the applicable piping material specified. Complete assembly shall have ASME B31.1 rating equal to or higher than that of the joint and pipeline, shall be galvanically compatible with the piping, and shall be resistant for the intended exposure, operating temperatures, and products in the pipeline. Union Type, 2 Inches and Smaller shall have screwed or solder-joint, O-ring sealed with molded and bonded insulation to body. Flange Type, 2-1/2-inches and larger shall be flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts. Flange Insulating Kits shall include gaskets, full face, Type E with O-ring seal supplemented with neoprene facing on each side to accomplish the seal. Insulating sleeves shall be full length mylar. Insulating washers shall be plated, hot-rolled steel, 1/8-inch thick.

a. Manufacturers:

1. Dielectric Flanges and Unions

2. Pipeline Seal and Insulator, Inc., Houston, TX

3. Central Plastics Co., Shawnee, OK

4. Or Equal

5. Insulating Couplings

6. Dresser; STAB-39

7. Baker Coupling Company, Inc.; Series 216

2.9.2 Couplings General

Coupling linings for use in potable water systems shall be in conformance with NSF 61. Couplings shall be rated for working pressures not less than indicated in the Piping Schedule for the service or 150 psi, whichever is greater. Coupling shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA M11, and restrained with retainer bar or ring welded to pipe end, or

as shown on the Drawings. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

a. Flexible Sleeve Type Couplings

1. Manufacturers:

a) Steel Pipe:
Dresser Piping Specialties; Style 38
Smith-Blair; Style 411
Or Equal

b) Ductile Iron Pipe:
Dresser Piping Specialties; Style 153
Smith-Blair; Style 411
Or Equal

b. Bolted Split Sleeve Type Coupling

1. Manufacturers:
Victaulic Co
Depend-O-Lok Couplings
Or Equal

c. Transition Coupling for Steel Pipe

1. Manufacturers:
Dresser Piping Specialties; Style 162
Smith-Blair; Style 413
Or Equal

d. Flanged Coupling Adapter

1. Manufacturers:

a) Steel Pipe
Dresser Piping Specialties; Style 913
Smith-Blair; Style 128
Or Equal

b) Ductile Iron Pipe
Dresser Piping Specialties; Style 912
Smith-Blair; Style 127

e. Restrained Flange Adapter

1. Minimum working pressure rating shall be as indicated in the Piping Schedule or not less than 150 psi, whichever is greater. Safety Factor shall be not less than two times working pressure and shall be supported by manufacturer's proof testing. For thrust restraint provide hardened steel wedges that bear against engage outer pipe surface, and allow articulation of pipe joint after assembly, while wedges remain in their original setting position on pipe surface. Products employing set screws that bear directly on pipe will not be accepted.

a) Manufacturers:
EBAA Iron Sales Co.; Mega-Flange

Or Equal

f. Dismantling Joints

1. Minimum working pressure rating shall not be less than rating of the connecting flange. Proff testing shall conform to requirements of AWWA C219 for bolted couplings.

a) Manufacturers:
Dresser Piping Specialties; Style 131
Viking Johnson
Or Equal

2.9.3 Expansion Joints

a. Elastomer Bellows

1. Elastomer bellows shall be of the reinforced molded wide arch type. End connections shall be flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings. Provide washers over retaining rings to help provide leak-proof joint under test pressure. Thrust protection shall include control rods to protect the bellows from overextension. Bellows arch lining shall be Buna-N, nitrile, or butyl. Temperature rating shall be 250 degrees F. Later deflection shall be 3/4-inch minimum. Burst pressure shall be four times the working pressure. Compression deflection and minimum working pressure shall be: 1.06 inches at 150 psi for sizes 2-1/2-inches to 12-inches; 1.65 inches at 130 psi for sizes 14-inch; and 1.65 inches at 110 psig for sizes 16-inches through 20-inches.

a) Manufacturers:
General Rubber Corp.; Style 1015 Maxijoint
Mercer; Flexmore Style 450
Goodall Rubber Co.; Specification E-711
Unisource Manufacturing, Inc.; Series 1500
Proco Products, Inc.; Series 251
Or Equal

b) Metal Bellows

1. Metal bellows shall be single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds shall not be permitted. Materials of construction shall be Type 316 stainless steel. End connections shall be ANSI 150-pound carbon steel flanges. Minimum design working pressure shall be 150 psig at 750 degrees F. Length shall be determined based on a minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.

a) Manufacturers:
Hyspan Precision Products, Inc.; Series 1500
Pathway Bellow, Inc.; Style CT
Or Equal

c. Copper Pipe Expansion Compensator

1. Materials of construction shall be stainless steel bellows with female copper solder joint ends. Minimum working pressure

rating shall be 175 psig. Accessories shall include anti-torque device to protect bellows.

a) Manufacturers:
Senior Flexonics; Model HB
Hyspan; Model 8510
Unisource Manufacturing, Inc.; Style EC-FFS
Or Equal

d. Galvanized and Black Steel Pipe Expansion Compensator

1. Materials of construction shall be all stainless steel. Minimum working pressure shall be 175 psig. Accessories shall include anti-torque device to protect bellows.

a) Manufacturers:
Senior Flexonics; Model H
Hyspan; Model 8503
Unisource Manufacturing, Inc.; Style EC-MMT
Or Equal

e. Flexible Metal Hose

1. Type shall be close pitch, annular corrugated with single braided jacket. Materials of construction shall be stainless steel, ASTM A 276, Type 321. End connections shall be shop fabricated flanged ends to match mating flanges for 3-inches and larger, and screwed ends with one unio end for 2-1/2-inches and smaller. Minimum burst pressure shall be 600 psi at 70 degrees F for 12 inches and smaller. Provide hose live-length equal to lengths shown on the Drawings.

a) Manufacturers:
Senior Flexonics, Series 401M
Anamet Industrial, Inc.; BWC21-1
Or Equal

2.9.4 Flexible Expansion Joints

a. Ball and socket type for earth settlement compensation. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping. Assembly shall accommodate up to 4-inches of expansion in length. Materials of construction shall be ductile iron conforming to AWWA C153/A21.53, rated for 350 psig. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets. End connections shall be flanged or mechanical join as shown and as required by connecting pipe and fittings. Joint connecting to mechanical joint shall be thrust restrained.

b. Bonding: Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint. Provide 24-inch bond wires for field bonds to adjacent metallic piping. Bond wires shall be No. 2 AWG with two 12-inch long THHN insulated No. 12 AWG wire pigtails.

1. Manufacturers:
EBAA Iron Sales Co.; Flex-Tend
Or Equal

2.9.5 Connectors

a. Teflon Bellows Connector

1. Two convolutions, unless otherwise shown, with metal reinforcing bands. Flanges shall be ductile iron, drilled 150 psi ASME B16.5 standard. Working pressure rating shall be 150 psi at 120 degrees F. Thrust restraint shall consist of limit bolts to restrain force developed by specified test pressure.

a) Manufacturers:
Garlock; Style 214
Resistoflex; No. R6904
Unisource Manufacturing, Inc.; Style 112
Proco Products, Inc.; Series 442
Or Equal

b. Elastomer Bellow Connector

1. Fabricated spool, with single filled arch. Materials of construction shall be Nitrile tube and wrap-applied neoprene cover. End connections shall be flanged, drilled 125-pound ASME B16.1, standard, with full elastomer face and steel retaining rings. Minimum working pressure rating shall be 140 psig at 180 degrees F for sizes 12 inches and smaller. Thrust restraint shall consist of control rods to limit travel of elongation and compression.

a) Manufacturers:
Goodall Rubber Co.; Specification E-1462
Garlock; Style 204
Unisource Manufacturing, Inc.; Style 1501
Proco Products, Inc.; Series 220
Or Equal

c. Metal Bellows Connector

1. Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds shall not be permitted. Materials of construction shall be Type 316 stainless steel. End connections shall be ANSI 150-pound carbon steel flanges. Minimum design working pressure shall be 150 psig at 750 degree F. Minimum length shall be determined based on a minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.

a) Manufacturers:
Hyspan Precision Products, Inc.; Series 1500
Pathway Bellows, Inc.; Style CT
Or Equal

d. Flexible Metal Hose Connector

1. Close pitch, annular corrugated with single braided jacket. Materials of construction shall be bronze. End connections shall be female copper solder joint. Minimum burst pressure shall be 500 psig at 70 degrees F. Minimum length shall be determined by the manufacturer recommendation for vibration isolation.

a) Manufacturers:
Senior Flexonics
Anamet Industrial, Inc.
Unisource Manufacturing, Inc.
Proco Products, Inc.
Or Equal

e. Quick Connect Couplings for Chemical Services

1. Twin cam arm actuated, male and female, locking, for chemical loading and transfer. Materials of construction shall be glass-filled polypropylene or PVDF with EPDM, Vito-A or Teflon gaskets as recommended for the service by manufacturer. End connections shall be NPT threaded or flanged to match piping connections. Hose shank for chemical installations. Plugs and caps shall be female dust cap for each male end; male dust plug for each female end. Minimum pressure rating shall be 125 psig, at 70 degrees F.

a) Manufacturers:
OPW; Kamlock
Ryan Herco; 1300 Series
Or Equal

2.9.6 Service Saddles

Double-strap, capable of withstanding internal pressure as shown on the Piping Schedule, or 150 psig whichever is greater without leakage or over stressing. Run diameter, compatible with outside diameter of pipe on which saddle is installed. Taps shall be iron pipe threads. Body shall be similar materials as pipe; stainless steel for PVC pipe. Straps, hex nuts and washers shall be Type 316 stainless steel. Seal shall be EPDM.

a. Manufacturers:
Smith-Blair
Dresser
Or Equal

2.9.7 Pipe Sleeves

a. Steel pipe sleeve

1. Pipe sleeves shall have a minimum thickness of 3/16-inches. Seep ring shall be center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness with an outside diameter 3-inches greater than the pipe sleeve outside diameter with continuously fillet weld on each side all around. Pipe sleeves shall be hot-dip galvanized, meeting requirements of ASTM A 153/A 153M,. Electroplated zinc or cadmium plating shall not be accepted. Factory prepare, prime, and finish coat in accordance with Section 09 90 00.00 40.

b. Insulated and encased pipe sleeve

1. Manufacturers:
Pipe Shields, Inc.; Models WFB, WFB-CS and Series, as applicable
Or Equal

c. Modular Mechanical Seal

1. Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening. Fabrication shall consist of assembled interconnected rubber links with ASTM A 276, Type 316 stainless steel bolts, nuts, and pressure plates. Size shall be according to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of up to 40 feet of water.

a) Manufacturers:
Thunderline Corp., Link-Seal Division
Or Equal

2.9.8 Slab, Floor, Wall and Roof Penetrations

a. Ductile Iron Wall Pipe

1. Diameter and ends shall be the same as the connecting ductile iron pipe. Thickness shall be equal to or greater than remainder of pipe in line. Thrust collars shall be rated for thrust load developed at 250 psig with a minimum Safety Factor of 2, ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.

a) Manufacturers:
American Cast Iron Pipe Co.
U.S. Pipe and Foundry Co.
Or Equal

b. Steel or Stainless Steel Wall Pipe

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness. Lining shall be the same as the connecting pipe. Thrust collar outside diameter shall be 3 inches greater than outside diameter of wall pipe and shall be continuously fillet welded on each side all around.

2.9.9 Miscellaneous Specialties

a. Strainers, Water service, 2 Inches and Smaller

1. Bronze body, Y-pattern, 200-psi nonshock rated, with screwed gasket bronze cap. Screen shall be heavy gauge, Type 316 stainless steel or monel, 20-mesch.

a) Manufacturers:
Armstrong International Inc.; Model F
Mueller Steam Specialty; Model 351 M
Or Equal

b. Strainers, Water Service 2-1/2 Inches and Larger

1. Cast iron or ductile iron body, Y-pattern, 175 psi non shock rated with flanged gasketed iron cap. Screen shall be heavy-guage Type 316 stainless steel, 0.045-inch perforations.

a) Manufacturers:

Armstrong International, Inc.; Model A7FL 125
Mueller Steam Specialty; Model 751
Or Equal

c. Strainers, Plastic Piping Systems, 4 Inches and Smaller

1. Y-Pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals. End connections shall be screwed or solvent weld for 2-inches and smaller and Class 150 ANSI flanged for sizes 2-1/2-inches and larger. Screens shall be heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.

a) Manufacturers:
Hayward
Or Equal

d. Water Hose

1. Furnish 3 50-foot lengths of 1-inch and 3 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve. Rated minimum working pressure shall be 200 psi.

a) Manufacturers:
Goodyear
Boston
Or Equal

e. Hose Nozzles

1. Furnish 3 1-inch and 3 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.

a. Manufacturers:
Croker
Elkhart
Or Equal

f. Pump Seal Water sight Flow Indicators

1. Bronze body, 3/8-inch, horizontal, ball action with tempered glass. Rated minimum working pressure shall be 125 psi with NPT screwed ends. Operate with a minimum flow of 0.25 gpm.

a. Manufacturers:
Eugene Ernst Co.; Series E-57-4
Jacoby Tarbox Co.
Or Equal

2.10 VALVES

2.10.1 General Requirements For Valves

Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be

of a lower quality than those specified. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted.

2.10.2 Factory Finishing

Valves shall be lined and coated in accordance with Section 09 90 00.00 40 PAINTING AND COATING unless otherwise specified.

2.10.3 Check Valves

2.10.3.1 Swing Check Valves

Swing check valves shall conform to the following:

a. Type V602 Swing check valves, 2 inches and smaller, shall have a bronze conforming to ASTM B 61 or ASTM B 62 body, in accordance with ASME B16.11 threaded ends. Valves shall have a swing type, replaceable polytetrafluoroethylene (PTFE) disc. Valves shall be rated for 150-pound SWP, 300-pound WOG.

1. Manufacturers:
Walworth; Figure 3412
Milwaukee; Figure 510
Or Equal

b. Type V606 Swing check valves, 2.5 inches through 12 inch, shall have a cast iron body, in accordance with ASME B16.1 flanged ends. Valves shall have a bronze-mounted swing type, cast iron disc, solid bronze hinges, and stainless steel hinge shaft with outside lever and spring. Valves shall be rated for 125-pound SWP, 200-pound WOG.

1. Manufacturers:
Stockham; G-931
Crane Co.; Cat. No. 383
Or Equal

c. Type V608 Swing check valves, 2 inch through 36 inch, shall conform to AWWA C508, and have ASME B16.1 Class 125 flanged, end connections. Valves shall have a cast iron ASTM A 48 or ASTM A 125, Class B body, bronze-mounted disc, solid bronze hinges, and a stainless steel hinge shaft. Valves 2 inch through 12 inch shall be rated for 175 psig service and valves 14 through 36 inch shall be rated for 150 psig service at 140 degrees F. Valves shall be fitted with an adjustable outside lever and weight. An increasing-pattern body valve may be used where increased outlet piping size is shown.

1. Manufacturers:
M&H Valve; Style 59, 159, or 3259
American-Darling; No. 50 Line
Or Equal

2.10.3.2 Thermoplastic Check Valve

a. Type V611 Thermoplastic check valves, 0.25 inch through 4 inch, shall be a ball-check design, manufactured of chlorinated polyvinyl chloride (CPVC) with flanged socket threaded, in accordance with

ASME B1.20.1, end connections. Valves shall be rated for 150 psig service. Valves shall have Teflon O-ring seals and seats.

1. Manufacturers:
   Walworth
   Milwaukee
   Or Equal

2.10.3.3 Double Disc Swing Check Valve

a. Type V612 Double disc swing check valves, 2 inch through 48 inch, shall be wafer style, spring-loaded swing check valve, with a TP316 stainless steel body, TP316 stainless steel disc, EPDM resilient seats, TP316 stainless steel spring, hinge pin, and stop pin. Valves 2 inch through 12 inch shall be rated for 200 psig service and valves 14 inch through 48 inch shall be rated for 150 psig service.

1. Manufacturers:
   APCO; Series 9000
   Val-Matic; Dual Disc
   Crane/Stockham; WG-970
   Tyco: Gulf MB Series
   Or Equal

2.10.3.4 Check Valves, V613

a. Check Valves, 2-inches to 36-inches: Wafer style, swing check, one-piece body design, full resilient seal in machined body groove. Type 316 stainless steel body, ASME Class pressure rating as required for service. Type 316 stainless steel disc, Type 316 stainless steel spring and other internals. Buna-N seal, outside lever and weight assembly, limit switch assembly.

1. Manufacturers:
   Tyco; Prince Figure 800 Series
   Crane; Uni-Chek II
   Or Equal

2.10.3.5 Silent Check Valve

Silent check valves shall conform to the following:

a. Type V622 Silent check valves, 2 through 24 inch, shall be globe style, center guided valve with ASME B16.1 Class 125 flanged end connections, a TP316 stainless steel body, TP316 stainless steel trim, seat, and TP316 stainless steel spring. Valves shall be rated for 150 psig service.

1. Manufacturers:
   Stockham; G-931
   Crane Co.; Cat. No. 383
   Or Equal

2.10.3.6 Ball Check Valve

a. Type V630 Ball check valves, 4 inch and smaller, shall be dual union socket-welding ends, and ASTM D 1784 Type 1, Grade 1 polyvinyl chloride (PVC) bodies and ball, Viton seat and seal. Valves shall be rated for 150 psig service.

1. Manufacturers:
   Nibco; Chemtrol Tru Union
   ASHAI/American
   Spears; True Union
   Or Equal

2.10.3.7 CPVC Ball Check Valve

a. Type V631 Ball check valves, 4 inches and smaller, shall be single or dual union socket welding ends, ASTM D 1784 Cell Class 23477B chlorinated polyvinyl chloride body with Viton seat and seal. Valves shall be rated for 150 psig service.

1. Manufacturers:
   Nibco; Chemtrol Tru Union
   ASHAI/American
   Spears; True Union
   Or Equal

2.10.3.8 Type PVDC Ball Check Valve

a. Type V632 Ball check valves, 4 inches and smaller, shall be dual union socket welding ends, ASTM D 3222 Cell Class Type II polyvinylidene fluoride body with Viton seat and seal. Valves shall be rated for 150 psig service.

1. Manufacturers:
   Nibco; Chemtrol Tru Union
   ASHAI/American
   Spears; True Union
   Or Equal

2.10.3.9 Type Double Check Valve Backflow Prevention Assembly

a. Type V640 Double check valve backflow prevention assemblies 3/4 inch to 10 inches shall be two resilient seated check, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510, rated for 175 psig working pressure, meeting the requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.

1. Manufacturers:
   FEBCO; Model 850
   Danfoss Flomatic; Model DCVE/DCV
   Watts; Series 007/709
   Or Equal

2.10.3.10 Reduced-Pressure Principle Backflow Prevention Assembly

a. Type V642 Reduced-pressure principal backflow prevention assemblies 3/4 inch to 10 inches shall be two resilient seated check valves with and independent relief valve between the valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated for 175 psig working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research. Valves shall be lined for high salinity up to 7,000 TDS.

1. Manufacturers:

FEBCO; Model 860
Danfoss Flomatic; Model RPZE/RPZ
Watts; Series 009/909
Or Equal

2.10.3.11 Check Valve

a. Type V694 Check valves 1 inch to 48 inches, elastomer type flanged or slip-on, as shown on Drawings, round entry area to match pipe contoured duckbilled shaped exit, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, flanged, rated for 50 psig minimum operating pressure, flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Buna-N.

1. Manufacturers:
Red Valve Co.
Tideflex Check Valve Series TF-1 or 35-1
Or Equal

2.10.4 Ball Valves

2.10.4.1 General Purpose Ball Valves

General purpose ball valves shall conform to the two-piece following:

a. Type V300 Ball valves, 2 inch and smaller for general water and air service, shall be two-piece end entry type with ASTM B 62 bronze body and end piece. Valves shall have polytetrafluoroethylene (PTFE) seats and packing, chrome plated bronze or brass balls blowout-proof system, RTFE seats and packing, blowout proof stem, adjustable packing gland and zinc coated hand lever operators with vinyl grip. Valves shall be rated for 600-pound WOG, 150-pound SWP, complies with MSS SP-110.

1. Manufacturers:
Threaded:
Conbraco Apollo; 70-100
Nibco; T-580-70
Soldered:
Conbraco Apollo; 70-200
Nibco; S-580-70

b. Type V305 Ball valves, 2 inch and smaller for natural gas service shall be two-piece bronze or forged brass body and end piece, threaded ends, hard chrome plated brass ball, RTFE seats and seal, blowout-proof stem, zinc-plated hand lever operator with vinyl grip, UL Listed Guide YRPV for natural gas. Valves shall be rated for 600 psig WOG.

1. Manufacturers:
Conbraco Apollo; 80-100
Nibco; T-585-70-UL/T-580-70-UL
Or Equal

c. Type V306 Ball valves, 2 inch and smaller shall be two-piece, ASTM A 276 GR 316 or ASTM A 351/A 351M GR CF8M stainless steel body and end piece, threaded ends, standard port, ASTM A 276 Type 316 stainless steel ball, reinforced PTFE seats, PTFE packing, blowout proof

stainless steel stem, stainless steel lever operator with vinyl grip. Valves shall be rated 1,500-pound CWP, complies with MSS SP-110.

1. Manufacturers:
Conbraco Apollo; 76F-100 Series
Nibco; T-585-S6-R-66-LL
Or Equal

d. Type V307 Ball valves, 2 inch and smaller shall be three-piece, ASTM A 276 GR 316 or ASTM A 351/A 351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, threaded ends, reinforced PTFE seats, body seal and stem packing, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip. Valves shall be rated for 1,000-pound CWP, complies with MSS SP-110.

1. Manufacturers:
Conbraco Apollo; 86R-100/86-500 Series
Nibco; T-585-S6-R-66-LL
Or Equal

e. Type V320 Vee-Ball valves, 1 inch to 16 inches shall be ANSI Class 150-pound valve with flanged ends, Type 316 stainless steel body, heat treated nickel- or hard chromium-plated 316 stainless steel ball splined-type 17-4 PH stainless steel shafts, reinforced PTFE flow-ring seal, reinforced PTFE with stainless steel or Hastalloy sleeve bearings, and PTFE V-ring packing. Valves shall have 300:1 range ability and equal percentage characteristics.

1. Manufacturers:
Fisher Controls; Design V150
DeZurik; VPB V-Port Ball Valve
Or Equal

2.10.4.2 Thermoplastic Ball Valve

a. Type V330 Ball valves, 2 inch and smaller, ASTM D 1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Valves shall be rated for 150 psig service.

1. Manufacturers:
Nibco; Chemtrol Tru-Bloc
ASAHI/America; Type 21
Spears; True Union
Or Equal

b. Type V331 Ball valves, 3 inch and 4 inch, ASTM D 1784 Type I, Grade 1 polyvinyl chloride body, ball, and stem, full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball. Valves shall be rated for 150 psig service.

1. Manufacturers:
Nibco; Chemtrol Tru-Bloc
ASAHI/America; Type 21
Or Equal

2.10.5 Gate Valves

2.10.5.1 General Service Gate Valves

General service gate valves shall conform to the following:

a. Type V100 Gate valves, 2 inch and smaller, shall have ASTM B 62 bronze bodies and stems, screwed bonnets, packing gland, single solid wedge bronze discs, and non-rising stems. Valves shall be rated for 200 psi CWP, complies with MSS SP-80. End connections shall be ASME B16.11 threaded.

1. Manufacturers:
Crane; Figure 438, NPT threaded ends
Stockham; Figure B103, NPT threaded ends
Crane; Figure 1324, soldered ends
Stockham; Figure B-108, soldered ends
Or Equal

b. Type V132 Gate valves, 3 inch to 20 inch and larger for buried service, iron body, resilient seat, bronze mounted, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, design working water pressure 200 psig for 2 inches through 12 inches and 150 psig for 16 inches and higher, full port fusion epoxy coated inside and outside per AWWA C550.

1. Manufacturers:
M&H Valve; AWWA C509
U.S. Pipe; A-USPO
Or Equal

2.10.6 Globe Valves

2.10.6.1 General Requirements For Globe Valves

a. Type V200 Globe valve 3 inches and smaller, all-bronze, union bonnet, inside screw, rising stem, TFE disc. Valves shall be rated for 150-pound SWP, 300-pound WOG, complies with MSS SP-80 Type 2.

1. Manufacturers:
Stockham; Figure B-22T, NPT threaded end
Crane Co.; Figure 7TF, NPT threaded end
Milwaukee; Model 1590T, soldered ends
Or Equal

b. Type V206 Globe Valve 2 inches and larger, Type 316 stainless steel body with Class 300 flat faced flanges or as indicated, plain bonnet style, Type 316 stainless steel seat ring and stem, PTFE seal ring, anti-cavitation trim, EPR backup ring, graphite gaskets (FGM), PFTE packing with Type 316 stainless steel packing flange, studs and nuts, non-tapped bonnet, balanced Type 316 stainless steel plug, cage guided, Class IV shutoff, down flow and equal percent characteristic.

1. Manufacturers:
Fisher, ET Body
Or Equal

c. Type V236 Globe style hose valve 1 inch to 3 inches, all bronze,

screwed ends, inside screw-type, rising stem, TFE disc, outlet of cast brass NHT by NPT, male by male, nipple adapter with hexagonal wrench feature. Valve shall be rated for 300-pound WOG.

1. Manufacturers:
   Stockham; Figure B-22T
   Crane Co.; Cat. No. 7TF
   Nibco; Figure T-235-Y
   Or Equal

2.10.7 Plug Valves

a. Type V405 Eccentric plug valve 3 inches to 12 inches, nonlubricated type, drip-tight shutoff with pressure from either direction, plastic coated cast iron body rated to 175 psig CWP with flanged ends per ASME B16.1, unless otherwise indicated. Cast iron plug with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N or Hycar, seats welded nickel, stem bearing lubricated Type 316 stainless steel, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on stem. For valves 3-inch to 4-inch provide wrench lever manual operators. For valves 6-inch to 12-inch, provide totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel, size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide external epoxy coating and provide completely sealed operator filled with heavy lubricant.

1. Manufacturers:
   Pratt; Ballcentric
   Dezurik; Style PEC
   Millikin; Millcentric Series 600
   Or Equal

b. Type V406 Eccentric plug valve 14 inches to 20 inches, no lubricated type, drip-tight shutoff with pressure from either direction, plastic coated cast iron body rated to 150 psig CWP with flanged ends per ASME B16.1, unless otherwise indicated, plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area, valve shall be lined with soft rubber, seats welded nickel, stem bearing lubricated Type 316 stainless steel, stem seal multiple V-rings or U-cups with O-rings of nitrite rubber, and grit seal on stem. Totally enclosed, geared, manual operators with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide external epoxy coating.

1. Manufacturers:
   Pratt; Ballcentric
   Dezurik; Style PEC
   Millikin; Millcentric Series 600
   Or Equal

c. Type V407 Eccentric plug valve 24 inches to 48 inches, no lubricated type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, plastic coated cast iron body with flanged ends per ASME B16.1 for exposed service or mechanical joints ends for buried valves unless otherwise shown, plug cast iron port opening of no less than 70 percent of connecting pipe area and coated with Buna-N or

Hycar, seats welded nickel, stem bearing lubricated Type 3216 stainless steel, stem seal multiple V-rings or U-Cups with O-rings of nitrite rubber, grit seal on stem. Totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide external epoxy coating.

1. Manufacturers:
   Pratt; Ballcentric
   Dezurik; Style PEC
   Millikin; Millcentric Series 600
   Or Equal

d. Type V462 Gauge cock 1/8 inch to 1/4 inch, 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.

1. Manufacturers:
   United Brass Works; Figure 973
   Or Equal

e. Type V464 Corporation stop 1/2 inch to 2 inches, AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe. Stops shall be rated for 150 psig.

1. Manufacturers:
   Ford Meter Box Co.
   Mueller Co.
   Or Equal

2.10.8 Butterfly Valves

2.10.8.1 Standard Service Butterfly Valve

a. General, butterfly valves shall be in full compliance with AWWA C504 and the following requirements. Valves shall be suitable for throttling operations and infrequent operation after periods of inactivity. Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D 429, Method B. Bubble-tight with rated pressure applied from either side. No travel stops for disc on interior of body. Self-adjusting V-type or O-ring shaft seals. Isolate metal-to-metal thrust bearing surfaces from flow stream.

b. Type V500 Butterfly valve 3 inches to 72 inches, flanged end, short body type, AWWA C504, Class 150B, cast iron body, or cast or ductile iron disc with Type 316 stainless steel shaft, EPDM rubber seat bonded or molded in body only, and Type 316 stainless steel seating surface. Flange drilling in accordance with ASME B16.1 and shall be flat face.

1. Manufacturers:
   Pratt Model 2FII or Triton XR-70
   DeZurik; AWWA Valve
   Or Equal

c. Type V506 Butterfly valve high pressure service 3 inches to 48

inches, rated 250 psi cold water at 16 feet per second flow velocity, nonshock, watertight shutoff, body heavy cast or ductile iron, flanged ends, flange drilling in accordance with ASME B16.1 and shall be flat face. Class 250 disc cast or ductile iron with Type 316 stainless steel disc edge, shaft stainless steel ASTM A 564/A 564M, Type 630, Condition H-1100/1150 or Type 316, Buna N rubber seat bonded or molded in body only, seals self-adjusting V-type multi-ring seals.

1. Manufacturers:
   Pratt; Triton HP-250
   DeZurik; AWWA Flanged Class 250
   Mueller; Lineseal XP Class 250
   Or Equal

d. Type V514 High Performance butterfly valve 2 inches to 36 inches, ANSI Class 150 and 300 (valves on RO feed lines and RO concentrate lines shall be Class 300) style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, PTFE seat, PTFE stem packing, stainless steel with RTFE thrust washer.

1. Manufacturers:
   TYCO/Keystone; K-Lok Series
   DeZurik; BHP Series
   Or Equal

e. Type V520 Solid Polyvinyl Chloride butterfly valve 1-1/2 inches to 8 inches, wafer body type, pressure rated 150 psi at 70 degrees F CWP, solid ASTM D 1784, Type I, Grade 1, PVC body and contoured PVC or polypropylene valve disc, Type 316 stainless steel valve shaft, Viton seat, lever operator.

1. Manufacturers:
   ASAHI/America; Type 56
   Spears
   Or Equal

f. Type V530 Butterfly valve 4 inches to 20 inches for Fire Protection Service, UL Listed and FM Approved, flanged style, AWWA C504, Class 150B valve with cast iron body, aluminum-bronze disc, stainless steel stem, EPDM seat, geared operator with highly visible position indicator and detachable crank handle. For buried service, provide post-indicator and detachable crank handle.

1. Manufacturers:
   Pratt
   IBV
   Or Equal

2.19.11 Diaphragm Valves

2.10.9 Thermoplastic Diaphragm Valve

a. Type V903 diaphragm valves 1/2 inch to 4 inches, weir type with PVC Type 1, Grade 1 body, PTFE diaphragm with PVDF gas barrier and EPDM backing cushion, 150 pound flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.

1. Manufacturers:

ASAHI/America; Type 56
ITT Engineered Valves; Dia-Flo
Or Equal

b. Type V930 diaphragm valve, 1/2 inch to 4 inches, weir type with PVDF body, PTFE diaphragm with PVDF gas barrier and EPDM backing cushion, 150-pound flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.

1. Manufacturers:
ASAHI/America; Type 72
ITT Engineered Valves; Dia-Flo
Or Equal

2.10.10 Self-Contained Automatic Valves

2.10.10.1 Pressure-Reducing Valve

a. Type V712 Pressure-reducing valve 1/2 inch to 2 inches, spring controlled, Type 315 stainless steel body, spring case, seat, with elastomer diaphram, NPT threaded ends, 250 psig rated.

1. Manufacturers:
Fisher; 95 Series
Or Equal

b. Type V714 Pressure-reducing valve 3 inches and larger. Hydraulically operated, diaphragm actuated, pilot controlled, globe valve designed to automatically reduce a higher inlet pressure to a steady pre-determined lower downstream pressure regardless of changing flow rate and varying inlet pressure, ductile iron body, ASME B16.5, Class 150 flanged ends. Pressure settings shall be field adjustable. Provide position switch which shall provide automatic indication when valve is fully closed. Main valve trim, stem and spring shall be Monel. Provide Type 316 stainless steel pilot control with Monel trim. All tubing and fittings shall be Type 316 stainless steel. As indicated on the Drawings and as required in Specification Section 43 32 70, IRON AND MANGANESE FILTRATION SYSTEM, main valve pilot control shall be provided with a Type 316 stainless steel solenoid over-ride valve for automatic opening of the valve when the solenoid is energized. Valves shall be fussion bonded epoxy lined and coated in accordance with AWWA C213. Minimum dry film thickness for lining and coating shall be 12 mils, and pinhole free.

1. Manufacturers:
Cla-Val;
Or Equal

c. Type V716 Pressure-relief and pressure sustaining valve 3 inches and larger. Hydraulically operated, diaphragm actuated, pilot controlled, globe valve designed to automatically maintain constant upstream pressure within close limits, ductile iron body, ASME B16.5, Class 150 flanged ends. Valves shall be fussion bonded epoxy lined and coated in accordance with AWWA C213. Minimum dry film thickness for lining and coating shall be 12 mils, and pinhole free. Pressure settings shall be field adjustable. Provide position switch which shall provide automatic indication when valve is fully closed. Main valve trim, stem and spring shall be Monel. Provide Type 316 stainless steel pilot control with monel trim. All tubing and fittings shall be Type 316

stainless steel. The main valve pilot control shall be provided with a Type 316 stainless steel solenoid over-ride valve for automatic opening or closing of valve as indicated on the Drawings. The main valve shall have anti-cavitation trim design constructed of monel incorporating dual interlocked sleeves containing radial slots that deflect internal flow to impinge upon itself in the center of the flow path, harmlessly dissipating potential cavitation damage.

1. Manufacturers:
   Cla-Val;
   Or Equal

2.10.10.2 Pressure Relief Valves

a. Type V730 Pressure-relief valves 2 inches and smaller, direct diaphragm, spring controlled, cast iron body, spring case, nitrile seat, neoprene diaphragm, Type 316 stainless steel valve stem, NPT threaded ends, 200 psig rated. Opens when upstream pressure reaches a maximum set point. Size shall be as shown in the Valve Schedule.

1. Manufacturers:
   Cla-Val;
   Singer;
   Or Equal

b. Type V732 Pressure-relief valve 3 inches and larger, hydraulically operated, diaphragm actuated, pilot controlled globe valve, ductile iron body, ANSI Class 150 flanged ends, rated 250 psig, Type 316 stainless steel trim and stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point pressure. Opens when upstream pressure reaches a maximum set point. Size shall be as shown in the Valve Schedule.

1. Manufacturers:
   Cla-Val;
   Singer;
   Or Equal

2.10.10.3 Air and Vacuum Valves

a. Type V740 Air and vacuum valve 1/2 inch to 16 inch, cast iron or ductile iron body, cover with Type 316 stainless steel float and trim and protective hood and shall be in accordance with AWWA C512. Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness. Valves 1/2 inch through 3 inch NPT inlets and outlets, valves 4 inch and larger ASME B16.1 flanged inlet with plain outlet. Air and vacuum valves installed on vertical turbine discharge piping shall be equipped with surge check valves to prevent shock closure of the air and vacuum valve. The surge check valves shall be provided by the air and vacuum valve manufacturer and shall be sized and fitted to work with the air and vacuum valve. The valve shall have a disk with adjustable type throttling orifices. Under venting conditions, the disk shall open to allow free passage of air. When water reaches the disk, it shall close and therefore force water through the orifices and reduce the flowrate of water into the air and vacuum valve. All metallic pieces of the

surge check unit, except the valve body, shall by Type 316 stainless steel.

1. Manufacturers:
APCO;
Val-Matic;
Or Equal

b. Type V744 Air release valves shall vent accumulating air while the system is in service and under pressure and be of the size indicated and shall meet the same general requirements as specified for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a maximum pressure rating of 150 psig.

1. Manufacturers:
APCO;
Val-Matic;
Or Equal

c. Type V745 Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in the system under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as for air and vacuum valves.

1. Manufacturers:
APCO;
Val-Matic;
Or Equal

2.10.11 Manifold, Three-Valve Equalizing

Type 316 stainless steel, for isolation and equalizing of differential pressure transducers.

1. Manufacturers:
Anderson, Greenwood and Co.; Type M1
Evans
Or Equal

2.10.12 Needle Valves

Type 316 stainless steel body with 0.020-inch orifice.

1. Manufacturers:
Whitey; Model 21RF2
Hoke; 3700 Series
Or Equal

2.10.13 Regulating Valves

Type 316 stainless steel needle vavles with regulating stems and screwed bonnets.

1. Manufacturers:
Whitey; catalog No. RF or RS
Hoke; 3100 through 3300 Series

2.10.14 Solenoid Valve, Two Way

Brass globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation. Valve seat shall be Buna-N. The valve size shall be as noted on the Drawings and shall be normally closed or open as noted. The coil shall be 115V ac, unless otherwise indicated. Solenoid enclosure shall be NEMA 4.

1. Manufacturers:
   ASCO; Red Hat Series 8260
   Or Equal

2.10.15 Pressure Regulator, Water

Bronze body with cast-iron spring case, brass set rings, Buna-N and bronze valve disk and holder with Buna-N diaphragm. Sizing shall be for a maximum of 7 psi offset pressure.

1. Manufacturers:
   Fisher; Controls Type 95H or 95L
   Masoneilan; Series 17

2.10.16 Operators

Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power actuators. Furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers. All actuators shall be current models of the best commercial quality materials and sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed. All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power actuators shall be equipped with position indicators. Unless otherwise indicated, all actuators shall be in accordance with AWWA C540.

2.10.16.1 Manual Operator

Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of a maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

a. Traveling-nut actuators shall consist of a traveling-nut with screw (Scotch yoke) contained in a weather-proof cast-iron or steel

housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of grease nipples. All gearing shall be designed for a 100 percent overload.

b. Worm-gear actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90 degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

c. All buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Design buried service operators for quarter-turn valves to withstand 450 foot pounds of input torque at the fully open or fully closed positions, grease packed and gasketed to withstand a submersion in water to 10 psi. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required. Wrench-nuts shall comply with AWWA C500, and a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished.

d. Manually actuated valves with the stem located more than 7 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel, or stainless steel, extending to 5 feet 6 inches above the operating floor level. The valve stem of chain-actuated valves shall be sized for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.

e. Floor boxes shall be hot-dip galvanized cast-iron or steel and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

2.10.16.2 Electric Operator

Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece. Electric motor actuators shall comply with the latest version of AWWA C540. The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weatherproof NEMA 4 assembly. The actuator shall

be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simple removing the motor and changing the exposed or helical gear set ratio without further disassembly of the electric actuator. Size electric actuators to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve. Controls shall be integral with the actuator and fully equipped as specified in AWWA C540 and as shown on the Drawings. Provide stem protection for rising stem valves. Actuator operation shall be suitable for full 90-degree rotation of quarter turn valves or for use on multi-turn valves. Operators shall have a manually override handwheel. Operators shall have valve position indication and shall operate from full closed to the full open positions or the reverse in the number of seconds indicated in the Electric Operator Schedule.

a. Electric actuators for open-close service, size motors for one complete open-close-open cycle no less than once every 10 minutes. Actuator shall be suitable for throttling operation of valve at intermediate positions. Actuators shall have integral OPEN-STOP-CLOSE pushbottons, and OPEN and CLOSED indicating lights. Reversing motor starter with built-in overload protection shall be required. Provide FULL OPEN and FULL CLOSE auxiliary limit switch contacts for remote use, as described for limit switches. Provide LOCAL - REMOTE selector switch with auxiliary contact which closes when in REMOTE mode. Provide provisions for remote OPEN - CLOSE control when switch is in the REMOTE position.

b. Electric actuators for modulating service, size motors for a minimum of 1,200 starts per hour at full rated torque without over-heating. Actuators shall incorporate feedback potentiometer or solid-state non-contacting position feedback and integral electronic positioner/comparator circuit to maintain valve position. Actuators shall have Local-Remote selector switch: OPEN-STOP-CLOSE pushbutton to control valve in HAND position; 4 to 20 mA dc input signal to control valve in Remote position; auxiliary contact that closes in REMOTE position. Valves shall close upon loss of signal unless otherwise indicated. Actuators shall have OPEN and CLOSED indicating lights. Ac motor with solid-state reversing starter or dc motor with solid-state reversing controller, and built-in overload protection. Controller shall be capable of 1,200 starts per hour. Duty cycle limit timer and adjustable bandwidth to prevent actuator hunting shall be required. Valve position output converter that generates a 4 to 20 mA dc signal in proportion to valve position, and is capable of driving into loads up to 500 ohm at 24 volts dc shall be required. Actuator power supply shall be 480-volt, three-phase unless otherwise indicated. Control power transformer shall be 120-volt secondary. Actuators shall have an externally operable power disconnect switch.

c. Enclosures shall be as defined in NEMA 250, Type 4. Enclosures shall contain 120-volt space heaters. Actuators for below grade service shall be the NEMA 6 (IP68-watertight submersion of 20 feet of water column for 72 hours). Actuator shall come equipped with a plug in socket type, watertight terminal compartment seal. The seal shall prevent water, which may intrude into the electrical conduit from reaching and damaging the actuator. All external fasteners on the electric actuator shall be stainless steel. Fasteners on limit switch

and terminal compartments shall be captured to prevent loss while covers are removed.

d. Limit switches shall be single-pole, double throw (SPDT) type, field adjustable cam-operated with contact rated for 5 amps at 120 volts ac. Each valve actuator shall have a minimum of two auxiliary limit switch contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED. Limit switches shall be housed in the actuator control enclosure.

e. Electric actuators with additional features shall be as noted in the Electric Motor Actuator and Valve Schedule.

2.11 Accessories

a. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing the valve tag number shown on the valve schedule.

b. T-Handled Operating Wrench: 2 each galvanized operating wrenches, 4 feet long.

1. Manufacturers:
Mueller; No. A-24610
Clow; No. F-2520
Or Equal

c. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.

1. Manufacturers:
Henry Pratt
Allis-Chalmers
Or Equal

d. Floor Boxes: Cast-iron with counter type indicator, hinged, lockable lid with directional arrow, 2-inch square AWWA operating nut, packing gland providing drip-tight seal around valve shaft.

1. Manufacturers:
Waterman Industries
Rodney Hunt
H. Fontaine
Or Equal

e. Floor Stand Assemblies: Heavy-duty cast-iron, suitable for mounting specified operator.

1. Manufacturer:
Rodney Hunt Company
Waterman Industries
Or Equal

f. Bench Stands: Handwheel operators or hand crank, geared operators conforming to hand-cranked geared operator requirements, except capacity to be mounted on haunch, wall bracket, or self-contained gate yoke.

1. Manufacturer:

Rodney Hunt Company
Waterman Industries
Or Equal

g. Concrete Valve Box: Designed for traffic loads, sliding type, with minimum 8-inch ID shaft. Box shall be concrete, minimum depth 12 inches, cast iron ring seat. Lid shall be cast iron, minimum depth 3 inches, marked WATER. Extensions shall be ABS, PCV, or cast iron pipe.

h. Wall Brackets or Haunches shall be as indicated on the Drawings.

i. Stems shall be stainless steel, sized to match output of operator, minimum gate or valve operating stem diameter and a 200 maximum slenderness ratio.

j. Stem Couplings shall be stainless steel internally threaded to match stem, lockable to stem by set screw.

k. Stem Guides shall be cast-iron with silicon bronze bushing, maximum 200 slenderness ration, capable of being mounted with wall bracket, adjustable in 2 directions.

l. Wall brackets shall be cast-iron capable of withstanding output of operator, adjustable in 2 directions.

m. Stem Stuffing Boxes shall be cast-iron with adjustable gland and packing.

n. Fasteners and Anchor bolts shall be Type 316 stainless steel.

o. Accessory equipment for valves and gates requiring remote operators shall include operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

2.12 DRAINS

Valved drains may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them as indicated in the piping and instrumentation diagrams to complete the piping system for the use intended.

2.12.1 Locations

All pipeline low points shall be drained.

2.13 MISCELLANEOUS PIPING COMPONENTS

2.13.1 Air Release and Vacuum Breakers

Air release vents shall be located, and vented, such that a hazardous atmosphere will not be created upon operation.

2.13.1.1 Locations

Air release and vacuum breakers shall be located as indicated on the contract drawings.

2.13.2 Indicating Devices

2.13.2.1 Pressure Gauges

Gauges shall be industrial quality type with Type 316 stainless steel movement and stainless steel case. Unless otherwise indicated, gauges shall have a 3-1/2-inch dial, 1/4-inch threaded connection, a Type 316 stainless steel snubber adapter, and a shut-off valve. Gauges shall have an accuracy of 2 percent of span with a scale range such that normal operating pressure lies between 50 and 80 percent of scale range. All guagues shall be vibration and shock resistant.

1. Gauge Manufacturer:
Ashcroft; Gauge Series 1000
Ametek U.S.; Guage Series P500
Acculite: Series 2000
Or Equal

Snubber Manufacturer:
Cajon Company
Weksler Instruments, Corp.
Or Equal

2.13.3 Static Mixer

Mixer shall provide uniform mixing of dilute aqueous solutions of sodium bisulfite into the main water stream at flow rates ranging from 3,000 gpm to 5,000 gpm with a pressure drop of less than 1.4 psi maximum through its 18-inch NPS diameter housing. Mixer shall be fabricated in 0.375-inch, Type 316L stainless steel. Mixer housing shall have 150 pound, Type 316L stainless steel flanged ends. Basis for the mixer design shall be non-clog, low pressure drop Hi-Pass design with alternating right rotation elements followed by a set of left rotation elements set at 90 degrees from each other. Mixers shall contain a minimum of three sets of mixing elements. Edges of the mixing elements shall be smoothly contoured with a large radius. The intersection of each mixing element with the mixer housing wall shall be at an oblique angle with the midstream center section open to eliminate corners that can trap solid or fibrous materials. Trapezoidal tab type mixing elements shall not be accepted. Mixing elements configured as corrugated metal plates shall not be accepted. Helical, double action mixing elements shall not be accepted. Where indicated on the Drawings mixers shall include 2-inch flange additive ports each with Kynar flanged full diameter multi-orifice injector that is sized to pre-distribute the sodium bisulfite through the pipe diameter. Mixer shall achieve 0.05 CoV (coefficient of variance) mixing efficiency at 3 pipe diamters downstream of the mixer. Mixer overall length shall not exceed 64-inches.

1. Manufacturers:
Komax Systems Inc.
Or Equal

2.14 PIPE SUPPORTS AND PENETRATIONS

Auxiliary steel shall be provided by the Contractor where the support of piping systems and equipment is required between building structural elements. The Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of

support system manufacturer's products is not permitted.

2.14.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture, MSS SP-69, Pipe Hangers and Supports - Selection and Application, and MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Civil or Structural Engineer currently licensed in the State of California. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

2.14.1.1 Pipe Support Systems

Support load shall be dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation. Safety factor shall be a minimum of 5.

2.14.1.2 Materials

a. Wetted and Submerged: Stainless steel.

b. Atmospheric Exposed: Galvanized or painted steel.

c. Chemical Containment: Fiberglass reinforced plastic.

2.14.1.3 Maximum Support Spacing and Minimum Rod Size

Maximum Support Spacing and Minimum Rod Size shall be as follows:

a. Steel or Ductile Iron Piping:

Pipe Size	**Maximum Support/ Hanger Spacing**	**Minimum Rod Size Single Rod Hangars**
1-inch & Smaller	6 feet	1/4-inch
1-1/2-inch thru 2-1/2-inch	8 feet	1/4-inch
3-inch & 4-inch	10 feet	3/8-inch
6-inch	12 feet	3/8-inch
8-inch	12 feet	1/2-inch
10-inch & 12-inch	14 feet	5/8-inch
14-inch	16 feet	3/4-inch
16-inch & 18-inch	16 feet	7/8-inch
20-inch	18 feet	1-inch
24-inch	18 feet	1-1/4-inch
30-inch & larger	As shown on Drawings	As shown on Drawings

b. Copper Piping:

1. Maximum Support Spacing: 24-inches less per size than listed for steel pipe, with 1-inch and smaller pipe supported every 60-inches.

2. Minimum Hanger Rod Sizing: Same as listed for steel pipe.

c. Plastic and Fiberglass Piping:

1. Maximum Support Spacing: As recommended by manufacturer for flow temperature in pipe, or as indicated in the following Table.

d. Stainless Steel Piping:

Pipe Size	**Maximum Support/ Hanger Spacing**	**Minimum Rod Size Single Rod Hangars**
1-inch thru 4-inch	8 feet	1/4-inch
6-inch	8 feet	3/8-inch
8-inch & 10-inch	10 feet	1/2-inch
12-inch	10 feet	1/2-inch
14-inch & 16-inch	12 feet	5/8-inch
18-inch & 20-inch	14 feet	3/4-inch
24-inch	14 feet	7/8-inch

e. Framing Support Systems:

1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.

2. Column Members: Size in accordance with manufacturer's recommended method.

3. Support Loads: Calculate using weight of pipes filled with water.

4. Maximum Spans:

a) Steel and Ductile Iron Pipe, 3-inch Diameter and Larger: 10-foot centers, unless otherwise show.

b) Other Pipelines and Special Situations: May require supplementary hangers and supports

c) Electrical Conduit Support: Include in design offraming support system.

f. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support. Anchorage systems shall be designed, detailed, perpared and sealed by a Registered Civil or Structural Engineer currently licensed in the State of California.

g. Vertical Sway Bracing: 10-foot maximum centers, or as show.

2.14.1.4 Hangers

a. Clevis Type: MSS SP-58, Type 1 or 6

1. Manufacturers:
Grinnell; Figure 104 or 260

B-Line; Figure B3198 or B3100
Or Equal

b. Hinged Split-Ring Pipe Clamp: MSS SP-58, Type 6 or 12

1. Manufacturers:
Grineell; figure 104
B-Line; figure B3198H
Or Equal

c. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP-58.

d. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP-58, Type 21, 28, 29, 30, which engage both sides of flange.

2. Concrete Insert: MSS SP-58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.14.1.5 Saddle Supports

Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

a. Nonadjustable Saddle: MSS SP-58, Type 37 with U-bolt.

1. Manufacturers:
Grinnell; Figure 259
B-Line; figure B3090
Or Equal

b. Adjustable Saddle: MSS SP-58. Type 38 without clamp.

1. Manufacturers:
Grinnell; Figure 264
B-Line B3093
Or Equal

2.14.1.6 Wall Brackets

a. Welded Steel Bracket: MSS SP-58, Type 33 (heavy-duty)

1. Manufacturers:
Grinnell; Figure 199
B-Line; figure B3607
Or Equal

b. One-Hole Clamp:

1. Manufacturers:
Grinnell: Figure 126
Or Equal

c. Channel Type:

1. Manufacturers:
Unistrut

Kin-Line
Or Equal

2.14.1.7 Pipe Clamps

a. Riser Clamp: MSS SP-58, Type 8

1. Manufacturers:
Grinnell; figure 261
B-Line; Figure B3373
Or Equal

2.14.1.8 Channel Type Support Systems

a. Material:

1. Galvanized: Pre-galvanized in accordance with ASTM A 525, Class G90, or hot-dip galvanized after fabrication.

2. Stainless Steel; Type 304 stainless steel.

3. Channel Size: 12-gauge, 1-5/8-inch wide series.

4. Members and Connections: Design for all loads with safety factor of 5

5. Manufacturers:
Kin-Line; Series CI3812
Unistrut; Seires P3200
Or Equal

2.14.1.9 Accessories

Insulation Shields:

a. Type: Galvanized steel or stainless steel, MSS SP-58, Type 40

1. Manufacturers:
Grinnell; Figure 167
B-Line; figure B3151
Or Equal

b. Welded Insulation Saddles, MSS SP-58, Type 39

1. Manufacturers:
Grinnell; Figure Series 160
B-Line; figure Series B3160
Or Equal

c. Vibration Isolation Pads, Neoprene Waffle Type

1. Manufacturers:
Mason Industries; Type W
Korfund; Korpad 40
Or Equal

d. Flush Type Insert Channels: As specified in Section 05 12 00, STRUCTURAL STEEL

2.14.1.10 Intermediate Pipe Guides

Piping 6 Inches and Smaller:

a. Type: Pipe clamp with oversized pipe sleeve to provide minimum 1/8-inch clearance.

1. Manufacturer:
Kin-line, Inc.; Figure 417
Grinnell Power Strut; Figure P5932
Or Equal

Piping 8 Inches and larger:

a. Type: Specially formed U-bolts with double nuts to provide 1/4-inch minimum clearance around pipe.

b. U-Bolt Stock Size:

1. 8-inch Pipe: 5/8-inch

2. 10-inch Pipe: 3/4-inch

3. 12- Through 16-Inch Pipe: 7/8-inch

4. 18- Through 30-inch Pipe: 1-inch

Pipe Alignment Guides

a. Type:

1. Piping 8 Inches and Smaller: Spider or sleeve type

2. Piping 10 Inches and Larger: Roller type

a) Manufacturers:
Flexonics
Kin-Line
Or Equal

Pipe Anchors

a. Type Anchor chair with U-bolt strap

1. Manufacturers:
Grinnell; Figure 198
B-Line; Figure B3147A or B3147B
Or Equal

Anchoring Systems

a. Material:

1. Wetted and Submerged: Type 316 stainless steel

2. Atmospheric Exposed: Stainless steel

b. Size: Sized and designed by equipment manufacturer

2.14.1.11 Shop/Factory Finishing

Prepare, and prime, and finish coat in accordance with Section 09 90 00.00 40 PAINTING AND COATING

2.14.2 Wall Penetrations

2.14.2.1 Above Grade Wall Penetrations

Piping which passes through fire-rated or smoke-rated walls, floors, or ceilings shall be provided with insulated and encased pipe sleeves, fire stopping sealant for metal and plastic piping systems in accordance with Section 07 84 00, FIRESTOPPING.

2.14.2.2 Galvanizing

Galvanizing shall be hot-dip applied and meet the requirements of ASTM A 153/A 153M. Stainless steel components may be substituted where galvanizing is specified.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.1.2 System Preparation

3.1.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. The Contractor shall clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.1.2.2 Damaged Coatings

The Contractor shall repair damaged coating areas in the field with material equal to the original coating, except for damaged glass-lined pipe which shall be promptly removed from the site. The Contractor shall not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A 780.

3.1.2.3 Field Fabrication

The Contractor shall notify the Contracting Officer at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work. Field welding shall be performed in accordance with Section 40 17 26.00 20 WELDING PRESSURE PIPING. Welding electrodes shall be provided in accordance with Table 4.1 of AWS D1.1/D1.1M as required for the applicable base metals and welding process. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

3.2 EXPOSED PIPING INSTALLATION

Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and Appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

3.2.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.2.1.1 Pipe Support Systems

a. General:

1. Install support systems in accordance with MSS SP-69, Pipe Hangers and Supports-Selection and Application and MSS SP-89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.

2. Support piping connections to equipment by pipe support and not by the equipment.

3. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

4. Support no pipe from the pipe above it.

5. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

6. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

7. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

8. Install lateral supports for seismic loads at all changes in direction.

9. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

b. Standard Pipe Supports:

1. Horizontal Suspended Piping:

a) Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.

b) Grouped Pipes: Trapeze hanger systems.

c) Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

d) Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

2. Horizontal Piping Supported From Walls:

a) Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

b) Stacked Piping:

1) Wall mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.

2) Piping clamps which resist axial movement of pipe through support not acceptable.

c) Wall mounted piping clips not acceptable for insulated piping.

3. Horizontal Piping Supported From Floors:

a) Stanchion Type:

1) Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

2) Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

3) Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

b) Floor Mounted Channel Supports:

1) Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

2) Attach channel framing to floors with anchor bolts.

3) Attach pipe to channel with clips or pipe clamps.

c) Concrete Cradles: Use for piping larger than 3-inch along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

4. Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

5. Standard Attachments:

a) To Concrete Ceilings: Concrete inserts.

b) To Steel Beams: I-beam clamp or welded attachments.

c) To Wooden Beams: Lag screws and angle clips to members

not less than 2-1/2 inches thick.

d) To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

6. Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

c. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides (or pipe supports that provide the same function) at all expansion joints and loops.

3.2.2 Piping Expansion and Contraction Provisions

The piping shall be installed to allow for thermal expansion and contraction resulting from the difference between installation and operating temperatures. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Anchors shall be installed as shown in the contract drawings to withstand expansion thrust loads and to direct and control thermal expansion. An intermediate pipe guide shall be installed for every pipe at each metal channel framing support not carrying an anchor or alignment guide. Where pipe expansion joints are required, pipe alignment guides shall be installed adjacent to the expansion device and within four pipe diameters. Expansion devices shall be installed in accordance with the manufacturer's instructions and at the locations shown in the contract drawings.

3.2.3 Piping Flexibility Provisions

Thrust protection shall be provided as required. Flexible couplings and expansion joints shall be installed at connections to equipment, and where shown on the contract drawings. Additional pipe anchors and flexible couplings beyond those shown on the contract drawings, shall be provided to facilitate piping installation, in accordance with reviewed shop drawings.

3.2.4 Couplings, Adapters and Service Saddles

Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with soapy water or the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts.

3.2.5 Piping Equipment/Component Installation

Piping components and indicators shall be installed in accordance with manufacturer's instructions. Required upstream and downstream clearances, isolation valves, and miscellaneous devices shall be provided for an operable installation. Straight runs of piping upstream and downstream of flow measuring devices shall be as shown in the contract drawings.

3.2.5.1 Local Indicators

All direct-reading indicator devices, thermometers, and pressure gauges shall be installed so that they can be easily read from floor level, and are readily accessible for maintenance and service. All temperature sensing bulbs shall be coated with a silver base heat transfer grease prior to insertion into the thermowell. Pressure gauges and thermometers shall be installed where indicated in the contract drawings. Field calibration of all indicators shall be performed at time of installation to ensure measuring and reading accuracy. Differential pressure gauges shall be installed across the process equipment indicated in the contract drawings, in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.2.6 Pipe Flanges

Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe and shall straddle the vertical centerline of the pipe.

3.2.7 Valve Locations

Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.

3.2.8 Pipe Tap Connections

Taps to pipe barrels are unacceptable. Taps to ductile iron piping shall be made only with a service saddle or at a tapping boss of a fitting, valve body, or equipment casting. Taps to steel piping shall be made only with a welded threadolet connection.

3.2.9 Plastic Pipe Installation

All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Heat joining shall be performed in accordance with ASTM D 2657. Electrofusion joining shall be performed in accordance with ASTM F 1290. Schedule 40 pipe shall not be threaded. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings. Pipe shall not be laid when the temperature is below 40.1 degrees F, nor above 90 degrees F when exposed to direct sunlight. Any plastic pipe installed above grade and outdoors shall be ultraviolet (UV) protected or UV resistant. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during the laying operation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be in accordance with ASTM F 402. The Contractor shall provide and install supports and hangers in accordance with the manufacturer's recommendations as specified and shown on the contact drawings. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. This shall be accomplished with the use of expansion joints and offset piping arrangements. All lines shall be hydrostatically tested at the pressures listed in the Pipe Schedule shown on the contract drawings.

3.2.9.1 PVC Piping

Solvent-cemented joints shall be constructed in accordance with ASTM D 2855.

3.2.9.2 FRP Piping

Pipe, duct, and fittings shall be cut, fabricated, and installed in strict accordance with the pipe manufacturer's written recommendations and as shown on the contract drawings. All FRP pipe and fittings shall have interior surfaces which are highly polished, with no exposed fibers. Field joints shall be cured as recommended by the manufacturer. Where it is absolutely necessary to make a field weld on pipe specified to be field flanged only, the weld shall be made only under direct supervision of the pipe manufacturer's field representative, who shall be experienced in FRP pipe lay-up techniques.

3.2.10 HDPE Pipe Installation

a. General:

1. Install polyethylene pipe in conformance with ASTM D 2774, AWWA M55, PPI TR-33, ASTM F 2620, and pipe manufacturer's recommendations.

2. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavation.

3. If HDPE pipe surface temperature is above 100 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.

4. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:

a) Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.

b) Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.

c) Follow requirements of PPI Technical Note 38 including mandatory 4 hour bolt re-torquing.

5. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

6. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8 2.

b. Placement in Trench:

1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.

2. Position slings for handling pipeline away from butt-fused joints.

3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.

4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.

5. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

3.2.11 Double Containment Piping Installation

Factory trained field representatives of the piping supplier shall provide technical field support during critical periods of piping and leak detection system installation including final check out of the leak detection/location system, and end user training.

3.2.12 Insulation

Insulation shall be installed on piping as indicated on the Pipe Schedule in the contract drawings.

3.3 BURIED PIPE PLACEMENT

Thermoplastic piping systems shall be installed underground in accordance with ASTM D 2774. Thermosetting resin and reinforced plastic mortar piping systems shall be installed underground in accordance with ASTM D 3839.

3.3.1 Excavation and Backfilling

Earthwork shall be performed as specified in Section 31 00 00 EARTHWORK. Backfilling shall be accomplished after inspection by the Contracting Officer. The Contractor shall exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.3.2 Fittings

At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.3.3 Thrust Restraint

Thrust restraint devices are generally not shown in the contract drawings; their absence will not relieve Contractor of the responsibility for providing them as required to provide complete systems for the use intended. The Contractor shall provide thrust blocks and ties where required, whether or not shown on the contract drawings. At a minimum, thrust restraint shall be provided at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.

3.3.3.1 Restrained Joints

For ductile iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD and as specified.

3.3.4 Marking Tape

Pipe marking tape shall be provided and installed in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.3.5 Plastic Pipe Installation

Plastic pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations. Offset loops from the trench centerline shall be as recommended by the manufacturer for the maximum temperature variation between the pipe temperature at the time of solvent welding and operating temperature. Design for installation of plastic pipe exposed to ambient conditions or in which the temperature variation of the contents is substantial shall have provisions for movement due to thermal expansion and contraction documented to be in accordance with PPI TR-21. Flexible plastic pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between the plastic pipe at the flanged joint and the rigid structures is possible. Thrust blocking shall not be used for flexible plastic piping. The piping shall be designed and installed to withstand the compression and expansion forces imposed by the trench conditions. .

3.4 CONNECTING DISSIMILAR PIPE

Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.5 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.5.1 Underground Metallic Piping

Buried metallic piping shall be protected from corrosion using protective coatings. Where dissimilar metals are joined underground, gas-tight isolation joints shall be used. Insulating joint material shall be provided where shown to control galvanic or electrical action.

3.5.2 Above Grade Metallic Piping

Nonferrous and stainless steel piping shall not be painted except for aluminum alloy piping. Where dissimilar metals are joined, isolation joints shall be used.

3.6 DOUBLE CONTAINMENT PIPING LEAK DETECTION SYSTEM

The system shall be installed in accordance with the manufacturer's recommended installation procedures. All local, state and federal codes and requirements shall be followed. The system shall be installed by properly trained personnel. A location map shall be provided with the system by the Contractor indicating the "as built" system configuration and sensing string layout. Markings along the cable length shall be provided

as references to locate leaks. Markings shall be based upon calibration points. The Contractor shall be responsible for taking and recording calibration points along the sensing string per the manufacturer's recommended procedures.

3.6.1 Assistance and Training

The Contractor shall provide manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. The Contractor shall follow manufacturer's instructions for installation.

3.6.2 Field Test of System

Tests shall be performed to demonstrate the ability of the system to detect and locate breaks, shorts and probes on the sensor string. Leak testing shall be performed pursuant to the following procedure in order to verify operation and the ability to work with condensation pools or other static moisture. The double containment piping system leak detection field test procedures shall be as follows: (1) Wet the sensor cable near the start of the sensor string and acknowledge the detection/location alarm and remap the system. (2) Wet the sensor cable near the end of the sensor string with the first location still wetted and acknowledge the detection/location alarm and remap the system. (3) Wet the sensor cable in three additional locations between the first and second leak locations with each detection/location alarm being acknowledged and with all prior leak locations still wetted. (4) Prepare and submit a report verifying each leak location and detection accuracy. A hard copy report of the test results shall be furnished.

3.7 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Flexible joints shall be provided at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints shall be considered flexible joints; welded pipe joints shall not.

3.8 CLOSURES

Closure pieces shall be installed as necessary to end pipe runs and shall conform to ASME B16.9 or ASME B16.11. Elastomer sleeves bonded to pipe ends are not acceptable. Pressure piping shall have closures of butt-welded caps blind flanges threaded plugs, unless otherwise shown on contract drawings or approved by the Contracting Officer. Pipes with restrained joints shall have pipe closures installed with thrust tie-rod assemblies or as shown in contract drawings.

3.9 PENETRATIONS

Steel pipe sleeves shall be hot-dipped galvanized after fabrication for above grade applications in nonsubmerged areas. For below grade, or in submerged and damp environments, steel pipe sleeves shall be lined and coated as specified in Section 09 90 00.00 40 PAINTING AND COATING. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09 90 00.00 40 PAINTING AND COATING. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires.

3.10 VALVE INSTALLATION

Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

3.10.1 Valve Orientation

The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings. Automatic valves shall be installed in accordance with the manufacturer's instructions and approved drawings.

3.10.1.1 Butterfly Valves

Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.

3.10.1.2 Plug Valves

If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.

3.10.2 Isolation Valve

Safety isolation valves shall be installed on compressed air supplies. The valve shall be located to provide accessibility for control and maintenance. If necessary, access doors shall be installed in finished walls and plaster ceilings for valve access.

3.10.3 Operator Extension Stems

Where the depth of the valve is such that its centerline is more than 3 feet below grade, an operator extension stem shall be furnished with a 2 inch operating nut to bring the operating nut to a point 5.9 inches below the surface of the ground and/or box cover. The operating nut shall be located in a floor box.

3.10.4 Torque Tube

Where the operator for quarter-turn valve is located on a floor stand, an extension stem torque tube shall be furnished, properly sized for the maximum torque capacity of the valve.

3.10.5 Chain Wheel and Guide

Chain wheel and guide assemblies or chain lever assemblies shall be

installed on manually operated valves located over 6.73 feet above finished floor elevation. Where chains hang in normally traveled areas, appropriate "L" type tie-back anchors shall be used.

3.11 AIR RELEASE, DRAINS AND SAMPLE PORTS

Sample ports shall be provided where indicated on the contract drawings. The Contractor shall install specified vents at piping high points for entrapped air release and install drains in the low points of pipelines regardless of whether shown on contract drawings.

3.12 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.12.1 General Support Requirements

Pipe support systems shall meet the requirements of MSS SP-58. Contractor-designed and selected support systems shall be installed in accordance with MSS SP-69 and MSS SP-89, and as specified herein. Piping connections to equipment shall be supported by pipe supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. Refer to Section 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT.

3.12.2 Support of Insulated Piping

The Contractor shall install oversized supports to fit the insulation inserts. Supports shall be provided with galvanized or stainless steel protection shields and oversized rollers.

3.12.3 Dielectric Barriers

Dielectric barriers shall be installed between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.13 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09 90 00.00 40 PAINTING AND COATING. Except where piping is required to be completely painted in its code color, piping or its insulation covering may be banded either with plastic adhesive tapes or painted stripes around pipe designating piping contents in accordance with

following options and requirements. A single individual band, of plastic adhesive tape or paint, designating pipe contents shall be provided with sufficient length to permit the stenciling of pipe contents in letters. Identification shall be provided at branch connections, inlets and outlets of equipment, every 20 feet of straight run, upstream of valves, and within 3.0 feet of entrance to or exit from wall curtains, or other similar type barrier.

3.14 FIELD QUALITY CONTROL

3.14.1 Hydrostatic Tests

Where any section of a pipeline is provided with concrete thrust blocking for fitting, the hydrostatic tests shall not be made until at least 5 days after the installation of the concrete thrust blocking, unless otherwise approved by the Contracting Officer.

3.14.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic test pressure as listed in the Pipe Schedule in the contract drawings. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 31 00 00 EARTHWORK.

3.14.1.2 Exposed Piping

Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions (as indicated in the Piping Schedule in the contract drawings) to demonstrate compliance. The test pressure shall not be less than 1.5 times the design pressure unless otherwise indicated. Water shall be used as the hydrostatic test fluid. The Contractor shall provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling.

a. For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe in accordance with the manufacturer's instructions. The Contractor shall test all

parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined by the Contractor for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. The Contractor shall correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, the piping system shall be left full of water after leaks are repaired.

b. For non-rigid, non-metallic piping and metallic piping with a non-metallic liner hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed 1.5 times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe in accordance with the manufacturer's instructions. The system shall be initially pressurized to 50 percent of the normal service conditions and inspected. Any leaks shall be repaired by the Contractor. The system shall then be pressurized to the test pressure. Small amounts of water shall be added as required on a hourly basis for a maximum of 3 hours in order to maintain the test pressure. After 4 hours, the test pressure shall be lowered by 10.2 psi . If the hydrostatic pressure remains steady for 1 hour, then no leakage is indicated. The Contractor shall inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for 8 hours before retesting.

3.14.1.3 Double Containment Primary Piping

The primary piping of a double containment piping system shall be tested in accordance with Subparagraph Exposed Piping of this paragraph. Secondary containment piping of a double containment piping system shall be pneumatically pressure tested in accordance with Subparagraph Double Containment Secondary Piping at the maximum test pressure of 5 psi or manufacturer's recommended maximum. times the maximum pressure rating of the lowest rated component in the piping system. The maximum velocity during filling shall be in accordance with the manufacturer's instructions. The system shall be initially pressurized to 50 percent of the normal service conditions and inspected. Any leaks shall be repaired by the Contractor. The system shall then be pressurized to the test pressure. Small amounts of water shall be added as required on a hourly basis for a maximum of 3 hours in order to maintain the test pressure. After 4 hours, the test pressure shall be lowered by 10.2 psi . If the hydrostatic pressure remains steady for 1 hour, then no leakage is indicated. The Contractor shall inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for 8 hours before retesting.

3.14.1.4 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.14.2 Pneumatic Tests

Pneumatic testing shall be prepared for and conducted in accordance with the requirements of ASME B31.3. Care must be taken to minimize the chance of a brittle fracture or failure during a pneumatic leak test. Only non-toxic, nonflammable, inert gases or air shall be used.

3.14.2.1 Pressure Relief Device

During pneumatic testing, a pressure relief device shall be provided for each piping section being tested. The device shall have a set pressure not higher than the test pressure plus the lesser of 10 percent of the test pressure or 50.8 psi .

3.14.2.2 Pneumatic Testing Procedures

The test fluid shall be air and the test pressure shall be 110 percent of the design pressure. The test pressure shall be incrementally increased until the gage pressure reaches the lesser of 50 percent of the test pressure or 25 psig. The Contractor shall examine piping joints for leakage. If no leakage is occurring, the Contractor shall continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. The test pressure shall then be reduced to the design pressure and maintained for 10 minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated. The Contractor shall inspect for and repair leaks, and retest if necessary.

3.14.2.3 Double Containment Secondary Piping

The primary piping of a double containment piping system shall be hydrostatically tested in accordance with Subparagraph Exposed Piping. Secondary containment piping of a double containment piping system shall be pneumatically pressure tested at the maximum test pressure of 5 psi or manufacturer's recommended maximum. The test fluid shall be air. Testing procedures shall be in accordance with manufacturer's recommendations. The test pressure shall be incrementally increased until the gage pressure reaches 50 percent of the test pressure. The Contractor shall examine piping joints for leakage. If no leakage is occurring, the Contractor shall continue to increase the pressure incrementally, while maintaining each incremental increase long enough to equalize pipe strains, until the test pressure is reached. The test pressure shall then be reduced to the design pressure and maintained for 10 minutes without additional energy expenditure. If the pneumatic pressure remains steady, then no leakage is indicated. The Contractor shall inspect for and repair leaks, and retest if necessary.

3.14.3 Pipe Leakage Tests

Unless approved by the Contracting Officer, leakage testing shall be conducted after the pressure tests have been satisfactorily completed. The duration of each leakage test shall be at least 2 hours, and during the test the piping shall be subjected to not less than 200 psig pressure. Leakage is defined as the quantity of the test liquid, water, that is supplied to the piping system, or any valved or approved section thereof, in order to maintain pressure within 5 psi of the specified leakage test pressure after the piping has been filled with the test liquid and all air is expelled. No piping installation will be accepted if leakage exceeds the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5
Cf = conversion factor = 0.0001351
L = allowable leakage, gallons per hour
N = number of joints in the length of piping tested
D = nominal pipe diameter, inches
P = average test pressure during the test, psig.

Should any test disclose leakage greater than that allowed, the leaks shall be located and repaired until the leakage is within the specified allowance, without additional cost.

3.14.4 Testing New to Existing Connections

New piping connected to existing pipe, existing equipment, existing treatment systems, or tanks and treatment systems furnished under other Sections shall be tested. The Contractor shall isolate the new piping with pipe caps, spectacle blinds, or blind flanges. The joint between new piping and existing piping shall be tested by methods that do not place the entire existing system under the test load. The Contractor shall then proceed with the testing of new piping systems as specified herein.

3.14.5 Valve Testing

Valves may either be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications. The Contractor shall count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data. Air and vacuum relief valves shall be examined as the associated pipe is being filled to verify venting and seating is fully functional. The Contractor shall set, verify, and record set pressures for all relief and regulating valves. Self-contained automatic valves shall be tested at both maximum and minimum operating ranges, and reset upon completion of test to the design value. Automatic valves that are not self-contained shall be tested in conjunction with control system testing.

3.15 FINAL CLEANING

3.15.1 Interim Cleaning

The Contractor shall prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

3.15.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. The Contractor shall provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps . For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and

sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

3.15.3 Disinfection

The Contractor shall disinfect the pipelines so noted in the Piping Schedule in the contract drawings. Before acceptance of piping system operation, each section of completed pipeline shall be disinfected in accordance with AWWA C651. After pressure tests have been made, the piping section to be disinfected shall be thoroughly flushed with water until all entrained dirt and mud have been removed before introducing the chlorinating material. The chlorinating material shall be liquid chlorine or sodium hypochlorite. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the piping in an approved manner. PVC pipe lines shall be chlorinated using only the above specified chlorinating material in solution. In no case shall the agent be introduced into the line in a dry solid state. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. Except where a shorter period is approved, the retention time shall be at least 24 hours and shall produce not less than 25 ppm of free chlorine residual throughout the line at the end of the retention period. All valves on the lines being disinfected shall be opened and closed several times during the contact period. The line shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period, each outlet on the line shall be opened and closed several times. From several points in the pipeline section, Contractor personnel, approved by the Contracting Officer, shall take samples in sterilized containers and have a bacterial examination performed by a commercial laboratory in accordance with state approved methods. The commercial laboratory must be certified by the state's approving authority for examination of potable water. The disinfection shall be repeated until the piping system passes the bacterial examination for 2 consecutive days. The piping system will not be accepted until satisfactory bacteriological results have been obtained.

3.16 WASTE WATER DISPOSAL

The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Contracting Officer prior to performing any testing, cleaning, flushing and disinfection activities.

-- End of Section --