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USACE / NAVFAC / AFCESA / NASA **UFGS-40 05 13 (October 2007)**

Preparing Activity: USACE **Superseding UFGS-40 05 13 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2011
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SECTION 40 05 13

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PIPELINES, LIQUID PROCESS PIPING
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NOTE: This guide specification covers the requirements for above and below grade liquid process piping located both inside and outside of treatment plants.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

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NOTE: Show the following information on the project drawings:

a. Location of pipelines indicating pipe designation, diameter and valves.

b. Pipe schedule relating pipe designation and service.

c. Valve schedule indicating valve designation and service.

d. Piping details.
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1.1 UNIT PRICES

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NOTE: This paragraph does not apply to invitation for bid (IFB) contracts. If it is determined that a lump-sum contract may be more advisable, this paragraph will be deleted. If a unit price contract is to be used, the bid items for the unit price contract will be defined for each unit to be furnished and installed.
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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.

1.1.1 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.

1.1.2 Payment

Payment will be made at the price per linear meter 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.

1.1.2.1 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.

1.1.2.2 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.

1.2 REFERENCES

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NOTE: This paragraph is used to list the

publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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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.

ALUMINUM ASSOCIATION (AA)

AA H35.2	(2009) ANS Dimensional Tolerances for Aluminum Mill Products
AA H35.2M	(2009) ANS Dimensional Tolerances for Aluminum Mill Products

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2007; Errata 2009; Addenda 1 2009; Addenda 2 2010; Addendum 2 2011; 44th Ed) Specification for Line Pipe

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2008) Performance Requirements for Atmospheric Type Vacuum Breakers (ANSI approved 2009)
ASSE 1012	(2009) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent - (ANSI approved 2009)
ASSE 1013	(2009) Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers - (ANSI approved 2010)
ASSE 1015	(2009) Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies - (ANSI approved 2010)

ASSE 1020	(2004; Errata 2004; Errata 2004) Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI Approved 2004)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

ANSI/AWWA C541	(2008) Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
ANSI/AWWA C542	(2009) Electric Motor Actuators for Valves and Slide Gates
AWWA C104/A21.4	(2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
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 C150/A21.50	(2008) Thickness Design of Ductile-Iron Pipe
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 C500	(2009) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2010) Standard for Rubber-Seated Butterfly Valves
AWWA C508	(2009) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2009) 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 C550	(2005; Errata 2005) Protective Epoxy Interior Coatings for Valves and Hydrants
AWWA C606	(2006) Grooved and Shouldered Joints
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains

AMERICAN WELDING SOCIETY (AWS)

AWS A5.10/A5.10M	(1999; R 2007) Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods
AWS A5.11/A5.11M	(2010) Specification for Nickel and Nickel Alloy Welding Electrodes for Shielded Metal Arc Welding
AWS A5.14/A5.14M	(2009; Errata 2009) Specification for Nickel and Nickel Alloy Bare Welding Electrodes and Rods
AWS A5.3/A5.3M	(1999; R 2007) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS A5.8/A5.8M	(2004) Specification for Filler Metals for Brazing and Braze Welding
AWS D1.1/D1.1M	(2010) Structural Welding Code - Steel

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 B1.20.2M	(2006) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B1.20.7	(1991; R 2008) Standard for Hose Coupling Screw Threads (Inch)
ASME B16.1	(2010) Gray Iron Threaded Fittings; Classes 25, 125 and 250
ASME B16.11	(2009) Forged Fittings, Socket-Welding and Threaded
ASME B16.15	(2006) Cast Bronze Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2001; R 2005) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.20	(2007) Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral Wound, and Jacketed

ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2001; R 2010) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2006) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2010) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End
ASME B16.42	(1998; R 2006) Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Standard for Square and Hex Nuts
ASME B31.1	(2010) Power Piping
ASME B31.3	(2010) Process Piping
ASME B36.10M	(2004; R 2010) Standard for Welded and Seamless Wrought Steel Pipe
ASME B36.19M	(2004; R 2010) Stainless Steel Pipe
ASME B40.100	(2005) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A105/A105M	(2011) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106/A106M	(2010) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A108	(2007) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A181/A181M	(2006) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A182/A182M	(2011) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2011) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2010a) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A240/A240M	(2011a) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A268/A268M	(2010) Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service
ASTM A269	(2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A312/A312M	(2011) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A334/A334M	(2004a; R 2010) Standard Specification for

	Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A351/A351M	(2010) Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A352/A352M	(2006) Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A395/A395M	(1999; R 2009) Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A403/A403M	(2010a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A423/A423M	(2009) Standard Specification for Seamless and Electric-Welded Low-Alloy Steel Tubes
ASTM A436	(1984; R 2006) Standard Specification for Austenitic Gray Iron Castings
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A479/A479M	(2011) Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels
ASTM A48/A48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A513	(2008a) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A53/A53M	(2010) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A576	(1990b; R 2006) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A587	(1996; R 2005) Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
ASTM A632	(2004; R 2009) Standard Specification for Seamless and Welded Austenitic Stainless

	Steel Tubing (Small-Diameter) for General Service
ASTM A727/A727M	(2009) Standard Specification for Carbon Steel Forgings for Piping Components with Inherent Notch Toughness
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A789/A789M	(2010a) Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A813/A813M	(2009) Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A814/A814M	(2008) Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe
ASTM A815/A815M	(2010a) Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings
ASTM A858/A858M	(2010a) Standard Specification for Heat-Treated Carbon Steel Fittings for Low-Temperature and Corrosive Service
ASTM A865/A865M	(2006) Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints
ASTM B124/B124M	(2011) Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes
ASTM B150/B150M	(2008) Standard Specification for Aluminum Bronze Rod, Bar, and Shapes
ASTM B161	(2005; R 2009) Standard Specification for Nickel Seamless Pipe and Tube
ASTM B164	(2003; R 2008) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B165	(2005; R 2009) Standard Specification for Nickel-Copper Alloy (UNS N04400)* Seamless Pipe and Tube
ASTM B167	(2008) Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, and N06045)* and Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617) Seamless Pipe and Tube

ASTM B210	(2004) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
ASTM B210M	(2005) Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric)
ASTM B211	(2003) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B211M	(2003) Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric)
ASTM B241/B241M	(2010) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
ASTM B247	(2009) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B247M	(2009) Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings (Metric)
ASTM B302	(2007) Standard Specification for Threadless Copper Pipe, Standard Sizes
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM B345/B345M	(2002) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube for Gas and Oil Transmission and Distribution Piping Systems
ASTM B361	(2008) Standard Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings
ASTM B366	(2010a) Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
ASTM B42	(2010) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B517	(2005; R 2009) Standard Specification for Welded Nickel-Chromium-Iron-Alloy (UNS N06600, UNS N06603, UNS N06025, and UNS N06045) Pipe
ASTM B546	(2004; R 2009) Standard Specification for Electric Fusion-Welded Ni-Cr-Co-Mo Alloy (UNS N06617), Ni-Fe-Cr-Si Alloys (UNS N08330 and UNS N08332),Ni-Cr-Fe-Al Alloy

	(UNS N06603), Ni-Cr-Fe Alloy (UNS N06025), and Ni-Cr-Fe-Si Alloy (UNS N06045) Pipe
ASTM B564	(2010) Standard Specification for Nickel Alloy Forgings
ASTM B574	(2010) Standard Specification for Low-Carbon Nickel-Molybdenum-Chromium, Low-Carbon Nickel-Chromium-Molybdenum, Low-Carbon Nickel-Molybdenum-Chromium-Tantalum, Low-Carbon Nickel-Chromium-Molybdenum-Copper,Low-Carbon Nickel-Chromium-Molybdenum-Tungsten Alloy Rod
ASTM B61	(2008) Standard Specification for Steam or Valve Bronze Castings
ASTM B619	(2010) Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Pipe
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B622	(2010) Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube
ASTM B725	(2005; R 2009) Standard Specification for Welded Nickel (UNS N02200/UNS N02201) and Nickel Copper Alloy (UNS N04400) Pipe
ASTM B75	(2002; R 2010) Standard Specification for Seamless Copper Tube
ASTM B75M	(1999; R 2005) Standard Specification for Seamless Copper Tube (Metric)
ASTM B775	(2008) General Requirements for Nickel and Nickel Alloy Welded Pipe
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B829	(2004a; R 2009) General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2005) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B98/B98M	(2008) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes

ASTM C552	(2007) Standard Specification for Cellular Glass Thermal Insulation
ASTM C600	(1985; R 2010)Thermal Shock Test on Glass Pipe
ASTM D 1418	(2010a) Rubber and Rubber Lattices - Nomenclature
ASTM D 1527	(1999; R 2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D 1784	(2011) 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 2104	(2003) Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40
ASTM D 2235	(2004; R 2011) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2239	(2003) Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D 2241	(2009) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2310	(2006) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2447	(2003) Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
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; R 2009e1) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2609	(2002; R 2008) Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
ASTM D 2657	(2007) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2683	(2010) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
ASTM D 2737	(2003) Polyethylene (PE) Plastic Tubing
ASTM D 2774	(2008) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2992	(2006) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D 3035	(2010) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3222	(2005; R 2010) Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
ASTM D 3261	(2010a) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D 3307	(2010) Perfluoroalkoxy (PFA)-Fluorocarbon Resin Molding and Extrusion Materials
ASTM D 3308	(2006) PTFE Resin Skived Tape
ASTM D 3350	(2010a) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3754	(2006) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe

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 3965	(2005) Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
ASTM D 4024	(2005) Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D 4101	(2011) Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM D 4161	(2010) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D 5421	(2005; R 2010) Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D 5685	(2011) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
ASTM E 438	(1992; R 2006) Glasses in Laboratory Apparatus
ASTM E 814	(2011a) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM F 1055	(2011) Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing
ASTM F 1056	(2004; R 2011) Socket Fusion Tools for Use in Socket Fusion Joining Polyethylene Pipe or Tubing and Fittings
ASTM F 1199	(1988; R 2010) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)
ASTM F 1200	(1988; R 2010) Fabricated (Welded) Pipe Line Strainers (Above 150 psig and 150 degrees F)
ASTM F 1290	(1998a; R 2011) Electrofusion Joining Polyolefin Pipe and Fittings
ASTM F 1545	(1997; R 2009) Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings

and Flanges

ASTM F 336 (2002; R 2009) Design and Construction of Nonmetallic Enveloped Gaskets for Corrosive Service

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 438 (2009) Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40

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 442/F 442M (2009) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

ASTM F 477 (2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F 493 (2010) Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

ASTM F 656 (2010) Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

ASTM F 714 (2010) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

ASTM F 876 (2010) Crosslinked Polyethylene (PEX) Tubing

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

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

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 228-1 (2000) Pipe Threads Where Pressure-Tight Joints Are Not Made on The Threads - Part 1: Dimensions, Tolerances and Designation

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; Errata 2010) Wrought Stainless Steel Butt-Welding Fittings
MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NACE INTERNATIONAL (NACE)

NACE SP0185	(2007) Extruded Polyolefin Resin Coating Systems with Soft Adhesives for Underground or Submerged Pipe

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; TIA 11-1; Errata 2011) National Electrical Code
NFPA 704	(2007) Standard System for the Identification of the Hazards of Materials for Emergency Response

PLASTICS PIPE INSTITUTE (PPI)

PPI TR-21	(2001) Thermal Expansion and Contraction in Plastic Piping Systems

RUBBER MANUFACTURERS ASSOCIATION (RMA)

RMA IP-2	(2009) Hose Handbook; 8th Edition

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2007; Change 1) Seismic Design for Buildings

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

29 CFR 1910	Occupational Safety and Health Standards

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

****

NOTE: Determine the design wind speed from ASCE 7 and/or UFC 3-301-01 STRUCTURAL LOAD DATA, although a minimum of 161 km/h (100 miles per hour) will be used. Similarly, use 1.2 kPa (25 psf) snow load for most heavy snow climates. In some cases, local climates and topography will dictate that a larger value is required. This may be determined from ANSI A58.1, local codes or by research and analysis data of the effect of local climate and topography. Snow load requirements can be deleted for locations where the maximum snow is insignificant. Provide seismic requirements and show on the drawings. Delete the bracketed phrase if seismic details are not included. Pertinent portions of UFC 3-310-04 and Sections 13 48 00 and 13 48 00.00 10, properly edited, must be included in the contract documents.

****

Support systems shall be selected and designed in accordance with MSS SP-58, MSS SP-69, and MSS SP-58 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 and Sections 13 48 00 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 13 48 00.00 10 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as indicated], accounting for a [_____] MPa psf soil bearing capacity, a maximum wind speed of [_____] km/h mph, a ground snow load of [_____] kPa psf, a maximum ambient air temperature of [_____] degrees Cdegrees F and a minimum ambient air temperature of [_____] degrees C degrees F.

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. Buried ferrous piping shall have cathodic protection in accordance with Section [26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED

CURRENT)]

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

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials and Equipment
Cable System

SD-03 Product Data

Qualifications
Welders
Waste Water Disposal
Manufacturer's Field Services
Delivery, Storage and Handling
Materials and Equipment
Installation
Pipe Schedule
Valve Schedule
Operator Schedule

SD-06 Test Reports

Double Containment Piping System
Pipe Leakage Tests
Hydrostatic Tests
Pneumatic Tests
Double Containment Piping Leak Detection System
Valve Testing
Disinfection

SD-07 Certificates

Fiberglass Reinforced Plastic (FRP) Piping System
Plastic Piping System
Plastic Pipe Installation

SD-10 Operation and Maintenance Data

Piping and Appurtenances

1.5 QUALIFICATIONS

1.5.1 Contractor

Submit a statement certifying that the Contractor has the specified experience. 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

****
NOTE: Delete the following paragraph when it is not required.
****

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 Welders

Submit 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. 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 05 13.96 WELDING PROCESS PIPING. Structural members shall be welded in accordance with Section 05 05 23 WELDING, STRUCTURAL.

1.6 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.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Environmental Requirements

****
NOTE: HTRW sites are typically well studied and investigated. Site conditions found during these previous investigations (e.g., soil resistivity testing for corrosion control design) must be incorporated into the design. The next paragraph must be edited carefully to address existing site conditions.
****

Buried piping at the site may be subject to corrosion from the surrounding soil. Testing and measurements [shall be] [has been] conducted in accordance with [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)]. Piping system design, supply and installation shall address the external corrosion conditions so indicated.

1.7.2 Existing Conditions

****
NOTE: Connection locations and wet/dry connections must be clearly indicated to avoid confusion and claims.
****

Verify existing piping and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. 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 SEQUENCING AND SCHEDULING

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

1.9 MAINTENANCE

1.9.1 Service

****
NOTE: Selectively require manufacturer's service. Automatic valves in critical or hazardous systems require service assistance. Coordinate these services with specification sections that address instrumentation and control.
****

Services for [automatic valve] [double containment leak detection monitoring system] [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.

1.9.2 Extra Materials

****
NOTE: Include items needed for future maintenance and repair, items that might be difficult to obtain because of color or pattern match, or spare parts to ensure operation of critical systems.
****

Submit the manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation. Concurrent with delivery and installation of the specified piping systems and appurtenances, spare parts for each different item of material and equipment specified that is recommended by the manufacturer to be replaced any time up to [3 years] [_____] of service shall be furnished. For each type and size of valve, the following extra materials shall be provided: lubricator, lubricant (with appropriate temperature rating), lubricator/isolating valve; [galvanized operating wrench, [1.2] [____]m [4.1] [_____] feet long, for T-handled operators;] [galvanized operating key for cross handled valves;] [_____]. Extra materials shall include [2] [_____] of the following spare parts for each type and size of valve: gaskets; [O-ring seals;] [diaphragms (molded);] all elastomer parts; stem packing; [seat rings [and seat ring pulling tool];] [_____].

PART 2 PRODUCTS

****
NOTE: All materials of construction specified will be retained except under conditions where they would not be suitable (see UFC 3-240-07FA); upon specific instructions of HQUSACE; as stipulated in specific

project directives.; and as described within notes throughout the specification. A study of the process conditions will be made to determine the suitability of the materials. Where a material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be stated in the contract specifications and shown on the contract drawings.

Soil conditions that may affect the corrosion rate of buried ferrous piping should be evaluated. The evaluation and corrosion control design will be performed in accordance with the directions provided in UFC 3-570-02A.

****

2.1 MATERIALS AND EQUIPMENT

****
NOTE: Verify that the pipe schedule is included in the contract drawings.
****

Submit 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. Provide piping materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Piping materials, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting pipe, 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 shall be in accordance with TABLE I and are indicated by service in the [Pipe Schedule] [contract drawings] [_____]. Submit 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. Pipe fittings shall be compatible with the applicable pipe materials.

2.1.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least [2] [_____] years prior to bid opening. Submit the following: Equipment shop drawings and support system detail drawings 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. 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.

2.1.2 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 [No. 12 AWG copper wire] [stainless steel wire] [chrome-plated beaded chain] [plastic straps designed for that purpose]. Identification tags shall be [35 mm 1.375 inch] [[_____] mm inches] minimum diameter, made of [brass] [engraved laminated plastic] [engraved anodized aluminum] [stamped stainless steel] [_____]. [Indentations shall be black for reading clarity.] The service, valve identification number shown on the [Operator Schedule] [Valve Schedule] in the contract drawings, the manufacturer's name, and the valve model number shall be displayed.

2.2 DUCTILE IRON PIPING SYSTEM

2.2.1 Ductile Iron Pipe

****
NOTE: Standard thicknesses of ductile iron pipe are governed by AWWA C150/A21.50 or AWWA C151/A21.51, except for integral flanged piping. The thickness of integral flanged pipe is regulated in AWWA C115/A21.15. If restrained joint pipe is used, thickness must conform to AWWA C151/A21.51.
****

Ductile iron pipe for pressure service shall have a design and wall thickness conforming to [AWWA C150/A21.50] [AWWA C151/A21.51] [AWWA C115/A21.15]. Ductile iron pipe shall have a [[standard] [double thickness] cement lining conforming to AWWA C104/A21.4] [standard asphaltic lining] [_____].

2.2.2 Ductile Iron Joints

****
NOTE: Flanged connections should not be used for buried service. Use joints for pipe and fittings installed underground (buried).
****

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] [or] [gray] iron with an [asphaltic] [_____] coating. Gaskets shall be [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].] [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 A47/A47M] [or] [ductile iron, ASTM A536] and gaskets of molded synthetic rubber, [halogenated isobutylene isoprene] [nitrile] [_____] shall be used. Bolts and nuts shall be [heat treated carbon steel, ASTM A183, minimum tensile 760 MPa 110,000 psi] [_____].] [Mechanical joints shall have bolt holes oriented [straddling the vertical centerline of the valves and fittings] [_____].]

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 [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____]. 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 the requirements of AWWA C111/A21.11, and be designed for a working pressure equal to connected pipe rating. When using ductile iron pipe with restrained joints, field cuts shall be supplied with a lock ring complete with retainer, retainer lock and roll-pin, as required by manufacturer's recommendations, procedures and/or installation instructions.

2.2.2.4 Flanged Joints

Flanged joints shall conform to AWWA C110/A21.10. Gaskets, bolts and nuts shall be provided with flanged joints in sufficient quantity for the complete assembly of each joint. Gaskets shall be [vulcanized synthetic rubber, reclaimed rubber is not acceptable] [_____].

2.2.3 Ductile Iron Fittings

****

NOTE: Fittings for ductile-iron or gray-iron piping involving 1.03 MPa (150 psi) and 1.72 MPa (250 psi) service are specified in AWWA C110/A21.10; for 2.41 MPa (350 psi) service use AWWA 153. Typically, either gray or ductile iron fittings are acceptable. Specify the exact material if service conditions warrant.

Take special precaution with mating flanges specified in this paragraph; that is, mating flanges conforming to AWWA C110/A21.10 with flanges that are specified elsewhere using ASME B16.1 or B16.5 standards.

****

Fittings shall be gray iron ASTM A48/A48M or ductile iron [AWWA C110/A21.10] [AWWA C153/A21.53]. Up to [300] [_____] mm [12] [_____] inches inclusive, the fittings shall be [1.7] [_____]MPa [250] [_____] psig

rated. Gray iron fittings shall be cement mortar lined [standard] [double] thickness. Flanges and flanged fittings shall conform to [AWWA C110/A21.10] [ASME B16.1] and shall be rated for [1.03 MPa 150 psig] [1.72 MPa 250 psig] [[_____] MPa psig] service. Materials shall be [ductile iron] [or] [gray iron] [_____]. For tie-in to existing flanges, field check existing flanges for nonstandard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolts and nuts shall be [carbon steel conforming to ASTM A307, Grade [B] [_____]] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be [rubber] [ring] [_____] [full face], maximum [3.2] [_____] mm [0.125] [_____] inch thick.

2.2.4 Corrosion Control

Ductile iron piping shall be [coated with the manufacturer's standard asphaltic coating, approximately [0.025 mm 1 mil] [[_____] mm mil] thick, applied to the outside of pipe and fittings] [hot-dipped galvanized in accordance with ASTM A153/A153M] [_____]. Buried pipe shall be coated and wrapped, and provided with cathodic protection in accordance with [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

2.3 CARBON STEEL PIPING SYSTEM

****

NOTE: Consult the referenced standards for the proper carbon steel use and fittings. For example, ASTM A53/A53M carbon steel piping is a good general piping material and ASTM A106/A106M carbon steel is for high temperature applications. In addition, some of the types and grades may not be suitable for certain joining methods or cold bending; etc. Steel pipe meeting API Spec 5L is specified only with 50 mm (2 inch) and smaller pipe that is subject to a low pressure application and the use of taper-threaded couplings.

****

2.3.1 Carbon Steel Pipe

2.3.1.1 General Service

Carbon steel pipe shall meet the requirements of [ASTM A53/A53M [seamless] [butt welded] [electric-resistance welded], Grade [A] [B]] [API Spec 5L, Schedule [40] [80] [_____]] and shall be [in accordance with Pipe Schedule] [, hot-dipped galvanized]. Buried carbon steel piping and fittings shall be Schedule [80] [_____].

2.3.1.2 High Temperature Service

Seamless carbon steel pipe for high temperature service shall [conform to ASTM A106/A106M Grade [A] [B] [C], [hot-finished] [cold-drawn], Schedule [40] [80] [_____]] [be in accordance with Pipe Schedule] with dimensions conforming to ASME B36.10M.

2.3.1.3 Chemical Process Service

Electric-resistance welded low-carbon steel pipe shall conform to ASTM A587 with a nominal wall thickness [of [_____] mm inch] [in accordance with Pipe

Schedule].

2.3.2 Carbon Steel Tubing

Tubing shall meet the requirements of [ASTM A334/A334M, [seamless] [welded], Grade [1] [_____] carbon steel] [ASTM A423/A423M, [seamless] [electric-resistance-welded], Grade [1] [2] low-alloy carbon steel] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.3.3 Carbon Steel Joints

Carbon steel piping shall be joined by [straight-threaded couplings] [taper-threaded couplings] [welding fittings] [flanges] [mechanical joints for grooved ends meeting the requirements of AWWA C606]. Tubing shall be joined using [compression] [_____] fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.3.4 Carbon Steel Fittings

[Fittings shall be [cast malleable iron] [carbon steel] [heat-treated low-carbon steel] [_____].] [Where cast fittings are not available, segmental welded steel fittings, ASTM A53/A53M, Grade B, meeting the requirements of manufacturer's recommended wall thicknesses shall be fabricated.]

2.3.4.1 Threaded Fittings

Threaded fittings shall be Class [150] [300] [_____], [malleable iron, ASTM A47/A47M, conforming to ASME B16.3, black, banded] [forged carbon steel ASTM A105/A105M, conforming to ASME B16.11] [low carbon steel, ASTM A858/A858M, conforming to ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1. Threaded, rigid couplings shall be [welded] [seamless], [black] [Type I (hot-dipped galvanized)] [Type II (electrogalvanized)] carbon steel in accordance with [ASTM A865/A865M] [_____] and threaded in accordance with ASME B1.20.2MASME B1.20.1. [Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] shall be used for lubricant/sealant.

2.3.4.2 Welding Fittings

Welding fittings shall be [butt-welding] [or] [socket-welding]. Welding fittings shall be forged [steel, ASTM A105/A105M Class [150] [300] [_____]] [low-carbon steel, ASTM A858/A858M [seamless] [or] [welded]] [_____] conforming to [ASME B16.9] [, or] [ASME B16.11].

2.3.4.3 Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Flanges and flanged fittings shall be [forged steel, [ASTM A105/A105M] [ASTM A727/A727M] [_____]] [_____], faced and drilled to ASME B16.5 Class [150] [300] [_____] with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, shall be drilled in conformance with [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall be [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M

Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____] shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3.2] [_____] mm [0.125] [_____] inch thick [chloroprene rubber, durometer hardness No.80,] [_____] 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.3.4.4 Compression Fittings for Tubing

Compression fittings shall be of [carbon steel [ASTM A108] [ASTM A576]] [_____] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight conforming to [ISO 228-1] [ASME B1.1].

2.3.5 Carbon Steel Coatings

****

NOTE: Carbon steel piping system components will be coated with corrosion resistant materials suitable for exposure to the environmental and process conditions of the site. For potential exposures to pressures less than 70 kPa (10 psi), temperatures less than 100 degrees C (212 degrees F) and mild chemicals, the surfaces shall be prepared in accordance with SSPC SP 6/NACE No.3.

For potential exposures to pressures and temperatures greater than those previously mentioned, and mild chemicals, intermediate options may be appropriate. For severe chemical exposures, the thermoplastic resin system should be used.

****

Carbon steel piping components shall be coated with corrosion resistant materials. Coatings and finishes shall be 100 percent holiday free.

2.3.5.1 Silicone Coating

Carbon steel piping surfaces shall be prepared in accordance with SSPC SP 6/NACE No.3. The surfaces shall have an alkyd primer of [0.0625] [_____] mm [2.5] [_____] mils dry film thickness followed by two alkyd modified silicone final coats.

2.3.5.2 Zinc Coating

Galvanizing shall be hot-dip applied and meet the requirements of ASTM A153/A153M; electroplated zinc or cadmium plating is unacceptable. Stainless steel components may be substituted where galvanizing is specified.

2.3.5.3 Thermoplastic Resin Coating System

[Carbon steel piping surfaces shall have a minimum of [4] [_____] coats of phenolic type coatings applied at a minimum dry film thickness of [0.040] [_____] mm [1.6] [_____] mils per coat. Each coat shall be baked at [149]

[____] degrees C [300] [_____] degrees F for [10] [_____] minutes. The full coating system shall be cured in an oven at [190] [_____] degrees C [375] [_____] degrees F for [30] [_____] minutes.] [Carbon steel piping system components shall be coated with an adhesively mounted polyethylene coating system. The continuously extruded polyethylene and adhesive coating system materials shall conform to NACE SP0185 Type A.]

2.3.6 Carbon Steel Cathodic Protection

Buried ferrous piping shall have cathodic protection.

2.4 LINED STEEL PIPING SYSTEM

2.4.1 Outer Pipe Shell

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NOTE: For the outer shell, carbon steel is most common; stainless steel will considerably limit suppliers. Flanged joining, Class 150 or 300, is commonly used. Most thermoplastic liners allow some vapors to permeate and become trapped between the liner and the shell. Therefore, venting via weep holes in the outer shell or venting flange collars (note that a single manufacturer has a patent on venting collars) are required to avoid gas accumulation. These are not required for nonpermeable liners such as PVDC. The use of thermoplastics with aggressive chemicals may result in a lower maximum operating temperature than that rated for an unlined pipe composed of the same material.

****

The outer shell of the lined piping system shall be [carbon steel meeting the requirements of [ASTM A53/A53M [electric-resistance welded] [_____], Grade [B] [_____]] [_____], Schedule [40] [80] [in accordance with Pipe Schedule]] [TP304 stainless steel, [ASTM A312/A312M [seamless] [welded]] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule]] [_____]. The outer pipe shall be equipped with [3] [_____] mm [0.125] [_____] inch vent holes spaced axially at [_____] mm inches on center or locking and venting collars at each flange. If insulated, the vents of the lined piping system shall be equipped with the manufacturer's standard vent extensions to avoid blocking. [Carbon steel piping components shall be externally coated with corrosion resistant materials. Coatings and finishes shall be 100 percent holiday free.]

2.4.2 Lined Steel Joints

Lined piping shall be joined by [[cast steel] [forged steel] flanges] [_____].

2.4.3 Lined Steel Fittings

Fittings shall be [cast gray iron, [ASTM A126 Grade B] [_____], conforming to ASME B16.1] [cast ductile iron, [ASTM A395/A395M] [_____], conforming to ASME B16.42] [cast carbon steel, [ASTM A216/A216M Grade WCB] [_____], conforming to ASME B16.5] [cast, fabricated or forged carbon steel, [ASTM A587] [ASTM A106/A106M Grade B] [ASTM A53/A53M] [ASTM A105/A105M]] [stainless steel, [ASTM A312/A312M Grade 304L] [ASTM A276] [_____],

conforming to ASME B16.5] [_____].

2.4.4 Lined Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. [Cast steel, [ASTM A216/A216M Grade [WCB] [_____]] [_____],] [Forged steel, [ASTM A105/A105M] [_____],] [Stainless steel, [ASTM A312/A312M Grade 304L] [_____],] flanges and flanged fittings shall be faced and drilled to ASME B16.5 Class [150] [300] [_____]. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall be [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____] shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5 and shall be nonmetallic conforming to ASME B16.21.

2.4.5 Lined Steel Spacers

For making connections between lined piping systems and other types of pipe or equipment, spacers shall be used. The spacers shall be composed of the same material as the liner, and shall have a bore identical to the internal diameter of the associated lined pipe. Unless otherwise specified for the liner systems, a gasket shall be used between the spacer and the unlined piping system or equipment that conforms to the gaskets required for the unlined piping system or equipment nozzle. Spacers shall be [standard ring] [standard full face] [lined steel ring] [as indicated on the contract drawings] [_____] for flanged connections. Spacers shall be a minimum of [13] [_____] mm [1/2] [_____] inch thick for piping 200 mm 8 inches and smaller in diameter, and a minimum of [15] [_____] mm [5/8] [_____] inch thick for piping larger than 200 mm 8 inches in diameter. A tapered face spacer [may] [shall not] be used for piping directional changes less than [5] [_____] degrees, and shall not be used for piping directional changes larger than [5] [_____] degrees.

2.4.6 Glass Liner

****
NOTE: A pressure rating of 2 MPa (300 psi) is available for the lining and piping system if Class 300 split flanges are used as joints.
****

The liner shall be locked to the shell. The liner shall consist of [1.6] [____] mm [1/16] [____] inch of [chemical resistant, low-expansion, Type-I borosilicate glass, Glass A] [porcelain enamel] [_____] conforming to ASTM E 438 rated to operate between -29 and plus 66 degrees C -20 and plus 450 degrees F at a nominal working pressure of [1.03] [_____] MPa [150] [_____] psig and full vacuum. [Thermal shock resistance shall be tested in accordance with ASTM C600.] [Polytetrafluoroethylene (PTFE)] [_____] enveloped gaskets shall be used that conform to ASTM F 336.

2.4.7 Perfluoroalkoxyl (PFA) Liner

****
NOTE: Liner thicknesses range from 1.5 to 3.8 mm

(60 to 150 mil), depending on the size of the pipe. Nominal pipe diameters 25 mm (1 inch) through 80 mm (3 inches) are rated for full vacuum up to 230 degrees C (450 degrees F); 100 mm (4 inches) diameter pipe is rated for full vacuum to 150 degrees C (300 degrees F); 150 mm (6 inches) diameter pipe is rated for full vacuum at 120 degrees C (250 degrees F); and 200 mm (8 inches) diameter pipe is rated for full vacuum at 65 degrees C (150 degrees F). Larger pipe diameters are available.

****

The liner shall be locked to the shell. The liner shall consist of PFA, ASTM D 3307 Type II, conforming to ASTM F 1545, and shall be rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. The lined piping system shall be rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. The pipe liner shall have a minimum wall thickness of [_____] mm mil. The liner for fittings shall have a minimum wall thickness and minimum uniform face thickness of [_____] mmmil. The part of the liner that extends onto a gasket face shall have a uniform thickness of not less than 80 percent of the pipe liner wall thickness.

2.4.8 Polypropylene (PP) Liner

****

NOTE: Liner thicknesses range from 3.8 to 8.6 mm (150 to 340 mil), depending on size of pipe. Nominal pipe diameters 25 mm (1 inch) through 300 mm (12 inch) are rated for full vacuum up to 107 degrees C (225 degrees F), if the liner is of swaged construction. For interference fit type liners, pipe diameters 25 mm (1 inch) through 200 mm (8 inch) are rated for full vacuum to 107 degrees C (225 degrees F); 250 mm (10 inch) and 300 mm (12 inch) diameter pipe is rated for full vacuum tot 38 degrees C (100 degrees F).

****

The liner shall be locked to the shell. The liner shall consist of PP, ASTM D 4101, shall conform to ASTM F 1545, and shall be rated to operate between -18 and plus 107 degrees C 0 and 225 degrees F. The lined piping system shall be rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. The pipe liner shall have a minimum wall thickness of [_____] mm mil. The liner for fittings shall have a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face shall have a uniform thickness of not less than 80 percent of the pipe liner wall thickness.

2.4.9 Polytetrafluoroethylene (PTFE) Liner

****

NOTE: Liner thicknesses range from 1.5 to 3.8 mm (60 to 150 mil), depending on pipe dimensions. Nominal pipe diameters 25 mm (1 inch) through 300 mm (12 inch) are rated for full vacuum up to 107 degrees C (225 degrees F), if the liner is of swaged

construction. For interference fit type liners, pipe diameters 25 mm (1 inch) through 100 mm (4 inch) are rated for full vacuum to 230 degrees C (450 degrees F); 150 mm (6 inch) and 200 mm (8 inch) diameter pipe is rated for full vacuum at 180 degrees C (350 degrees F). For swaged fit type liners, pipe diameters 25 mm (1 inch) through 200 mm (8 inch) are rated for full vacuum to 230 degrees C (450 degrees F). For slip fit type liners, pipe diameters 25 mm (1 inch) through 100 mm (4 inch) are rated for full vacuum to 230 degrees C (450 degrees F).

****

The liner shall be locked to the shell. The liner shall consist of PTFE, shall conform to [_____], and shall be rated to operate between -29 and plus 260 degrees C -20 and plus 500 degrees F. The lined piping system shall be rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. The pipe liner shall have a minimum wall thickness of [_____] mm mil. The part of the liner that extends onto a gasket face shall have a minimum uniform face thickness of [_____] mm mil.

2.4.10 Polyvinylidene Fluoride (PVDF) Liner

****

NOTE: Liner thicknesses range from 3.81 to 5.33 mm (150 to 218 mil) depending on the pipe dimensions. Proper liner thickness assures a non-permeable lining. Nominal pipe diameters 25 mm (1 inch) through 200 mm (8 inch) are rated for full vacuum up to 135 degrees C (275 degrees F), if the liner is of swaged or interference fit construction. For loose fit type liners, nominal pipe diameters 25 mm (1 inch) through 100 mm (4 inch) are rated for full vacuum to 135 degrees C (275 degrees F), and 150 mm (6 inch) and 200 mm (8 inch) diameter pipe is rated for 64.2 kPa (19 inch of mercury) of vacuum to 135 degrees C (275 degrees F).

****

The liner shall be locked to the shell. The liner shall consist of PVDF, ASTM D 3222, and shall be rated to operate between -18 and plus 135 degrees C 0 and 275 degrees F. The lined piping system shall be rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. The pipe liner shall have a minimum wall thickness of [_____] mm mil. The liner for fittings shall have a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face shall have a uniform thickness of not less than 80 percent of the pipe liner wall thickness.

2.4.11 Rubber Liner

****

NOTE: Liner thicknesses range from 3.2 mm (0.125 inch) to 12.7 mm (0.5 inch). Rubber lined pipe is not rated for vacuum service. Use a standard gasket for hard rubber lining. For soft rubber use a coating or sheet of polyethylene or similar material consistent with the application as a gasket.

Operating temperature ranges are as follows: natural rubber -54 to plus 82 degrees C (-65 to plus 180 degrees F), chloroprene -54 to plus 107 degrees C (-65 to plus 225 degrees F); isobutylene isoprene -54 to plus 149 degrees C (-65 to plus 300 degrees F); nitrile -54 to plus 107 degrees C (-65 to plus 225 degrees F); EPDM -54 to plus 149 degrees C (-65 to plus 300 degrees F); chlorosulfonated polyethylene -54 to plus 121 degrees C (-65 to plus 250 degrees F).

****

The liner shall be locked to the shell. The liner shall consist of [_____] mm inch of elastomeric material, ASTM D 1418 Class [_____], with a hardness of [_____]. The lining shall be terminated inside of the bolt holes. The remaining space from the liner to the flange edge shall be filled with a [_____] mm inch [polytetrafluoroethylene (PTFE)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [_____] spacer. Flange gaskets shall be [a maximum [3] [_____] mm [1/8] [_____] inches thick [polyethylene (PE)] [_____] [sheet] [or] [coating]] [[_____] gasket].

2.4.12 Polyvinylidene Chloride (PVDC) Liner

****

NOTE: No vents are needed in the outer pipe for PVDC. Liner thicknesses range from 3.8 to 5.5 mm (150 to 218 mil) depending on the pipe dimensions.

****

The liner shall be locked to the shell. The liner shall consist of PVDC conforming to ASTM F 1545, and shall be rated to operate between -18 and plus 79 degrees C 0 and 175 degrees F. The lined piping system shall be rated at a maximum pressure of [_____] MPa psig at a temperature of [_____] degrees C degrees F. The pipe liner shall have a minimum wall thickness of [_____] mm mil. The fittings liner shall have a minimum wall thickness and minimum uniform face thickness of [_____] mm mil. The part of the liner that extends onto a gasket face shall have a uniform thickness of not less than 80 percent of the pipe liner wall thickness.

2.4.13 Lined Steel Cathodic Protection

Buried ferrous piping shall have cathodic protection.

2.5 STAINLESS STEEL PIPING SYSTEM

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NOTE: The following paragraphs specify general liquid service use of stainless steel piping. To specify the material, review the application. For example, of the austenitic steels, TP316 or TP316L have better resistance to pitting corrosion than TP304 or TP304L where brines, sulphur-bearing waters or halogen salts, such as chlorides, are present.

The option for crimped couplings and fittings requires a low pressure application - less than 1.03 MPa (150 psig), service where the stainless steel piping materials (TP304, TP304L, TP316 and TP316L) are compatible to the fluid and thin wall (schedule

5S) pipe or tubing. A limited number of manufacturers are available so include other joint/fitting option(s).

****

2.5.1 Austenitic Piping

2.5.1.1 Stainless Steel Pipe

Stainless steel pipe intended for general corrosive service shall meet the requirements of [ASTM A312/A312M, [seamless] [welded]] [ASTM A813/A813M for fit-up and alignment quality, Class [SW] [DW]] [ASTM A814/A814M for flanged and cold-bending quality, Class [SW] [DW]] [_____], Grade [TP304] [TP304L] [TP316] [TP316L] [_____], Schedule [10S] [40S] [80S] [5S] [in accordance with Pipe Schedule] [_____] with dimensions conforming to ASME B36.19M.

2.5.1.2 Stainless Steel Tubing

Stainless steel tubing shall meet the requirements of [[ASTM A269] [ASTM A632], [seamless] [welded], Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [ASTM A789/A789M, [seamless] [welded], Grade [S32760] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.5.1.3 Stainless Steel Joints

Stainless steel piping shall be joined by [threaded couplings] [welded fittings] [flanges] [crimping couplings]. Tubing shall be joined using [crimping couplings] [compression] [_____] fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.5.1.4 Stainless Steel Threaded Fittings

Threaded fittings shall be [austenitic stainless steel, [ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1.]] [Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] shall be used for lubricant/sealant.

2.5.1.5 Stainless Steel Welding Fittings

Welding fittings shall be [butt-welding] [or] [socket-welding]. Welding fittings shall be forged austenitic stainless steel, [ASTM A403/A403M Grade [TP304] [TP304L] [TP316] [TP316L] [_____], [butt-welding fittings, Class [CR], conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX] [WP-WU], conforming to ASME B16.11].] [_____].

2.5.1.6 Stainless Steel Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Flanges and flanged fittings shall be [forged austenitic stainless steel, ASTM A182/A182M Grade [TP304] [TP304L] [TP316] [TP316L] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Cast austenitic stainless steel backing flanges, ASTM A351/A351M Grade [_____], Van Stone type, shall be drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole

configurations and design as required to assure new pipe and flange mate properly. Bolting shall be [alloy-steel ASTM A193/A193M Grade [B8] [B8C] [_____] hex head bolts and ASTM A194/A194M Grade [8] [8C] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, [ASTM A193/A193M Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____] shall be used. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3] [____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.5.1.7 Stainless Steel Crimping Fittings

Crimping fittings shall be cold drawn, [TP304] [TP304L] [TP316] [TP316L] austenitic stainless steel. O-ring seals shall be [butadiene acrylonitrile] [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [_____].

2.5.1.8 Compression Fittings for Tubing

Compression fittings shall be of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight conforming to [ISO 228-1] [ASME B1.1].

2.5.1.9 Stainless Steel Cathodic Protection

Buried ferrous piping shall have cathodic protection.

2.5.2 Ferritic and Martensitic Piping

2.5.2.1 Pipe

Stainless steel pipe shall meet the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [S44627] [S43035TP430] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with Pipe Schedule]] [_____] with dimensions conforming to ASME B36.19M.

2.5.2.2 Tubing

Stainless steel tubing shall meet the requirements of [ASTM A268/A268M, [seamless] [welded], Grade [TP410] [_____]] [ASTM A789/A789M, [seamless] [welded], Grade [S31500] [_____]] [ASTM A268/A268M, welded, unannealed Grade [S44627] [_____]] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.5.2.3 Joints

Stainless steel piping shall be joined by [threaded couplings] [welding fittings] [flanges]. Tubing shall be joined using [compression] [_____] fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.5.2.4 Threaded Fittings

Threaded fittings shall be [stainless steel, ASTM A182/A182M Grade [TP430]

[6a Class 1] [_____], conforming to [ASME B16.11] [_____], and threaded in accordance with ASME B1.20.2MASME B1.20.1.] [Polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] shall be used for lubricant/sealant.

2.5.2.5 Welding Fittings

Welding fittings shall be [butt-welding] [or] [socket-welding]. Welding fittings shall be forged stainless steel, [ASTM A815/A815M Grade [TP430] [TP410] [_____], [butt-welding fittings, Class CR, conforming to ASME B16.9] [socket-welding fittings, Class [WP-S] [WP-W] [WP-WX], conforming to ASME B16.11].] [_____].

2.5.2.6 Flanged Fittings

The internal diameter bores of flanges and flanged fittings shall be the same as that of the associated pipe. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Flanges and flanged fittings shall be [forged stainless steel, ASTM A182/A182M Grade [TP430] [6a Class 1] [_____]] [_____], Class [150] [300] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. [Cast stainless steel backing flanges, ASTM A352/A352M Grade [_____], Van Stone type, shall be drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____].] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall be [alloy-steel ASTM A193/A193M Grade [L7] [L7A] [_____] hex head bolts and ASTM A194/A194M Grade [7] [7A] [_____] hex head nuts] [_____]. When mating flange on valves or equipment is cast iron, [ASTM A193/A193M Grade Grade [B8 Class 1] [_____] bolts and ASTM A194/A194M Grade [8] [_____] heavy hex head nuts] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.5.2.7 Compression Fittings for Tubing

Compression fittings shall be of [ASTM A479/A479M] [_____] stainless steel, Grade TP316, nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight conforming to [ISO 228-1] [ASME B1.1].

2.5.2.8 Cathodic Protection

Buried ferrous piping shall have cathodic protection.

2.6 NICKEL AND NICKEL ALLOYS PIPING SYSTEMS

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NOTE: The preferred method for joining nickel and nickel alloy pipe is welding due to cost of flanges. In all cases, only Schedules 40S and 80S can be threaded due to wall thickness. Flanges should be used when attaching nickel pipe to pumps, process vessels, and other equipment that requires removal periodically. Generally, for temperatures

up to 115 degrees C (240 degrees F), and normal pressures encountered, the chloroprene gasket specified is appropriate for most "dilute" process liquids, water and sludge services. However, other liquids may require other, more suitable gasket materials.

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2.6.1 Nickel

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NOTE: Alloy N02200 and alloy N02201 are the 2 basic compositions of nickel pipe. Alloy N02200 is limited to a maximum operating temperature of 315 degrees C (600 degrees F).

****

2.6.1.1 Nickel Pipe

[Alloy N02200] [Alloy N02201] nickel pipe shall be [seamless conforming to ASTM B161 and ASTM B829] [welded conforming to ASTM B725 and ASTM B775], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule in the contract drawings].

2.6.1.2 Nickel Joints

Joining shall use [welded] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed shall be [flanged] [_____]. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.6.1.3 Nickel Fittings

Fittings including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43 shall be [butt] [or] [socket] welding and shall meet the requirements of ASTM B366. Fittings for alloy N02200 shall be [corrosion resistant, Grade CRN] [Class [150] [_____], Grade WPN] and for alloy N02201, fittings shall be [corrosion resistant, Grade CRNL] [Class [150] [_____], Grade WPNL].

a. Welding Fittings. Welding shall be conducted in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

b. Threaded Fittings. Threads shall be in accordance with ASME B1.20.2M ASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] for lubricant/sealant.

c. Flanged Fittings. Flanges and flanged fittings shall be [ASTM B564 forged nickel alloy [N02200] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____] shall be used. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure

new pipe and flange mate properly. Bolting shall consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Nonmetallic enveloped gaskets used for corrosive service shall conform to ASTM F 336.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.6.2 Nickel-Molybdenum-Chromium (NMC) Alloy

2.6.2.1 NMC Pipe

[Alloy N06022] [Alloy N06455] [Alloy N10276] [Hastelloy] [_____] NMC alloy pipe shall be [seamless conforming to ASTM B622 and ASTM B829] [welded conforming to ASTM B619 and ASTM B775], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.6.2.2 NMC Tubing

Tubing shall be seamless and shall conform to ASTM B622 NMC alloy [N06022] [N06455] [Hastelloy] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.2.3 NMC Joints

Joining shall use [welded] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed shall be [flanged] [_____]. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.6.2.4 NMC Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, shall be [butt] [or] [socket] welding and shall meet the requirements of ASTM B366. Fittings for alloy N06022 shall be [corrosion resistant, Grade CRHC22] [Class [150] [_____], Grade WPHC22]; for alloy N06455, fittings shall be [corrosion resistant, Grade CRHC4] [Class [150] [_____], Grade WPHC4]; and for alloy N10276, fittings shall be [corrosion resistant, Grade CRHC276] [Class [150] [_____], Grade WPHC276] [_____].

a. Welding Fittings. Welding shall be conducted in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

b. Threaded Fittings. Threads shall be in accordance with ASME B1.20.2M ASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] for lubricant/sealant.

c. Flanged Fittings. Flanges and flanged fittings shall be [ASTM B564

forged NMC alloy [N06022] [N10276] [Hastelloy] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system, Class [150] [300] [600] and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face]] [_____]. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. Cast steel backing flanges, [ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1 Class [150]] [_____]] shall be used. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall consist of [low carbon NMC alloy, ASTM B574 alloy [N06022] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and shall be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Nonmetallic enveloped gaskets used for corrosive service shall conform to ASTM F 336.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.6.2.5 NMC Compression Fittings for Tubing

Compression fittings shall be of ASTM B574 [low carbon NMC alloy] [Hastelloy], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight conforming to [ISO 228-1] [ASME B1.1].

2.6.3 Nickel-Copper Alloy

2.6.3.1 Nickel-Copper Pipe

Alloy [N04400] [_____] nickel-copper alloy pipe shall be [seamless conforming to ASTM B165, [annealed] [stress-relieved] condition, and ASTM B829] [welded conforming to ASTM B725 and ASTM B775], and dimensioned Schedule [5S,] [10S,] [40S,] [80S] [in accordance with the Pipe Schedule].

2.6.3.2 Nickel-Copper Tubing

Tubing shall be seamless and shall conform to ASTM B165 nickel-copper alloy N04400, [annealed] [stress-relieved] condition, with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.6.3.3 Nickel-Copper Joints

Joining shall use [welded] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed shall be [flanged] [_____]. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.6.3.4 Nickel-Copper Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9,

ASME B16.11, and MSS SP-43, shall be [butt] [or] [socket] welding and shall meet the requirements of ASTM B366. Fittings for alloy [N04400] [_____] shall be [corrosion resistant, Grade CRNC] [Class [150] [_____], Grade WPNC] [_____].

a. Welding Fittings. Welding shall be conducted in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

b. Threaded Fittings. Threads shall be in accordance with ASME B1.20.2M ASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] for lubricant/sealant.

c. Flanged Fittings. Flanges and flanged fittings shall be [ASTM B564 forged nickel-copper alloy [N04400] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], and drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____] shall be used.] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall consist of [nickel-copper alloy, ASTM B164 alloy [N04400] [_____] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Nonmetallic enveloped gaskets used for corrosive service shall conform to ASTM F 336.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.6.3.5 Nickel-Copper Compression Fittings for Tubing

Compression fittings shall be of ASTM B164 nickel-copper alloy [N04400] [N04405] nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight, conforming to [ISO 228-1] [ASME B1.1].

2.6.4 Nickel-Chromium-Iron (NCI) Alloy

2.6.4.1 NCI Pipe

Alloy [N06600] [N06025] [N06045] [_____] NCI alloy pipe shall be [seamless conforming to ASTM B167 and ASTM B829] [welded conforming to ASTM B517 and ASTM B775] [electric fusion-welded conforming to ASTM B546, and dimensioned Schedule [5S,] [10S,] [40S,] [80S]] [in accordance with the Pipe Schedule in the contract drawings].

2.6.4.2 NCI Joints

Joining shall use [welded] [or] [threaded] [_____] methods, except that

connections to equipment or spool pieces that may be periodically removed shall be [flanged] [_____]. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.6.4.3 NCI Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, and MSS SP-43, shall be [butt] [or] [socket] welding and shall meet the requirements of ASTM B366. Fittings for alloy N06600 shall be [corrosion resistant, Grade CRNCl] [Class [150] [_____], Grade WPNCl]; for alloy N06025, fittings shall be [corrosion resistant, Grade CRV602] [Class [150] [_____], Grade WPV602]; and for alloy N06045, fittings shall be [corrosion resistant, Grade CRV45TM] [Class [150] [_____], Grade WPV45TM] [_____].

a. Welding Fittings. Welding shall be conducted in accordance with AWS A5.11/A5.11M and AWS A5.14/A5.14M.

b. Threaded Fittings. Threads shall be in accordance with ASME B1.20.2M ASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] for lubricant/sealant.

c. Flanged Fittings. Flanges and flanged fittings shall be [ASTM B564 forged NCI alloy [N06600] [_____]] [forged stainless steel, ASTM A182/A182M Grade F316L with a serrated insert constructed of the same material or alloy as the piping system] [_____], Class [150] [300] [600], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. [Cast steel backing flanges, ASTM A216/A216M Grade [WCA] [WCB] [WCC], Van Stone type, and drilled to [ASME B16.5] [ASME B16.1] Class [150] [_____] shall be used.] For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall consist of [NCI alloy, ASTM B164 alloy [N06600] Temper [_____], bolts dimensioned to ASME B18.2.1 with ASME B1.1 coarse threads and ASTM A194/A194M Grade [_____] heavy hex head nuts] [alloy-steel ASTM A193/A193M Grade [B5] [B7] [_____] hex head bolts and ASTM A194/A194M Grade [_____] hex head nuts] [_____]. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall meet the requirements of ASME B16.5. [Nonmetallic gaskets shall conform to ASME B16.21 and be a maximum [3] [_____] mm [1/8] [_____] inch thick [chloroprene rubber, durometer hardness No.80] [_____], 10.34 MPa 1,500 psi minimum tensile strength, [125] [_____] percent minimum elongation, flat ring type for use with raised face flanges and full face type for use with flat face flanges.] [Nonmetallic enveloped gaskets used for corrosive service shall conform to ASTM F 336.] [Metallic ring joint gaskets shall conform to ASME B16.20 and be constructed of [_____].]

2.7 ALUMINUM PIPING SYSTEM

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NOTE: Alloys 1060, 3003, 5052, 6061 and 6063 are the most common compositions of aluminum pipe. Alloy 6063 is most widely used due to economical cost, good corrosion resistance and mechanical properties.

The preferred method for joining aluminum pipe to handle corrosives is welding. Be aware that welding reduces tensile strength. Threading is not recommended for aluminum piping systems that handle corrosives. Flanges are usually limited to connecting aluminum pipe to pumps, process vessels, etc.

****

2.7.1 Aluminum Pipe

Aluminum and aluminum alloy pipe shall be seamless alloy [6063] [6061] [5052] [3003] [1060], Temper [TL] [_____], Schedule [5S] [10S] [40S] [80S] [in accordance with the Pipe Schedule], with AA H35.2M AA H35.2 standard dimensions, and conforming to [ASTM B241/B241M with [ASME B1.20.2M ASME B1.20.1 threaded] [standard] ends] [ASTM B345/B345M with [ASME B1.20.2M ASME B1.20.1ASME B1.20.2M threaded] [grooved] [beveled] [standard] [_____] ends].

2.7.2 Aluminum Tubing

Tubing shall be drawn seamless and shall conform to ASTM B210M ASTM B210 alloy [6061, temper T6,] [_____] with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.7.3 Aluminum Joints

Joining shall use [welded] [mechanical coupling] [or] [threaded] [_____] methods, except that connections to equipment or spool pieces that may be periodically removed shall be [flanged] [_____]. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.7.4 Aluminum Fittings

Fittings, including 45 degree and 90 degree elbows, 180 degree bends, caps, tee reducers, lap-joint stub ends and other parts as covered by ASME B16.9, ASME B16.11, shall be [butt][or][socket] welding and shall meet the requirements of ASTM B361. Fittings shall be Grade [WP1060] [WP3003] [WP Alclad 3003] [WP6061] [or] [WP6063].

2.7.4.1 Aluminum Welding Fittings

Welding fittings shall be [butt-welding] [or] [socket-welding] and shall be factory made, wrought alloy [WP6063] [_____] in accordance with ASTM B361. [Butt-welding fittings shall conform to ASME B16.9.] [Socket-welding fittings shall conform to ASME B16.11.] Welding shall be conducted in accordance with AWS A5.3/A5.3M and AWS A5.10/A5.10M.

2.7.4.2 Aluminum Threaded Fittings

Threaded fittings shall be forged aluminum alloy [3003] [6061] [_____], Temper [_____], in accordance with ASTM B247M ASTM B247 and conforming to ASME B16.11. Threads shall be in accordance with ASME B1.20.2MASME B1.20.1 with [polytetrafluoroethylene (PTFE) pipe-thread tape conforming to ASTM D 3308] [_____] for lubricant/sealant.

2.7.4.3 Aluminum Flanged Fittings

Flanges and flanged fittings shall be designed in accordance with ASME B31.3.

Flanges shall be forged aluminum alloy [3003] [6061] [_____] Temper [_____], conforming to ASTM B247M ASTM B247, Class [150] [300] [600] [_____], drilled to ASME B16.5 with a [1.6 mm 0.0625 inch raised face] [flat face] [_____]. The flanges shall be [welding neck] [slip-on] [socket welding] [lapped] [or] [threaded] type. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Bolting shall consist of [aluminum bolting material, conforming to ASTM B211M ASTM B211 and ASME B16.5, dimensioned to ASME B18.2.1 and ASME B18.2.2 and with ASME B1.1 coarse threads] [_____]. Bolts shall be provided with washers of the same material as the bolts. [Gaskets listed in ASME B16.5, Annex E, Fig. E1, Group 1a may be used with any flange rating class and bolting.] [Nonmetallic enveloped gaskets used for corrosive service shall conform to ASTM F 336.]

2.7.4.4 Aluminum Compression Fittings for Tubing

Compression fittings shall be of ASTM B211M ASTM B211 aluminum alloy [2014], temper [T4] [T6], nuts, ferrules and bodies rated to a minimum [_____] kPa psig. Threads shall be straight conforming to [ISO 228-1] [ASME B1.1].

2.7.5 Aluminum Piping Supports

****
NOTE: Galvanic corrosion must be prevented from occurring on piping support systems. Conventional steel hangers should not be used. Galvanized steel is acceptable only as long as the galvanizing is intact; therefore, a galvanized system should not be used where expansion/contraction or other piping movement is likely.
****

The piping system shall be supported using [aluminum] [[galvanized] [alloy] [_____] steel units, integrally padded with [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____],] [_____] piping supports conforming to MSS SP-58, MSS SP-69 and MSS SP-58. Conventional steel and galvanized pipe hangers shall not be used for aluminum piping systems.

2.8 COPPER PIPING SYSTEM

****
NOTE: This paragraph covers copper pipe that may be used for corrosive services, and tubing used for noncorrosive water; refrigerant, and sample lines, etc. Copper is rapidly corroded by oxidizing acids such as chromic and nitric acids. The most common copper alloy is alloy 122 (C12200); however, other alloys may also be suitable for use. These include C10200, C10300, C10800 and C12000.

Thin walled piping systems (ASTM B302) can only be assembled using brazed joint pipe fittings. However, for high pressure and Class 'M' fluid services soldered or brazed joints and fittings are not permitted pursuant to ASME B31.3.
****

2.8.1 Copper Pipe

Seamless [C12200] [_____] copper alloy pipe, shall be a [[O61 (annealed] [H55 (light-drawn)] [or] [H80 (hard-drawn)] Temper with [regular] [extra strong] standard dimensions conforming to ASTM B42] [H (drawn) Temper with standard dimensions conforming to ASTM B302].

2.8.2 Copper Tubing

Seamless copper alloy tubing shall conform to [ASTM B88M ASTM B88 alloy C12200, Type [K] [L] [or] [M], with a [O60 (annealed)] [H (drawn)] temper] [ASTM B75M ASTM B75 alloy [C12200] [_____] with a [O60 (soft-annealed)] [_____] temper]. Specifications for applications include: [refrigerant tubing - Type L, hard drawn] [P-trap priming connection - Type L, soft Temper] [sample lines - Type L, hard drawn] [_____].

2.8.3 Copper Joints

Pipe shall be joined using [threaded] [soldered] [or] [brazed] fittings and [flanged] [_____] connections to equipment. Tubing shall be joined using [solder] [flared] [or] [press] [compression] fittings. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.8.4 Copper Fittings

Component castings of flanges and fittings shall be copper alloy [C92200, Temper [_____] conforming to ASTM B61] [C83600 (also known as alloy 85-5-5-5), Temper [_____] in accordance with ASTM B62]. Solder joint fittings shall conform to ASME B16.22 and ASME B16.18. Fittings for flared copper tube shall conform to ASME B16.26. Cast bronze threaded fittings shall conform to ASME B16.15 and shall be threaded in accordance with ASME B1.20.2MASME B1.20.1. Flanges and flanged fittings shall be faced and drilled Class [150] [300] [_____] in accordance with ASME B16.26. Copper and bronze press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements shall be of EPDM and be factory installed or an alternative supplied by fitting manufacturer. For tie-in to existing flanges, field check existing flanges for non-standard bolt hole configurations and design as required to assure new pipe and flange mate properly. Tubing compression fittings shall be [forged brass alloy C37700, conforming to ASTM B124/B124M] [_____], nuts, ferrules and bodies rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.8.4.1 Bolting For Copper Piping

Bolting materials shall meet the requirements of ASME B31.1 and shall consist of [ASTM B98/B98M alloy [C65100] [C66100]] [ASTM B150/B150M alloy [C63000] [C64200]] [ASTM B164 alloy [N04400] [N04405]] [_____] materials. Bolts shall be provided with washers of the same material as the bolts.

2.8.4.2 Gaskets For Copper Piping

[Gaskets listed in ASME B16.5, Annex E, Group [1a] [1b] may be used with any flange rating class and bolting.] [Nonmetallic, full faced gaskets used with low strength or non-ferrous bolting shall have a seating pressure less than 11.0 MPa 1,600 psi.] Gasket dimensions shall conform to [ASME B16.21] [ASME B16.20].

2.8.5 Solder For Copper Piping

****
NOTE: Solder compositions can be selected from Table 5 contained in ASTM B32. Common solder types are Sb5 and SN95. Selection should be made based on suitability to the application considering temperature and corrosivity.
****

Solder [and flux] shall conform to ASTM B32 [and AWS A5.8/A5.8M]. The solder alloy shall [be [_____]] [contain less than 0.2 percent lead]. [The flux type shall be [R] [RMA] [RA] [OA] [OS] [IS] and shall conform to ASTM B813.]

2.8.6 Copper Piping Supports

****
NOTE: Galvanic corrosion must be prevented from occurring to piping support systems; conventional and galvanized steel hangers should not be used.
****

The piping system shall be supported using [copper] [brass] [padded steel] [_____] piping supports that conform to MSS SP-58, MSS SP-69 and MSS SP-58. Conventional steel and galvanized pipe hangers shall not be used for copper piping systems. All valves, instruments and other equipment attached to the piping system shall be individually supported.

2.9 PLASTIC PIPING SYSTEM

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NOTE: Plastic Piping Systems - Many of the thermoplastic piping systems are available in both a nominal pipe schedule dimension or in a standard dimension rating (SDR). Schedule based piping has the same dimensions, outer diameter and wall thickness, as steel pipe but the pressure rating decreases with increasing pipe diameter. For SDR pipe, the pressure rating is kept uniform for all nominal pipe sizes of a given material and SDR value by increasing wall thickness. Refer to ASTM D 2241 and D 1785 for PVC SDR piping.

Backing flanges for plastic piping systems can be stainless steel, ductile iron, steel (galvanized and plain), or aluminum, depending on the application. Change the flange subparagraphs accordingly. Similarly, change the gasket material selections as required by the liquid application.

Use PVC for selected chemical services, where pipelines may be subjected to exterior corrosion, and liquid processes of 60 degrees C (140 degrees F) or below.

Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm (4 inch). Schedule 80 threaded

joints larger than 50 mm (2 inch) must be back-welded to achieve fully rated maximum operating pressures.

****

Submit 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.

2.9.1 PVC Pipe

PVC, ASTM D 1784, minimum cell classification [12545-C] [_____], pipe shall be [Schedule [40] [80] [_____] conforming to ASTM D 1785] [manufactured to an SDR rating in accordance with ASTM D 2241, so that the pressure rating of the pipe is consistent for all pipe sizes. The pipe shall be SDR [_____] with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.9.2 PVC Tubing

Tubing shall be flexible and clear with nominal size and wall thickness [in accordance with Pipe Schedule] [_____] [and reinforcement].

2.9.3 PVC Joints

The piping system shall be joined by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded. Tubing connections shall use compression fittings.

2.9.4 PVC Fittings

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NOTE: Specify ASTM D 2464 for Schedule 80 threaded type; ASTM D 2466 for Schedule 40 socket type; ASTM D 2467 for Schedule 80 socket type.

****

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D 1784, minimum cell classification [_____], PVC conforming to the requirements of [ASTM D 2464, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM D 2466, socket type] [ASTM D 2467, socket type]. [[No] [_____] thread lubricant is required.]

2.9.4.1 Push-on Joints

Push-on type joints shall be sealed with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F 477.

2.9.4.2 Flanged Fittings

Flanges and flanged fittings shall be Class [125] [_____], [one piece, molded hub type, flat faced, and shall conform to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Flanges shall be complete with one-piece, molded PVC stub ends]. Flanged connections shall have the same

pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between outer diameter of the raised face and the flange outer diameter to protect the PVC flange from bolting moment.

2.9.4.3 Tubing Fittings

Fittings shall be compression type comprised of [forged brass alloy C37700, conforming to [ASTM B124/B124M] [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.9.5 PVC Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM D 2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. [Joints shall be prepared with primers conforming to ASTM F 656 prior to cementing and assembly.]

2.10 CHLORINATED POLYVINYL CHLORIDE (CPVC)

****

NOTE: Use CPVC for chemical or corrosive services that are between 60 degrees C (140 degrees F) and 99 degrees C (210 degrees F).

Like PVC, CPVC Schedule 40 pipe should not be threaded at all. Schedule 80 pipe should not be threaded in sizes larger than 100 mm (4 inch). Schedule 80 threaded joints larger than 50 mm (2 inch) must be back-welded to achieve fully rated maximum operating pressures.

****

2.10.1 CPVC Pipe

CPVC, ASTM D 1784, minimum cell classification [23447] [_____], pipe shall be [Schedule [40] [80] conforming to ASTM F 441/F 441M] [manufactured to an SDR rating in accordance with ASTM F 442/F 442M, so that the pressure rating of the pipe shall be consistent for all pipe sizes. The pipe shall be SDR [_____] with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [_____].

2.10.2 CPVC Joints

The piping system shall be joined by [socket-weld] [flanged] [or] [mechanical] connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded.

2.10.3 CPVC Fittings

****
NOTE: Specify ASTM F 437 for Schedule 80 threaded type; ASTM F 438 for Schedule 40 socket type; ASTM F 439 for Schedule 80 socket type.
****

The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM D 1784, cell classification [23447] [_____], CPVC conforming to the requirements of [ASTM F 437, threaded in accordance with ASME B1.20.2MASME B1.20.1] [ASTM F 438, socket type] [ASTM F 439, socket type]. [[No] [_____] thread lubricant is required.]

2.10.3.1 Push-on Joints

Push-on type joints shall be sealed with [ethylene propylene rubber (EPR)] [_____] gaskets in accordance with ASTM F 477.

2.10.3.2 Flanged Fittings

Flanges and flanged fittings shall be Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Flanges shall be complete with one-piece, molded CPVC stub ends]. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between outer diameter of the raised face and the flange outer diameter to protect the CPVC flange from the bolting moment.

2.10.4 Solvent Cement

Socket connections shall be joined with PVC solvent cement conforming to ASTM F 493. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

2.11 POLYVINYLIDENE FLUORIDE (PVDF)

****
NOTE: PVDF pipe is chemically resistant to most acids, bases and organics, and can transport liquid halogen solutions of chlorine or bromine. PVDF should not be used with strong alkalis, fuming acids, polar solvents, amines, ketones or esters. PVDF does not degrade in sunlight; therefore, PVDF does not require UV stabilizers or antioxidants. Use on liquids above 49 degrees C (120 degrees F) require continuous support. Care must be used in using PVDF piping under suction.
****

2.11.1 PVDF Pipe

[High Purity] PVDF, conforming to ASTM D 3222, pipe shall be [Schedule [40] [80]] [manufactured to a SDR rating so that the pressure rating of the pipe shall be consistent for all pipe sizes. The pipe shall be SDR with a pressure rating of [1.03 MPa 150 psig at 23 degrees C 73.4 degrees F] [1.6 MPa 232 psig at 23 degrees C 73.4 degrees F]] [_____].

2.11.2 PVDF Tubing

Tubing shall be flexible with nominal size and wall thickness [in accordance with Pipe Schedule] [_____].

2.11.3 PVDF Joints

****
NOTE: Fusion welding is the preferred method for joining PVDF pipe. Threading can only be accomplished on Schedule 80 pipe.
****

PVDF pipe shall be joined by [thermal butt-fusion] [socket heat fusion] [or] [socket electric-resistance fusion], except where connecting to valves and equipment that may require future disassembly, then joints shall be [threaded] [or] [flanged]. Tubing connections shall use compression fittings.

2.11.4 PVDF Fittings

PVDF fittings shall be molded. Fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. Flanges and flanged fittings shall be Class [125] [_____], [one piece, molded hub type, flat faced, and conforming to [ASME B16.1] [ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Flanges shall be complete with one-piece, molded PVDF stub ends]. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum [3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between outer diameter of the raised face and the flange outer diameter to protect the PVDF flange from bolting moment. Tubing fittings shall be compression type comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.12 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) Piping

****
NOTE: ABS piping is resistant to many chemicals, however, for mixed waste systems chemical analyses and corrosion testing may be necessary to properly

select the piping system. The recommended maximum temperature for continuous liquid applications is 82 degrees C (180 degrees F).

Verify acceptance and installation of ABS piping systems with local code enforcement authorities having jurisdiction.

****

2.12.1 ABS Pipe

ABS, ASTM D 3965, minimum cell classification [42222][_____], pipe shall be Schedule [40][80] conforming to ASTM D 1527, so that the pressure rating of the pipe shall be consistent for all pipe sizes. The pipe shall be SDR [_____] with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F. Where ABS 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.

2.12.2 ABS Joints

Pipe shall be joined by solvent cementing, except where connecting to valves and equipment that may require future disassembly, then [flanged] [_____] joints shall be provided.

2.12.3 ABS Fittings

ABS fittings shall be molded. Fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the specifications. Flanges and flanged fittings shall be Class [125][_____], [one piece, molded hub type, flat faced, and shall conform to [ASME B16.1][ASME B16.5]] [[ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1][ASME B16.5] drilling. Flanges shall be complete with one-piece, molded ABS stub ends]. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade [B8][B8M][_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21. When the mating flange has a raised face, a flat ring gasket shall be supplied and a filler gasket shall be provided between outer diameter of the raised face and the flange outer diameter to protect the ABS flange from bolting moment.

2.12.4 ABS Solvent Cement

Socket connections shall be joined with ABS solvent cement conforming to ASTM D 2235. Viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

2.13 POLYETHYLENE (PE)

****

NOTE: The requirements listed below are for normal pressure applications, and where operating temperatures will not exceed 38 degrees C (100

degrees F). For more difficult installations and/or higher temperatures, the ASTM D 3350 cell classification should be carefully chosen. In addition, use the cell classification to specify UV stabilizers and color additives.

****

2.13.1 PE Pipe

The pipe shall be extruded from PE, ASTM D 3350 with a minimum cell classification of [324433-C] [_____]. The PE pipe shall be [Schedule [40] [80] conforming to ASTM D 2447] [[manufactured to an SDR rating in accordance with ASTM D 3035 for piping systems less than 100 mm 4 inch in diameter, or in accordance with ASTM F 714 for piping systems with a diameter equal to or greater than 100 mm 4 inch] [manufactured to an SDR rating in accordance with ASTM D 2239 for use with insert fittings], so that the pressure rating of the pipe shall be consistent for all pipe sizes. The pipe shall be SDR [_____] with a pressure rating of [_____] MPa psig at [_____] degrees C degrees F] [Schedule 40 conforming to ASTM D 2104 for use with insert fittings] [_____].

2.13.2 PE Tubing

Tubing shall be flexible [low-density PE conforming to ASTM D 3350, minimum cell classification [_____], and dimensioned in accordance with ASTM D 2737] [crosslinked PE conforming to ASTM D 3350, minimum cell classification [35400] [_____], and dimensioned in accordance with ASTM F 876] with nominal size [in accordance with Pipe Schedule] [_____].

2.13.3 PE Joints

PE pipe shall be joined by [thermal butt-fusion] [socket heat fusion] [and/or] [socket electrofusion], except where connecting to valves and equipment that may require future disassembly, then joints shall be [threaded [polystyrene] [_____] fittings] [or] [flanged].

2.13.4 PE Fittings

PE fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. PE fittings shall be molded. Butt-fusion fittings shall conform to ASTM D 3261. Socket-fusion fittings shall conform to ASTM D 2683 with tools meeting the requirements of ASTM F 1056. Insert fittings shall conform to ASTM D 2609.

2.13.4.1 Couplings

Couplings and saddle joints shall be joined by electrofusion in accordance with ASTM F 1055.

2.13.4.2 Flanged Fittings

Flanges and flanged fittings shall be [Class [125] [_____]], [ASTM A240/A240M, TP304 stainless steel] [_____] backing flanges with [ASME B16.1] [ASME B16.5] drilling. Flanges shall be complete with one-piece, molded PE stub ends. Flanged connections shall have the same pressure rating as the pipe or greater. Bolting shall be stainless steel, ASTM A193/A193M, Grade [B8] [B8M] [_____] hex head bolts and ASTM A194/A194M, Grade [8] [8M] [_____] hex head nuts. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be full-faced, maximum

[3] [_____] mm [1/8] [_____] inch thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____] in accordance with ASME B16.21.

2.13.4.3 Tubing Fittings

Fittings shall be compression type comprised of [forged brass alloy C37700, conforming to ASTM B124/B124M [_____], nuts, ferrules and bodies] [[acetal] [polypropylene] [polyvinylidene fluoride (PVDF)] [_____] nuts and bodies, with elastomeric O-ring seals] [[polypropylene] [_____] bodies, barb and holding nut] [_____], rated to a minimum [_____] kPa psig with straight threads conforming to [ISO 228-1] [ASME B1.1].

2.14 RUBBER/ELASTOMER PIPING SYSTEM

****
NOTE: Rubber/elastomer piping systems are generally useful in applications requiring unusual flexing, resilience and abrasion service.
****

2.14.1 Elastomeric Hose

Elastomeric hose shall consist of an elastomeric tube, [reinforced] [not reinforced], and [with] [without] an external cover. The hose shall conform to RMA IP-2 Class [212-A] [_____], rated for [1.03 MPa 150 psig] [[_____] MPa psig] with a minimum burst pressure of [4] [_____] times the rated working pressure. The hose shall be a nominal diameter [of [_____] mm inch] [as indicated in the Pipe Schedule in the contract drawings] with tolerances conforming to RMA IP-2. The minimum bend radius shall be [6] [_____] times the hose internal diameter.

2.14.1.1 Elastomeric Tube

The hose tube shall be composed of [fluoro-elastomer] [isobutylene isoprene] [butadiene acrylonitrile] [chloroprene] [natural polyisoprene] [_____], [ASTM D 2000 Grade [_____], Type [_____], Class [_____] base requirements] [_____] materials.

2.14.1.2 Tube Reinforcement

[The tube shall be strengthened with [[one] [_____] wire-braid] [two spiral wire and one wire-braid] [two rayon-braid] [one textile-braid and one wire-braid] [synthetic-fiber] [[four] [six] -ply, [light] [heavy] spiral-wire] [_____] reinforcement.] [The tube shall not be reinforced.]

2.14.1.3 Hose Cover

[The hose shall be protected with a [synthetic rubber] [thin, nonskive] [textile-braid] [thermoplastic] [_____] cover.] [The hose shall not have a cover.]

2.14.2 Hose Joints

[Hose shall be continuous, without joints] [Hose shall be supplied cut to length with integral end connections] [Hose shall be joined using [swaged] [crimped] [insert] [internally expanded - full flow] [_____] fittings]. [_____].

2.14.3 Fittings For Elastomeric System

All fittings shall be supplied by the same manufacturer. Fittings shall join to the hose assembly as specified. Fittings shall be [supplied in accordance with the Pipe Schedule in the contract drawings and] shall be constructed of [aluminum] [TP304 stainless steel] [TP316 stainless steel] [_____]. Interconnections shall be accomplished through integral couplers configured as [ASME B1.20.7 threaded] [quick connect interlocking] [compression ring] [_____] couplings.

2.15 FIBERGLASS REINFORCED PLASTIC (FRP) PIPING SYSTEM

****
NOTE: Consult a reputable manufacturer to determine the FRP type for given application and temperature. Temperature is ambient if unlisted.
****

Submit the name and qualifications of the manufacturer's representative and written certification from the manufacturer stating that the representative is technically qualified to supply and install FRP piping systems. All FRP pipe, fittings, and flanges for each system shall be provided complete by one manufacturer and shall have a design internal pressure rating [in accordance with the Pipe Schedule in the contract drawings] [of 0.69 MPa 100 psig] [of [_____] MPa psig], as specified in ASTM D 2310 and ASTM D 2992.

2.15.1 FRP Pipe

The pipe shall be FRP pressure pipe conforming to ASTM D 3754 Type [1] [2] [3] [4], liner designation [_____], surface layer grade [_____], pressure Class [_____], pipe stiffness [_____]. Size shall be [in accordance with the Pipe Schedule in the contract drawings] [[_____] mm inches] [_____]. The inside diameter of the pipe shall be consistent with the inside diameter of the fittings.

2.15.2 FRP Joints

The pipe shall be joined using [axially unrestrained bell and spigot gasket joints, conforming to ASTM D 4161, with elastomeric gaskets meeting the requirements of ASTM F 477] [butt-joints with laminated overlays in accordance with ASTM D 3754] [bell and spigot joints with laminated overlays in accordance with ASTM D 3754] [adhesive bonded bell and spigot joints in accordance with ASTM D 3754] [flanged] [_____].

2.15.3 FRP Fittings

Fittings, other than flanges, shall conform to [ASTM D 5685] [_____]. Filament wound fittings shall be of the same thickness specified for adjoining pipe or duct. Other fitting types shall be of the minimum pipe wall thickness required for the specified pressure class. Contact molded flanges and flanged fittings shall conform to ASTM D 5421 Type [A] [B], Grade [_____], Class [I] [II], pressure rating [_____]. All other flange types shall conform to ASTM D 4024 Type [_____], Grade [_____], Class [_____], pressure rating [_____]. Flanges mating with flanges on thermoplastic-lined steel pipe shall be ductile iron castings, ASTM A395/A395M or cast steel, ASTM A216/A216M Grade WCB, Van Stone type, conforming to [ASME B16.1] [ASME B16.5] Class [150] [_____].

2.15.3.1 FRP Bolting

With flat ring gaskets, the bolting shall be stainless steel, ASTM A193/A193M Grade [B8] [B8M] [_____], hex head bolts and, ASTM A194/A194M Grade [8] [8M] [_____], hex head nuts. Bolts shall be provided with washers of the same material as the bolts.

2.15.3.2 FRP Gaskets

Gaskets shall be full-faced, maximum [3.2 mm 0.125 inch] [[_____] mm inch] thick, fabricated from [ethylene propylene rubber (EPR)] [chloroprene rubber] [polytetrafluoroethylene (PTFE)] [_____]. When the mating flange has a raised face, a flat ring gasket shall be used and a filler gasket shall be provided between the outer diameter of the raised face and the flange outer diameter in order to protect the FRP flange from the bolting moment. When mating a FRP flange, Van Stone type, to a thermoplastic-lined steel pipe, a [polytetrafluoroethylene (PTFE)] [_____] enveloped, flat ring type gasket shall be used in accordance with ASTM F 336.

2.16 DOUBLE CONTAINMENT PIPING SYSTEM

****
NOTE: Due to the difficulty of proper installation of double containment pipe, double containment piping should only be specified when it is absolutely required. Refer to the Handbook of Double Containment Piping Systems, Christopher G. Ziu, McGraw-Hill, NY, 1995, for the design and selection of a double containment piping system. According to Ziu, page 71, many pre-engineered double containment piping systems have only been conceptualized and not engineered.
****

Submit manufacturer's engineering end load calculations for anchors in double containment piping systems. Double containment piping systems shall conform to the requirements of ASME B31.3.

2.16.1 Primary (Carrier) Pipe

The primary, or carrier, pipe of the double containment piping system shall be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][TP304 stainless steel, Schedule [10] [40] [_____]][[FRP], pressure class [ ]] [_____], as specified elsewhere in this Section. The primary piping shall be rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. 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.

2.16.2 Secondary (Containment) Pipe

The secondary, or containment, pipe of the double containment piping system shall be [[PVC][CPVC][PVDF][PE][_____], [Schedule [40] [80] [_____]] [SDR [_____]]][carbon steel, Schedule [40] [80] [_____]] [TP304 stainless steel, Schedule [10] [40] [_____]] [_____], as specified elsewhere in this Section. The secondary piping shall be resistant to weathering, impacts,

and ambient temperature variations, and rated at a working pressure of at least [_____] MPa psig at a maximum operating temperature of [_____] degrees C degrees F. 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 [compartmentalized] [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 [19] [_____] mm [0.75] [_____] inch. Containment pull ports shall be located a maximum of [150] [_____] m [492] [_____] feet apart for straight runs and reduced by [45] [_____] m [148] [_____] feet for every 90 degree change in direction.

2.16.3 Cathodic Protection For Double Containment System

Buried ferrous piping shall have cathodic protection.

2.16.4 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.]

2.16.4.1 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 [five] [_____].

2.16.4.2 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.

2.16.5 Leak Detection

The leak detection system shall be a [cable detection] [sensing probe] [visual detection] system. [The leak detection system shall be equipped with an electronic monitoring and control unit.]

2.16.5.1 Leak Detection Monitoring Unit

The monitoring unit shall be microprocessor based. The monitoring unit shall indicate when any liquid leaks into the secondary containment piping by sounding an alarm, actuating output relays, displaying a message that a

leak has been detected and the location of that leak. The unit shall be capable of monitoring [sensor cables] [probe sensors] [and] [switch sensors]. The monitoring unit power requirements shall be [120] [240] [_____] VAC, [60] [_____] Hz, [single] [_____] phase. Monitoring units shall be equipped with [an RS-232 communication port] [and] [one common and one SPDT output relay per cable, rated for 250 VAC, 10 amp]. [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. [The unit shall be Underwriters Laboratory (UL) listed and Factory Mutual approved to provide connections for intrinsically safe sensor circuits for use in Class [1] [_____], Division [I] [_____], Groups [C and D] [_____] hazardous locations.] 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. [A NEMA 250 Type 4X outer enclosure shall be furnished with a viewing window for mounting outdoors] [A NEMA 250 Type 7 explosion proof outer enclosure shall be furnished] [_____].

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 [_____] 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 have multilevel security passwords for access to operating functions with recording of all password entries to nonvolatile memory.] The system shall not permit unauthorized modifications to the sensing string to be made without causing an alarm condition.

2.16.5.2 Cable System

Submit 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 meters feet along the length of the cable shall be provided as references to locate leaks. [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 [30 m 98.4 feet] [[_____] m feet] of wetted cable without significant inaccuracy in location. The system shall be capable of monitoring up to [600 m 1,970 feet] [[_____] m 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.] [Two cables shall be furnished to detect and differentiate between hydrocarbons/solvents and aqueous liquids.] [Only hydrocarbons are to be detected.] [Only acids are to be detected.] 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 mm to m 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.

2.16.5.3 Sensing Probes

Sensing probes for the leak detection system shall be [pH probes] [conductivity probes] [liquid level switches] [specific ion probes] [or] [pressure transducers].

2.16.5.4 Visual Leak Detection System

All low points of the secondary piping system shall be equipped with sample valves meeting the requirements specified in paragraph [SAMPLE PORTS] [_____] of this Section.

2.16.6 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.] [Support clips will not be allowed.]

2.17 ISOLATION JOINTS AND COUPLINGS

****
NOTE: Isolation joints and couplings require gaskets for isolating and/or sealing. The gaskets are typically shaped to meet each particular manufacturer's coupling requirements and may not be interchangeable. Refer to manufacturers' catalogs for material compatibility and selection.
****

2.17.1 Dielectric Fittings

Dielectric fittings shall be provided between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure, temperature and corrosive application.

2.17.2 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.17.3 Metallic Piping Couplings

Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by [1.5] [_____] times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For ductile iron pipe, thrust ties shall be attached with socket clamps against a grooved joint coupling or flange. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111/A21.11, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, [TP304] [_____] stainless steel bolts and nuts shall be provided. Steel middle rings and followers shall be [fusion bonded epoxy-lined and coated in accordance with Section 09 90 00 PAINTS AND COATINGS and] pressure tested beyond yield point.

2.17.3.1 Sleeve-Type Couplings

Sleeve-type couplings shall be used for joining plain end pipe sections in a flexible manner with a diameter to properly fit the pipe. A coupling shall consist of one [steel] [ductile iron] middle ring, two [steel] [ductile iron] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. For pipe sizes between 13 through 40 mm 0.5 through 1.5 inch, the

followers shall be [ductile iron] [malleable iron], and the middle ring shall be in accordance with [ASTM A513] [ASTM A395/A395M] with AWWA C111/A21.11 bolting, [light pattern coupling]. For pipe sizes 50 mm 2 inch and larger, the followers shall be [ASTM A395/A395M] [_____], and the middle ring shall be [ASTM A513] [ASTM A395/A395M] [_____] with AWWA C111/A21.11 bolting, [light pattern coupling]. Gaskets shall be [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____]. [Split sleeve-type couplings may be used in aboveground installations under special situations and when approved in advance by the Contracting Officer.]

2.17.3.2 Transition Couplings

Transitional couplings may be used to connect two pipes of the same material that have small differences in outside diameter. A fully assembled transitional coupling shall be sized to properly fit pipe diameters. The coupling shall consist of one [steel] [ductile iron] [_____] middle ring, two [steel] [ductile iron] [malleable iron] [_____] followers, two elastomeric [wedge] [_____] section gaskets and elliptic-neck, track-head steel bolts designed to properly compress the gaskets. The coupling shall use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. The coupling shall be sized to match the associated piping.

2.17.3.3 Flanged Coupling Adapters

Flanged coupling adapters shall be fully assembled units manufactured to meet [ASTM A126 Class [B] [_____], cast iron]. The flanges shall mate with [ASME B16.1] [ASME B16.5] [AWWA C207] Class [_____] flanges of the same nominal size. [A factory applied corrosion resistant coating shall be applied.] The coupling shall use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. Where pipe movement out of the adaptor may occur, proper anchorage of the pipe shall be provided [and couplings shall be furnished with lock pins]. The coupling shall be sized to match the associated piping.

2.17.4 Couplings for Nonmetallic Piping

2.17.4.1 Bellows Coupling

A bellows coupling shall have a minimum of two [polytetrafluoroethylene (PTFE)] [_____] convolutions unless otherwise shown, with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____]], [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure shall be [960 kPa 140 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. Bolting shall be limited to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. The coupling shall be sized to match the associated piping.

2.17.4.2 Compression Coupling

A compression coupling shall consist of one [steel] [_____] middle section, two [steel] [_____] mechanical nuts, two elastomeric gaskets and two

machined steel lock rings. The coupling shall use [natural rubber] [butadiene acrylonitrile] [isobutylene isoprene] [ethylene propylene diene monomer (EPDM)] [ethylene propylene terpolymer (EPT)] [fluoro-elastomeric] [_____], [wedge] [insulated] gaskets. The maximum allowable working pressure shall be [1.03 MPa 150 psig] [_____] at [49] [_____] degrees C [120] [_____] degrees F. The coupling shall be sized to match the associated piping.

2.18 VALVE BOXES[, SERVICE BOXES][, VALVE MANHOLES][AND VALVE PITS]

****
NOTE: Construction of valve manholes is to be avoided where feasible because of problems with dewatering/drainage and frostproofing. Use manually operated gate and butterfly valves suitable for direct burial and fitted with valve boxes in lieu of valves in manholes whenever possible. Review project-specific valve box requirements. Select and modify as required or refer to Section 33 60 01 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.
****

The box length shall adapt [to the length required for the depth of the line] [to the depth of cover required over the pipe at the valve location] without full extension. Boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subjected to vehicular traffic. The boxes shall have housings of sufficient size to completely cover the valve or service stop and shall be complete with covers.

2.18.1 Valve Boxes

Cast-iron valve boxes shall have minimum metal thickness of 5 mm 3/16 inch and boxes shall be extension type with slide-type adjustment and with flared base. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment.

2.18.2 Service Boxes

Service boxes shall be extension service boxes with either screw or slide-type adjustment.

2.18.3 Valve [Manholes] [or Pits]

Valve [manholes] [or pits] for automatic valves and meters installed below grade shall be constructed in accordance with Section 33 60 01 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES.

2.19 VALVES

****
NOTE: This paragraph will be coordinated with Section 33 60 01 VALVES, PIPING, AND EQUIPMENT IN VALVE MANHOLES. Material selection based on piping materials and liquid characteristics is also provided. For critical or hazardous applications, insert specific material requirements, grades and alloys, and standards rather than a general material name.

Valves are grouped together by type. If a valve is required for your application that is not listed, insert the valve specification and notify the Contracting Officer. Check manufacturer's catalogs to make sure valves selected are current. Operator options vary by both manufacturer and valve size.

****

2.19.1 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. [Valves shall be the same size as adjoining pipe]. 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.

2.19.2 Valve Schedule

****

NOTE: Verify that the schedules are included in the contract drawings. Delete this subparagraph if the valve schedule is not used.

****

Submit 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. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly. Requirements relative to this paragraph are shown on the [Valve Schedule] [and Operator Schedule] located [in the contract drawings] [_____].

2.19.3 Factory Finishing

[Valves shall have an epoxy [lining and] coating in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy [lining and] coating shall have a minimum [0.180 mm 7.0 mils] [[_____] mm mils] dry film thickness except where it is limited by valve operating tolerances.] Exposed valves shall be finished in accordance with Section 09 90 00 PAINTS AND COATINGS. [Safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be painted "safety yellow."]

2.19.4 Check Valves

****

NOTE: "Check valves" are generally service oriented. Specific types of check valves should be specified for the specific applications; for example, the ball check valve is capable of passing

solids. Rated operating pressures vary based on body and seat materials, size and other parameters such as wafer class. Consult manufacturer's information to select the appropriate rating for the application.

Piping plane and valve orientation may affect check valve performance. Certain types of check valves will only operate under specific conditions; for example, lift check valves can only operate in horizontal lines, and swing check valves can operate in either horizontal or vertical (flow up) positions.

****

2.19.4.1 Swing Check Valves

****
NOTE: The requirements on subpart c. below are based on general water service and AWWA ratings.
****

Swing check valves shall conform to the following:

a. Swing check valves, 50 mm 2 inches and smaller, shall have a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Valves shall have a swing type, replaceable [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [_____] disc. Valves shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

b. Swing check valves, 65 mm 2.5 inches through 300 mm 12 inch, shall have a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [_____] ends. Valves shall have a bronze-mounted swing type, [bronze] [ductile iron] [cast iron] [_____] disc, [solid bronze] [ductile iron] [_____] hinges, and stainless steel hinge shaft [with outside lever and [weight] [spring]]. Valves shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service.

c. Swing check valves, 50 mm 2 inch through 900 mm 36 inch, shall conform to AWWA C508, and have [ASME B16.1 Class [_____] flanged], [welding], [mechanical joint] [grooved] [_____] end connections. Valves shall have a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [_____] -mounted disc, solid [bronze] [ductile iron] [_____] hinges, and a stainless steel hinge shaft. Valves 50 mm 2 inch through 300 mm 12 inch shall be rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and valves 350 through 900 mm 14 through 36 inch shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves shall be fitted with an [adjustable outside lever and spring] [adjustable outside lever and weight]. An increasing-pattern body valve may be used where increased outlet piping size is shown.

2.19.4.2 Thermoplastic Check Valve

Thermoplastic check valves, 8 mm 0.25 inch through 400 mm 16 inch, shall be

a [Y-check] [ball-check] design, manufactured of [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] with [flanged] [socket] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] end connections. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service. Valves shall have [fluoro-elastomeric O-ring] [_____] seals and seats. [Discs shall be fitted with a polyvinyl chloride (PVC) coil guide.] [Caps shall be of hex design.]

2.19.4.3 Double Disc Swing Check Valve

Double disc swing check valves, 50 mm 2 inch through 1300 mm 52 inch, shall be wafer style, spring loaded swing check valve, with a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, a [aluminum-bronze] [ductile iron] [stainless steel] [bronze] [carbon steel] [_____] disc, resilient seats, stainless steel hinge pin, and a stainless steel stop pin spring. Valves 50 mm 2 inch through 300 mm 12 inch shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F and valves 350 mm 14 inch through 1300 mm 52 inch shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.19.4.4 Slanting Disc Check Valve

Slanting disc check valves, 50 mm 2 inch through 1500 mm 60 inch, shall be of a slanting or tilting disc design, with off-center pivot. Valve bodies shall be [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____], and of a [two-piece] [wafer-style] design. Seats shall be [bronze] [stainless steel] [_____] set on a [55] [_____] -degree angle. Discs shall be [bronze] [ductile iron] [cast iron] [stainless steel] with pivot pin and bushing constructed of [TP304 stainless steel] [aluminum bronze] [_____], [butadiene acrylonitrile] [_____] disc seal, [TP316 stainless steel] [Monel] [_____] spring, [bottom mounted buffer cylinder for cushion closing] [and] [valve disc position indicator]. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service [and have [ASME B16.5] [ASME B16.1] Class [_____] flanged end connections].

2.19.4.5 Silent Check Valve

Silent check valves shall conform to the following:

a. Silent check valves, 50 through 250 mm 2 through 10 inch, shall be wafer style, center guided valve with a [cast iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] springs. Valves shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

b. Silent check valves, 65 through 1050 mm 2.5 through 42 inch, shall be globe style, center guided valve with [ASME B16.1] [ASME B16.5] Class [125] [250] [_____] flanged end connections, a [cast iron] [ductile iron] [cast steel] [bronze] [TP316 stainless steel] [_____] body, [bronze] [stainless steel] [_____] trim, [butadiene acrylonitrile] [_____] seat, and [bronze] [stainless steel] [_____] spring. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service.

2.19.4.6 Ball Check Valve

Ball check valves, 25 mm 1 inch and larger, shall be in accordance with [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] ends, and [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [polyvinyl chloride (PVC)] [_____] bodies with a cleanout and [floating] [sinking] type [hollow steel] [phenolic] [butadiene acrylonitrile covered metal] ball. [Flanges shall be ASME B16.1 Class [125] [_____].] Valves shall be rated for [690 kPa 100 psig] [[_____] MPa psig] service and shall be suitable for vertical or horizontal flow.

2.19.5 Ball Valves

****

NOTE: Top or bottom entry bronze ball valves are not readily available. An end entry valve requires additional unions or ability to spring pipe clear in order to service valve. Flanged and wafer style valves can be readily removed.

****

2.19.5.1 General Purpose Ball Valves

General purpose ball valves shall conform to the following:

a. Ball valves, 50 mm 2 inch and smaller, shall be end entry type with [bronze] [brass] [_____] bodies and [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [soldered] [_____], [full bore] [regular] ports. Valves shall have [polytetrafluoroethylene (PTFE)] [_____] seats and packing, [chrome plated] [brass] [stainless steel] [_____] balls and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Valves shall be rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and shall conform to ASME B16.34 Class [_____]. [A union shall be installed adjacent to the valves to provide access to the seat.]

b. Ball valves, 65 mm 2.5 inch and larger, shall be end entry type with [bronze] [cast iron] [_____] bodies and [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] ends. Valves shall have [polytetrafluoroethylene (PTFE)] [_____] packing and seats, a [chrome plated] [brass] [stainless steel] [_____] ball, [regular] [full bore] ports, and [hand lever] [tee-handle] [hand wheel] [pneumatically actuated] [electrically actuated] [_____] operators. Valves shall be rated for [2.76 MPa 400 psig] [[_____] MPa psig] service at 66 degrees C 150 degrees F and shall conform to ASME B16.34 Class [_____].

c. Ball valves, 50 to 300 mm 2 to 12 inch, shall conform to ASME B16.34 Class [_____], and have a [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] body, stainless steel ball and stem, polytetrafluoroethylene (PTFE) packing and gasket, and [flanged] [welding] [_____] ends, full port. Valves shall be rated for [1.38 MPa 200 psig] [[_____] MPa psig] service, and have [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.5.2 Multiple Piece Body Ball Valves

Multiple piece body ball valves, 40 to 150 mm 1.5 to 6 inch, shall have

[three] [_____] piece bodies constructed of [stainless steel ASTM A276 Grade [TP316] [_____]] [cast steel ASTM A351/A351M Grade [CF8M] [_____]] [ASTM A216/A216M] [_____] stainless steel. Valves shall have a [TP316] [_____] stainless steel ball, and [ASME B16.11 threaded] [ASME B16.5 flanged] [_____] end connections. Valves shall be rated for [6.89 MPa 1000 psig] [_____] service and shall conform to ASME B16.34 Class [_____]. Valves shall have [reinforced polytetrafluoroethylene (PTFE)] [_____] seats and stem packing, shall be [full] [standard] bore, and shall be equipped with [handwheel] [hand lever] [tee-handle] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.5.3 Thermoplastic Ball Valve

Thermoplastic ball valves, 150 mm 6 inch and smaller, shall be rated for [1.03 MPa 150 psig] [1.55 MPa 225 psig] [[_____] MPa psig] service at 49 degrees C 120 degrees F, and have ASTM D 1784, minimum cell classification [_____], [polyvinyl chloride (PVC)] [chlorinated polyvinyl chloride (CPVC)] [ASTM D 3222 polyvinylidene fluoride (PVDF)] [_____] bodies, balls, and stems. Valves shall be end entry, double union design, with [solvent-weld socket] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [flanged] [butt] [_____] ends connections, a [ethylene propylene diene monomer (EPDM)] [fluoro-elastomer] [_____] seat, and [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] O-ring stem seals. Valves shall have [hand lever] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.6 Gate Valves

2.19.6.1 General Service Gate Valves

****
NOTE: The requirements on subpart b. below are based on general water service and AWWA ratings.
****

General service gate valves shall conform to the following:

a. Gate valves, 50 mm 2 inch and smaller, shall have [bronze] [_____] bodies and stems, [screwed] [union] [bolted] [yoke] bronze [_____] bonnets, single [solid] [split] wedge bronze discs, and [rising] [non-rising] stems. Valves shall be rated for [1.2 MPa 175 psig] [[_____] MPa psig] service and conform to ASME B16.34 Class [_____]. End connections shall be [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [_____]. Valves shall be equipped with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

b. Gate valves, 65 mm 2.5 inch and larger, shall have [Ni-resistant] [3 percent nickel-iron] [cast-iron] [_____] bodies with [iron] [bronze] [Ni-resistant stainless steel] [_____] trim. Valves shall meet the requirements of [AWWA C500] [AWWA C509] and have Class [125] [250] [_____] [flanged] [welding] [threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [mechanical joint] [push-on] [_____] end connections. Bonnet shall be a [clamp] [OS&Y Bolted] [NRS Bolted] type. Discs shall be [wedge] [double] type of [iron] [bronze] [ductile iron] [bronze faced iron] [rubber coated ductile iron] [_____] construction, and have [nonrising] [rising] stems [with backseats]. Each gate valve, 400 mm 16 inch and larger, shall include a by-pass of the same materials as the gate valve. The bypass shall meet the requirements of AWWA C500.

Valves shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Valves shall be equipped with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.6.2 Thermoplastic Gate Valve

Thermoplastic gate valves, 13 mm1/2 inch and larger, shall have [ASTM D 1784 polyvinyl chloride (PVC), minimum cell classification [_____],] [ASTM D 1784 chlorinated polyvinyl chloride (CPVC), minimum cell classification [_____],] [_____] bodies, [bolted] [_____] bonnets, single [styrene butadiene rubber] [polypropylene] [_____] wedge discs, [non-rising] [rising] stems, and [flanged] [threaded, in accordance with ASME B1.20.2MASME B1.20.1,] [_____] end connections. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves shall be equipped with [handwheel] [_____] [pneumatically actuated] [electrically actuated] operators.

2.19.7 Globe Valves

2.19.7.1 General Requirements For Globe Valves

Globe valves, 80 mm 3 inch and smaller, shall be [angle pattern] [globe style] valve and shall have [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, with [bronze] [brass] [stainless steel] [_____] trim, and [bronze] [brass] [_____] bonnets. Valves shall conform to ASME B16.34 Class [_____], and shall have [ASME B16.11 socket-welding] [ASME B16.11 threaded] [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.18 solder joint] [_____] end connections. Valves shall include [union] [threaded] [OS&Y] bonnets, inside screws, rising stems, [plug] [needle] [conventional] discs constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], and [bronze] [brass] [stainless steel] [_____] rings. Valves shall be rated for [1.4 MPa 200 psig] [[_____] MPa psig] service. Valves shall be equipped with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.7.2 Needle Valve

Needle valves, 25 mm 1 inch and smaller, shall be of a [straight] [angle] [cross] pattern and shall have [brass] [TP316 stainless steel] [_____] bodies and trim. Valves shall [conform to ASME B16.34 Class [_____] with ASME B16.11 [male] [female] threaded, in accordance with ASME B1.20.2M ASME B1.20.1,] [have tubing compression fittings, that match associated tubing fittings,] [_____] end connections. Valves shall include [threaded] [integral] [union] [_____] bonnets, [TP316 stainless steel] [_____] stems, [plug] [soft tip] [non-rotating ball] [_____] stem tips constructed of [polytetrafluoroethylene (PTFE)] [butadiene acrylonitrile] [bronze] [stainless steel] [_____], [fluoro-elastomer] [polytetrafluoroethylene (PTFE)] [ethylene propylene diene monomer (EPDM)] [_____] packing [and O-ring stem seals]. Valves shall be rated for [2.07 MPa 300 psig] [[_____] MPa psig] service. Valves shall be equipped with [toggle-handle] [handwheel] [tee-handle] [pneumatically actuated] [_____] operators.

2.19.7.3 Hose Valve

Hose valves, 20 through 80 mm 0.75 through 3 inch, shall be [globe style] [angle pattern] hose valves with [cast iron] [ductile iron] [carbon steel] [bronze] [TP316 stainless steel] [_____] bodies, [bronze] [stainless steel] [_____] trim, inside screws, rising stems, and [polytetrafluoroethylene

(PTFE)] [rubber] [_____] disc. The outlet ports shall be [cast brass] [_____] in accordance with [ASME B1.20.2MASME B1.20.1 pipe threads, male by male, nipple adapter with hexagonal wrench feature [and brass cap with chain]] [_____]. Valves shall be rated for [860 kPa 125 psig] [[_____] MPa psig] service.

2.19.8 Plug Valves

2.19.8.1 Eccentric Valve

Nonlubricated type eccentric valves, 80 mm 3 inch and smaller, shall be rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [acid resistant bronze] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies, in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [AWWA C606 grooved] [_____] end connections, [all metal, matching body] [rubber lined] [_____] plugs with [round] [rectangular] ports, [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [Monel] [nickel] [_____] stem bearings, and [butadiene acrylonitrile] [polytetrafluoroethylene (PTFE)] [filled polytetrafluoroethylene (PTFE)] [fluoro-elastomer filled polytetrafluoroethylene (PTFE)] [_____] [U-cup] [_____] seals. [Valves shall conform to ASME B16.34 Class [_____].] Valves shall be equipped with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.8.2 Lined Eccentric Valve

Nonlubricated type eccentric valves, 80 through 1350 mm 3 through 54 inch, shall be rated for [1.2 MPa 175 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F. Valves shall have drip-tight shutoff with pressure from either direction, and [cast iron] [bronze] [Ni-resistant] [aluminum] [carbon steel] [stainless steel] [nickel] [_____] bodies in accordance with [ASME B16.5 flanged] [ASME B16.1 flanged] [ASME B16.11 threaded] [AWWA C606 grooved] [AWWA C111/A21.11 mechanical joint] [_____] end connections. Plugs shall be cast iron with [round] [or] [rectangular] ports of no less than [80] [_____] percent of the connecting pipe area [and coated with] [butadiene acrylonitrile] [chloroprene] [fluoro-elastomer] [hard natural rubber] [_____]. Valves shall have [stainless steel] [nickel] [_____] seats, self-lubricating [stainless steel] [reinforced polytetrafluoroethylene (PTFE)] [_____] stem bearings, and [multiple [V-rings] [U-cups] [O-rings] stem seals] [[nitrile rubber] grit seals on the stems]. [Valves shall be equipped with [handwheel] [pneumatically actuated] [electrically actuated] [_____] operators.] [Valves 150 mm 6 inch and smaller shall have a wrench lever manual operator and valves 200 mm 8 inch and larger shall have a totally enclosed, geared, manual operator with handwheel, 2-inch nut, or chain wheel.] [Valves shall conform to ASME B16.34 Class [_____].]

2.19.9 Butterfly Valves

****
NOTE: Refer to AWWA C504 and manufacturers' data for valve selection and torque calculation data. Only valves with high velocities, heavy grit loads, or severe throttling service should be specified with a seat in the body.
****

2.19.9.1 Standard Service Butterfly Valve

Butterfly valves, 50 mm 2 inch and larger, shall have [ASTM A126 cast iron] [ductile iron] [carbon steel] [stainless steel] [_____] bodies, [[wafer] [lugged] styled] [with [ASME B16.5 flanged] [ASME B16.1 flanged] [AWWA C111/A21.11 mechanical joint] [_____] end connections]. Valves shall conform to [AWWA C504 Class [125] [150] [_____]] [ASME B16.34 Class [_____]]. Discs shall be contoured [ASTM A436 Type 1 Ni-resist cast iron with maximum lead content of 0.003 percent] [ASTM A536 Grade 65-45-12 ductile iron] [stainless steel] [polyvinylidene fluoride (PVDF) coated ductile iron] [bronze] [_____]. The valve shafts shall be [carbon steel] [stainless steel] [_____] with self-lubricating, corrosion-resistant sleeve type bearings. Valve seats for [600 mm 24 inch] [_____] and smaller valves shall be attached to either the valve body or the disc and shall be constructed of [chloroprene] [_____]. Valve seats for valves larger than [750 mm 30 inch] [[_____] mm inch] shall be field replaceable in accordance with AWWA C504. Valves shall have [manual, locking hand lever] [hand wheel] [crank] [chain wheel] [pneumatically actuated] [electrically actuated] [_____] operators.

2.19.9.2 Thermoplastic Butterfly Valves

Thermoplastic butterfly valves, 40 mm 1.5 inch and larger, shall have [wafer] [lugged] style bodies constructed of [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF) coated ductile iron] [_____]. Valves shall have [polyvinyl chloride (PVC)] [polyvinylidene fluoride (PVDF)] [polypropylene (PP)] [polytetrafluoroethylene (PTFE)] [_____] discs, [ethylene propylene diene monomer (EPDM)] [fluoro-elastomeric] [butadiene acrylonitrile] [natural rubber] [ethylene propylene diene monomer (EPDM) backed] [_____] seats, [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [same material as seats] [_____] seals, and [lever] [gear] [_____] [pneumatically actuated] [electrically actuated] operators. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.19.10 Pinch Valves

****

NOTE: Pinch valves are commercially available in sizes ranging from 50 mm (2 inch) to 1500 mm (60 inch). Consider using an enclosed bevel gear operator for valves 150 mm (6 inch) and larger and above 500 kPa (72.6 psig). The pinch valve included is illustrative, consult manufacturers' catalogs for other styles, pressure ratings, and operators.

****

Pinch valves shall have [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, in accordance with [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] flanged end connections, [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene monomer (EPDM)] [_____] seats, [full port] [double wall] [reduced port] [cone] [variable orifice] sleeves, and [manual] [pneumatically actuated] [electrically actuated] [upper] [and] [lower] pinch bars.

2.19.11 Diaphragm Valves

****
NOTE: Diaphragm valves are commercially available in sizes ranging from 15 mm (0.5 inch) to 250 mm (10 inch) depending upon the materials of construction. Contact manufacturers to confirm availability based upon size and material.
****

2.19.11.1 Standard Service Diaphragm Valve

Diaphragm valves, 13 mm 1/2 inch and larger, shall have [aluminum] [stainless steel] [carbon steel] [ductile iron] [cast iron] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [_____] end connections and [natural rubber] [chloroprene] [chlorobutyl] [butadiene acrylonitrile] [fluoro-elastomeric] [ethylene propylene diene monomer (EPDM)] [_____] seals, and are [manually] [pneumatically] [_____] actuated. Position indicators shall be provided to indicate diaphragm position. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 60 degrees C 140 degrees F.

2.19.11.2 Thermoplastic Diaphragm Valve

Thermoplastic diaphragm valves, 13 mm 1/2 inch and larger, shall have [polyvinyl chloride (PVC)] [polypropylene (PP)] [polyvinylidene fluoride (PVDF)] [_____] bodies, [ASME B16.1] [ASME B16.5 Class [125] [150] [_____]] [flanged] [union socket] [butt-fusion] [_____] end connections and [ethylene propylene diene monomer (EPDM)] [polytetrafluoroethylene (PTFE)] [_____] seals, and shall be [manually] [pneumatically] [_____] actuated. [Pneumatically operated valves shall be [fail-closed] [fail-open] [double acting].] Position indicators shall be provided to indicate diaphragm position. Valves shall be rated for [1.03 MPa 150 psig] [[_____] MPa psig] service at 20 degrees C 68 degrees F.

2.19.12 Self-Contained Automatic Valves

2.19.12.1 Pressure-Reducing Valve

****
NOTE: Verify that the valve schedule is included in the contract drawings.
****

Pressure-reducing valves, 13 mm 1/2 inch and larger, shall be [direct] [hydraulically] operated, diaphragm actuated, [pilot] [spring] controlled [angle] [globe] valves with [cast iron] [ductile iron] [steel] [aluminum] [stainless steel] [bronze] [_____] bodies. End connections shall be [ASME B16.1] [ASME B16.5 Class [150] [_____] flanged] [ASME B16.11 [threaded] [socket-welded]]. Trim and stem shall be [stainless steel] [_____]. Valves shall be normally [open] [closed] to maintain a constant downstream pressure regardless of fluctuations in flow or upstream pressure [, and prevents backflow,] [and have externally mounted strainers with cocks]. Valves sizes and ratings shall be as [shown in the Valve Schedule on the contract drawings.] [as follows.] PCV [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig.

2.19.12.2 Pump Control Valve

Pump control valve shall be [hydraulically operated, diaphragm actuated, pilot controlled globe valve with [cast iron] [ductile iron] [cast steel] [_____] bodies, [ASME B16.1] [ASME B16.5] Class [_____] flanged end connections, [bronze] [stainless steel] [_____] trim, stainless steel stems, and externally mounted strainers with cocks] [_____]. Valves shall be designed to eliminate pipeline surge caused by pump startup and shutdown, and shall include automatic check features.

2.19.13 Operators

2.19.13.1 Operator Schedule

****
NOTE: Verify that the operator schedule is included in the contract drawings. Delete this subparagraph if an operator schedule is not used.
****

Requirements relative to this paragraph are shown on the Operator Schedule located [in the contract drawings] [_____].

2.19.13.2 Manual Operator

The force in a manual operator shall not exceed [175 N 39.3 pound] [[_____] N pound] under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds [175 N 39.3 pound] [[_____] N pound]. The manual operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threader steel reach rods with an internally threaded bronze or ductile iron nut.

a. Exposed Operators. Exposed operators shall have galvanized and painted handwheels. Lever operators are allowed on quarter-turn valves [200 mm 8 inch] [[_____] mm inch] and smaller. Cranks shall be supplied on gear type operators. If located off of the operator floor, chain wheel operator with tiebacks, extension stem, floor stands, and other accessories shall be provided to permit operation from normal operation level. Valve handles shall be capable of padlocking, and wheels shall be lockable with a chain and padlock.

b. Underground Operators. Buried service operators on valves larger than [65 mm 2.5 inch] [[_____] mm inch] shall have a [50 mm 2 inch] [[_____] mm inch] operating nut. Buried operators on valves [50 mm 2 inch] [[_____] mm inch] and smaller shall have a cross handle for operation by a forked key. The moving parts of valve and operator shall be enclosed in housing to prevent contact with the soil. Buried service operators for quarter-turn valves shall be designed to withstand an input torque of [^610 N-m (450 foot-pound) 450 foot-pound] [[_____] N-m foot-pound] of input torque at the fully open or fully closed positions, and shall be grease packed and gasketed to withstand a submersion in water to [70 kPa 10.2 psig] [[_____] MPa psig]. Buried valves shall have extension stems, bonnets, and valve boxes.

2.19.13.3 Pneumatic Operator

****

NOTE: Associated transducers shall pneumatically provide the same pressure range as used by the actuator. Piston actuators shall not be used at less than 275 kPa (40 psig) supply pressure. Include a safety vented isolation valve in the operator paragraph for use on air sets.

****

Pneumatic operators shall be provided complete with actuators, air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories. The pneumatic operators shall be suitable for full operation range of valve at air supply pressure indicated. Actuators shall return the valve to the closed position upon loss of signal unless otherwise indicated. [Springs shall return valve to this failed position.] Pneumatic operators shall be furnished with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Limit switches shall be provided on all actuators.]

a. Cylinder Actuators. Cylinder actuators shall conform to ANSI/AWWA C541 and ANSI/AWWA C542, and operate with an air supply pressure of [550 kPa 80 psig] [[_____] MPa psig]. The nonswivel type shall be totally enclosed with travel stops and position indicator, and shall be factory lubricated and sealed, requiring no additional lubrication. The double acting type shall be nonmetallic for operation on nonlubricated air and shall have a [manual] [handwheel] override independent of the cylinder. The manual override shall be located [_____].

b. Diaphragm Actuators. Diaphragm actuators shall have a spring return with a [steel or aluminum] [_____] diaphragm case and spring barrel, steel spring and actuator stem, and [fabric-reinforced chloroprene] [_____] diaphragm. The actuators used on quarter-turn valves shall include a totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator with manual override if indicated. The actuating mechanism shall be factory lubricated and sealed. Diaphragm actuators shall be sized and configured for the service indicated and an air supply pressure of [240 kPa 35 psig] [[_____] MPa psig].

c. Air Sets. The air set shall include a pressure regulator with internal relief, filter, outlet pressure gauge, and adjustable reduced pressure range as required by the valve actuator. The air set shall have an aluminum body and handwheel, safety vented lockout isolation valve, and gauge range [1.33 to 2] [_____] times maximum operating pressure.

d. Limit Switches. Limit switches shall be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

e. Positioners. The positioners for modulating actuators shall be pneumatic force balance instruments to control valve positions as a function of the input signals. The positioners shall accomplish positive positioning of valve by a mechanical feedback connection from the valve actuating mechanism. Position feedback shall be provided through a characterized linear cam to allow adjustment of valve positioning and input signal. The positioner shall be suitable for

either a double acting or spring return actuator. The positioner shall have zero and span adjustment and be field reversible for direct or reverse action. Gauges shall be included for supply and output pressure and for input signal pressure. Modulating valve positioners shall operate on a [21 to 103 kPa 3 to 15 psig pneumatic] [or] [[4 to 20 mA] [1 to 5 v dc] electric] input signal unless otherwise indicated. [A positioner for dc input signal with transducers shall convert the electrical signal to the appropriate pneumatic signal. The transducer shall be [integral with the positioner] [or] [a separate component]. If separate, the transducer shall be factory mounted on the pneumatic operator. Line electric power not shall not be required for transducer operation.] Corrosion-resistant enclosures for positioners and transducers shall be splash- and moisture-proof with gasketed covers.

f. Solenoid Valve. A solenoid valve shall pilot the control actuator in the appropriate configuration for the type of actuator being controlled. A pilot operated diaphragm type solenoid valve shall have a [brass] [_____] body and resilient seat and operate with minimum operating pressure differential no greater than [70 kPa 10.2 psi] [[_____] kPa psi] and maximum operating pressure differential no less than [1.03 MPa 150 psi] [[_____] MPa psi]. Internal parts shall be corrosion-resistant. The solenoid valve shall have Class F molded coils for operation on 120 volts, 60-Hz, ac, unless otherwise indicated. The solenoid enclosure shall conform to NEMA 250 Type [4] [_____]. Solenoids on double acting cylinders for open-close and throttling valves shall be four-way with dual coils. Solenoids on spring return cylinders for open-close and throttling valves shall be three-way, spring return. An air exhaust muffler shall be furnished in the exhaust port of all actuator pilot solenoid valves.

2.19.13.4 Electric Operator

Electric operators shall be provided complete with actuators, speed controls and accessories. The actuators shall operate on [120 VAC, 60 Hz] [_____] with a [75] [_____] percent duty cycle and shall be equipped with an AC thermal overload protector with automatic rest, reversing (bi-directional) operation for use with quarter-turn valves, or rotating equipment to full rotation. Gearing shall be a two-stage planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff. The start-up torque shall be [163 N-m 120 foot-pound] [[_____] N-m foot-pound]. The stall torque shall be [203 N-m 150 foot-pound] [[_____] N-m foot-pound]. [Two] [_____] travel stop limit switches with cams, internal, independent, adjustable, and actuated by cams shall be mounted on the drive shaft. A side mounted hand turn wheel shall be provided for a manual override. The actuators shall have a NEMA 250 Type [4] [_____] enclosure with a corrosion resistant, baked epoxy finish as standard. The actuator shall operate in a temperature range of -40 to plus 65 degrees C -40 to plus 150 degrees F. Actuators shall fail in last position unless otherwise indicated. Electric operators shall be furnished with features noted on the [Operator Schedule] [Valve Schedule] in the contract drawings. [Limit switches shall be provided on all actuators.]

a. Limit Switches. Limit switches shall be single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac, housed in a NEMA 250 Type [4] [_____] enclosure, and adjustable for open and closed valve positions.

b. Positioners. The positioners for modulating actuators shall control valve positions as a function of the input signals. The positioner shall operate on [120 VAC, 60 Hz.] [_____] voltage. The mode of operation shall be [direct acting] [reverse acting]. Modulating valve positioners shall operate on a [4 to 20 mA] [1 to 5 v DC] [_____] input signal unless otherwise indicated. Corrosion-resistant enclosures for positioners shall be splash-and moisture-proof with gasketed covers.

2.19.14 Valve Accessories

2.19.14.1 Extension Bonnet for Valve Operator

All extension bonnets shall be provided as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.19.14.2 Floor Stand and Extension Stem

A floor stand and extension stem shall be the nonrising, indicating type; complete with stem, coupling, handwheel, stem guide brackets, and yoke attachment. The stem guide shall be spaced such that stem L/R ratio does not exceed [200] [_____]. Anchors shall be supplied as required.

2.19.14.3 Floor Box and Stem

A floor box and stem shall be the plain type, for support of nonrising type stem; complete with stem, operating nut, and stem guide brackets. The stem guide shall be spaced such that stem L/R ratio does not exceed [200] [_____]. Anchors shall be supplied as required.

2.19.14.4 Chain Wheel and Guide

A chain wheel and guide shall be the handwheel direct-mount type, complete with galvanized or cadmium-plated chain.

2.20 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.

2.20.1 Locations

[Drains shall be located as indicated on the contract drawings] [All pipeline low points shall be drained] [_____].

2.20.2 Sizes

For pipelines 65 mm 2.5 inch and larger, drains shall be [20 mm 0.75 inch] [[_____] mm inch] and equipped with [gate valves] [globe valves] [ball valves] [_____]. For pipelines [50 mm 2 inch] [[_____] mm inch] and smaller, drains shall be [13 mm 1/2 inch] [[_____] mm inch] and equipped with [gate valves] [globe valves] [ball valves] [_____].

2.21 SAMPLE PORTS

****

NOTE: Sample port materials of construction

typically match the piping system. Coordination with Section 01 35 45.00 10 for sampling and analytic methods and requirements is necessary.

For highly critical situations where the materials being sampled are very hazardous or where valves may tend to clog or leak, the first sampling valve option is used to specify a sampling valve. Otherwise, the second option is used to specify the sampling configuration.

****

[Sample ports, shown on the flow diagrams and piping and instrument diagrams of the contract drawings, may not be shown on the detailed drawings of the individual pipelines; their absence shall not relieve the Contractor of the responsibility for providing them.] [Sample ports shall be provided as indicated in the piping and instrument diagrams to complete the piping systems for the use intended.] The sample ports shall be located in easily accessible locations, and shall avoid potential stagnant points and/or areas where material could collect. [A plug-type sampling valve with a stainless steel piston that extends beyond the inner surface of the pipe when closed shall be provided at [all the sampling ports] [the sampling ports indicated]. The piston shall be sealed by two compressible replaceable [polytetrafluoroethylene (PTFE)] [_____] rings, one above the discharge port, the other below the discharge port. The valve body shall be stainless steel Class [150] [_____] with a [male ASME B1.20.2M ASME B1.20.1 pipe threads] [_____] inlet connection and [female ASME B1.20.2MASME B1.20.1 pipe threads] [_____] outlet connection] [Sampling ports shall be comprised of pipe fittings, pipe, and [ball] [gate] [_____] valves which comply with material, temperature, and pressure requirements of the associated piping system as specified elsewhere in this Section.] [A double block and bleed configuration shall be provided] [_____].

2.22 MISCELLANEOUS PIPING COMPONENTS

2.22.1 Air Release and Vacuum Breakers

****

NOTE: For air and vacuum, vacuum, air release and combination valves, check trim materials for compatibility with service. In addition, discharge points should be designed to be safe for both the environment and personnel.

****

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

2.22.1.1 Locations

[Air release and vacuum breakers shall be located as indicated on the contract drawings.] [All pipeline high points shall have air release vents [and vacuum breakers].] [_____]. [Vacuum breakers shall be provided on all tanks and process equipment.]

2.22.1.2 Vacuum Breakers

Vacuum breakers [50] [_____] mm [2] [_____] inch and smaller shall be an

angle type with all [bronze] [cast iron] [semi-steel] [_____] bodies and bonnets, and shall [be installed at least [152] [_____] mm [6] [_____] inch above the flood line of associated equipment] [and] [shall conform to ASSE 1001 for pipe applied units].

2.22.1.3 Air and Vacuum Valve Suitable for Corrosive Service

The air and vacuum valve shall conform to [ASSE 1001] [ASSE 1020] [_____], and automatically exhaust air during the filling of a system while allowing air to re-enter during draining or when vacuum occurs. The valve shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. The valve shall have a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. End connections shall be as follows: for 13 through 80 mm 1/2 through 3 inch ASME B1.20.2MASME B1.20.1 pipe threaded inlet and outlet, for 100 mm 4 inch and larger [ASME B16.5] [ASME B16.1] Class [_____] flanged inlet with outlet. The air and vacuum valve shall be fitted with blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.

2.22.1.4 Air Release Valve Suitable for Corrosive Service

The air release valve shall automatically exhaust entrained air that accumulates in a system and shall be [Factory Mutual listed] [ASSE approved] [_____]. The valve shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. The valve shall have a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Valve end connections shall be [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. The air and vacuum valve shall be fitted with blowoff valve, quick disconnect couplings, and a minimum 2 m 6.6 feet of hose in order to permit back flushing after installation without dismantling the valve.

2.22.1.5 Combination Air Valve Suitable for Corrosive Service

The valve combines the operating functions of both an air and vacuum valve and an air release valve. The air and vacuum portion shall automatically exhaust air during filling of a piping system and allow air to re-enter during draining or when a vacuum occurs. Air release portion shall automatically exhaust entrained air that accumulates in the piping system. The valve shall be a [single body unit] [or] [an individual air and vacuum valve and an air relief valve mounted on a common header]. The valve shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure and built with [a special short body] [a standard elongated body]. The valve shall have a [cast iron] [ductile iron] [semi-steel] [_____] body and cover, with [stainless steel] [_____] float and trim. Valve end connections shall be [ASME B1.20.2MASME B1.20.1 pipe threaded] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [_____]. [The air and vacuum valve to be fitted with a blowoff valve, quick disconnect couplings, and a minimum [2] [_____] m [6.6] [_____] feet of hose in order to permit back flushing after installation without dismantling the valve.]

2.22.2 Backflow Preventer

****

NOTE: Under process conditions, backflow prevention can be handled with either a double check valve

assembly or a backflow preventer specifically manufactured for that purpose. The backflow preventer should be used if pressure loss is a concern. However, if the backflow prevention device is to be installed on a potable water line at a treatment plant and the potential for contamination of the potable water line exists, a backflow preventer specifically manufactured for that purpose must be used.

The reduced pressure backflow preventer can be used on continuous duty systems only. The other backflow preventer can be used on either continuous or intermediate services.

****

The backflow preventer shall be identical in size to pipe. Total head loss through the complete backflow assembly shall not exceed [70] [_____] kPa [10.1] [_____] psi at rated flow.

2.22.2.1 Double Check Valve Assembly

The backflow preventer shall consist of two [check valves] [independently operating, spring loaded, "Y" check valves] rated for [1.25] [_____] MPa [175] [_____]psig service at 60 degrees C 140 degrees F, with [one isolation gate valve] [one isolation ball valve], [one differential relief valve], [and testing cocks]. Port size shall be [25] [_____] mm [1] [_____] inch and be ASME B1.20.2MASME B1.20.1 threaded, [female] [male]. The check valve assembly shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. The assembly shall meet the requirements of [ASSE 1015] [AWWA C510].

2.22.2.2 Reduced Pressure Backflow Preventer

The assembly body shall be two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2][_____] MPa [150] [_____] psig at 60 degrees C 140 degrees F, with an intermediate relief valve, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. [All internal parts shall be serviceable in-line.] Port sizes shall be [25] [_____] mm [1] [_____] inch and be ASME B1.20.2M ASME B1.20.1 threaded, [female] [_____]. The reduced pressure backflow prevention assembly shall be rated for [1.03] [_____]MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. The assembly body shall be in accordance with [AWWA C511] [ASSE 1013].

2.22.2.3 Backflow Preventer with Intermediate Vent

The assembly body shall be two independent [bronze] [epoxy coated cast iron] [_____] body check valves rated at [1.2] [_____] MPa [175] [_____] psig at 60 degrees C 140 degrees F, with an intermediate atmospheric vent, and [isolation gate valve,] [full-ported [ball valves] [gate valves] [_____]] as testing cocks. Port sizes shall be [25] [_____] mm [1] [_____] inch and be ASME B1.20.2MASME B1.20.1 threaded, [female] [_____]. The backflow prevention assembly shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F. The assembly body shall be in accordance with [AWWA C511] [ASSE 1012].

2.22.3 Strainers

Strainers shall be [simplex] [duplex] with a [Y-pattern] [_____] body. Port sizes shall be [25] [_____] mm [1] [_____] inch and be ASME B1.20.2M ASME B1.20.1 threaded, [female] [male]. The strainers shall be rated for [1.03] [_____] MPa [150] [_____] psig working pressure at 65 degrees C 150 degrees F and conform to [ASTM F 1199] [ASTM F 1200]. The body shall be [cast bronze] [cast iron] [welded steel] [_____] with a [screwed bronze] [bolted iron] [_____] cap. The screen shall be heavy-gauge [stainless steel] [Monel] [_____], [30] [_____] mesh [and be equipped with a ASME B1.20.2MASME B1.20.1 pipe threaded blowoff hole].

2.22.4 Indicating Devices

****
NOTE: This subparagraph will be coordinated with requirements for remote or control instrumentation. The devices specified by this section may be in addition to the control instrumentation.
****

2.22.4.1 Pressure and Vacuum Gauges

Pressure and vacuum gauges shall be [stem] [flush] [semi-flush] [panel] [_____] mounted, with [phenolic] [aluminum] [glass filled nylon] [glass filled polypropylene (PP)] [stainless steel] [brass] [acrylonitrile-butadiene-styrene (ABS)] [_____] cases [equipped with safety pressure blowout backs] and [dry] [[glycerine] [_____] -filled] [_____] dials. The gauge sensors shall be [diaphragm] [C-Type Bourdon tube] [helical Bourdon tube] [bellows] [_____] actuated and constructed of [phosphor bronze] [stainless steel] [Monel] [silicone rubber] [Inconel] [beryllium-copper] [_____]. The gauges shall be equipped with [brass] [Monel] [TP316L stainless steel] [alloy steel] [_____] threaded [8] [_____] mm [0.25] [_____] inch [male] [female] connections. The dials of the gauges shall be [114] [152] [_____]mm [4.5] [6] [_____]inch in diameter with scale readings in [MPa and mm of mercury psig and inches of mercury] [_____] ranging from zero to approximately twice the anticipated process operating or equipment pressure. A slotted adjustable pointer shall be provided with accuracy to conform to [ASME B40.100, Grade A] [_____]. [A lever handled gauge cock and filter type snubber shall be provided.][A snubber shall be installed between the pipeline and the gauge.] [The gauges shall be isolated from the process fluids using remote corrosion resistant diaphragm seals. The housing of the corrosion resistant seals shall be constructed of [stainless steel] [Monel] [tantalum] [titanium] [polytetrafluoroethylene (PTFE)] [polypropylene (PP)] [polyvinyl chloride (PVC)] [Inconel] [Hastelloy] [_____]. Seals shall be composed of [stainless steel] [Monel] [Hastelloy] [nickel] [polytetrafluoroethylene (PTFE)] [_____].]

2.22.4.2 Thermometers

Thermometers shall be bi-metal actuated, with [127] [_____] mm [5] [_____] inch dished anti-parallax dials that have [external] [_____] calibration adjustment and [stainless steel] [_____] cases. Mercury shall not be used in thermometers. The thermometers shall have [stainless steel] [_____] stems, [adjustable angle] [back-connection] [left side-connection] [or] [right side-connection] type for the correct viewing angle. The union connections with associated thermowells shall be included. Scale shall be [-5 to plus 50 degrees C 25 to 125 degrees F] [[_____] to [_____] degrees C

degrees F] with accuracy within one scale division.

2.22.4.3 Thermowells

Thermowells shall be [TP316 stainless steel] [brass] [steel] [_____] with a diameter of [25] [_____] mm [1] [_____] inch. The length shall be as shown on the contract drawings and coordinated with the associated temperature element. Process connections shall be constructed of [stainless steel] [_____] and shall have [flanges, faced and drilled to ASME B16.5 Class [150] [300] [_____]] [fixed hex nipples [male ASME B1.20.2MASME B1.20.1 threaded] [female ASME B1.20.2MASME B1.20.1 threaded sockets]] [_____]. Thermowells that shall be used with thermocouples or RTDs shall be equipped with terminal connection heads rated NEMA 250 Type [4X] [4] [7] [_____].

2.22.5 Static Mixer

The static mixer shall be designed to disperse the design flow, [_____] cubic m/s gpm of added chemicals in a process flow stream with flows ranging from [_____] to [_____] cubic m/s gpm. The minimum allowable pressure drop shall be [_____] kPa feet of water column. The maximum allowable pressure drop for the static mixer shall be [_____] kPa feet of water column in accordance with the requirements of the process stream pumping system. The diameter of the mixer housing shall be sized identical to the process piping. The length shall be in accordance with the number of mixing elements required. Housing materials shall be [TP316 stainless steel] [_____], providing chemical resistance to both the chemical additives and process stream. [The coatings on coated components shall be factory spark-tested to verify that the coating is free from pinholes.] End configurations shall be [plain ends] [ends prepared for welding] [ASME B1.20.2MASME B1.20.1 threaded ends] [[forged steel, [ASTM A105/A105M] [ASTM A727/A727M]] [_____], flanged faced and drilled to [ASME B16.5] [ASME B16.1] Class [150] [300] [_____]] [_____] and shall compatible with the piping system. Injection ports shall be of the same materials as the mixer housing in the number, dimensions, and positions shown on drawings, and with [female ASME B1.20.2MASME B1.20.1 threaded] [flanged] [_____] connections compatible with the chemical feed piping system. Each housing shall be supplied with a name plate which at a minimum provides the manufacturer's name and address, part model number, and direction of flow. Mixing elements shall be constructed of [TP316 stainless steel] [_____] providing resistance to both the chemical additives and process stream. Elements shall be installed consecutively, with the number required designed to provide mixing with a homogeneity of the final mix of less than or equal to [0.05] [_____] by the end of the static mixer.

2.22.6 Expansion Joints

****
NOTE: Thermal expansion of the piping systems must be taken into account. One of the most common methods to accommodate thermal expansion, the incorporation of expansion loops into the piping system, should be carefully investigated when corrosive materials are handled due to the potential of inducing stress corrosion. Alternatives are expansion joints and flexible connections or sections. Calculate maximum expansion compensation based on maximum pipeline temperature and pressure.
****

Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems.

2.22.6.1 Expansion Joint for Metallic Pipe

The expansion joint shall be a [single slip] [double slip] [ball] [bellows] [elastomer sleeve] [_____] type with [stainless steel] [_____] wetted materials of construction. The expansion joint shall be sized to match the associated piping. The maximum allowable working pressure shall be [1.03] [_____] MPa [150] [_____] psig at [48.9] [_____] degrees C [120] [_____] degrees F. The expansion joint shall be sized for a maximum axial [compressing] [expanding] deflection of [_____] mm inches [, a lateral movement of [_____] mm inch,] [and] [an angular rotation of [15] [_____] degrees.] End connections shall be [as specified for the associated pipe joints] [[ASME B16.5] [ASME B16.1] Class [_____] flanged] [ASME B16.11 [threaded] [welding]]. Required accessories for a complete assembly shall be provided including: [swivel joints,] [limit stops,] [internal guides,] [anti-torque device,] [internal flow liners,] [control rods,] [control cables,] [_____].

2.22.6.2 Expansion Joint for Nonmetallic Piping

A bellows expansion joint shall have a minimum of [_____] convolutions to accommodate an axial deflection of [_____] mm inch, [a lateral movement of [_____] mm inch,] [and] [an angular rotation of [_____] degrees,] with [[ductile iron] [_____] flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [125] [150] [300] [_____],] [_____] end connections, and metal reinforcing bands. The maximum allowable working pressure shall be [960] [_____] kPa [140] [_____] psig at [49] [_____] degrees C [120] [_____] degrees F. Bolting shall be limited to restrain the force developed by [1.5] [_____] times the specified maximum allowable operating pressure. The expansion joint shall be sized to match the associated piping.

2.22.7 Pressure Relief Devices

****
NOTE: Pressure relief devices must discharge to a safe location that does not endanger either operators or the environment. Discharge piping and the supports for the discharge piping must be carefully designed to prevent failure during a pressure relief event. Select all materials based upon the application; refer to manufacturers' catalogs.
****

Pressure relief devices shall conform to the requirements of ASME B31.3.

2.22.7.1 Pressure-Relief Valve

****
NOTE: Verify that the valve schedule is included in the contract drawings.
****

Pressure-relief valves shall conform to the following:

a. Pressure-relief valves, 50 mm 2 inch and smaller, shall be a direct diaphragm, spring controlled type with [cast iron] [_____] bodies and spring cases. Trim shall be [bronze] [stainless steel] [_____] and seats, [nitrile] [_____]. Diaphragms shall be elastomeric, [chloroprene] [nylon reinforced butadiene acrylonitrile rubber] [or] [_____]. Miscellaneous parts such as the valve stems, nuts, and springs shall be [stainless steel] [_____]. End connections shall be [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [_____]] [ASME B16.11 [threaded] [welding]] [_____]. The valves shall open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

b. Pressure relief valves, 65 mm 2.5 inch and larger, shall be hydraulically operated, diaphragm actuated, pilot controlled [globe] [angle] valves with externally mounted strainers and test cocks. Bodies shall be [cast iron] [ductile iron] [forged steel] [_____] and trim shall be [bronze] [stainless steel] [_____]. Stem shall be [stainless steel] [_____]. End connections shall be [flanged, faced and drilled to [ASME B16.1] [ASME B16.5] Class [150] [300] [_____]] [ASME B16.11 [threaded] [welding]] [_____]. The valves shall open when the upstream pressure reaches a maximum set point. Sizes and ratings [as shown in the Valve Schedule in the contract drawings.] [as follows: PSV- [_____] [_____] mm inch, maximum flow of [_____] cubic m/s gpm with inlet pressure of [_____] MPa psig. Outlet pressure set at [_____] MPa psig].

2.22.7.2 Rupture Discs

****
NOTE: Verify that the rupture discs are sized and rated in the contract drawings.
****

Rupture discs shall be the [tension loaded] [compression loaded] type [as indicated in contract drawings]. Discs shall be [copper] [aluminum] [stainless steel] [dual element with a seal composed of [metal] [plastic] [_____] conforming to piping system] with a maximum operating ratio of [70] [85] [90] [_____] percent. [Vacuum support shall be provided, if required, by the manufacturer.] [Knife blades shall not be necessary for initiating rupture.] The discs shall rupture when the upstream pressure reaches a set maximum. Sizes and ratings [as shown in the contract drawings.] [as follows: PSE- [_____] [_____] mm inch, diameter. Rupture pressure shall be [_____] MPa psig].

2.23 PIPE SUPPORTS AND PENETRATIONS

****
NOTE: Pipe-support is a major design consideration of any process piping system; carefully design and edit the following paragraphs.
****

Provide auxiliary steel where the support of piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A36/A36M. The Contractor has the option to use pre-engineered support systems of

electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, provide [TP304] [_____] stainless steel conforming to [ASTM A167, No. 1 Finish] [_____].

2.23.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58, MSS SP-69, and MSS SP-58. 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.

2.23.1.1 Beam Clamps

For upper attachments on structural steel, provide beam clamps of [ASTM A36/A36M carbon steel] [or] [ASTM A181/A181M forged steel] [_____] and MSS SP-58 Types [19 through 23, 25 or 27 through 30] [_____]. Holes drilled in structural steel for hanger support rods will not be permitted. Clamps shall be provided with hardened steel cup-point set screws and lock-nuts for anchoring in place. Clamp size selection shall only be based on the support of the required load.

2.23.1.2 Riser Clamps

Vertical runs of piping shall be supported at each floor, or closer where required, with [ASTM A36/A36M carbon steel] [_____] clamps bolted around pipes and attached to the building construction. [Copper plated clamps shall be provided for copper tubing support.] [Two bolt-type clamps designed for installation under insulation shall be used on insulated pipe runs.]

2.23.1.3 Brackets

Where piping is run adjacent to walls or steel columns, provide welded [ASTM A36/A36M steel] [_____] brackets, pre-punched with a minimum of two fastener holes.

2.23.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, supply a double-leg design two-piece pipe clamp.

2.23.1.5 Racks

Multiple pipe racks or trapeze hangers shall be fabricated from [ASTM A36/A36M steel] [_____], and designed to suit the conditions at the points of installation. Pipes shall be kept in their relative positions to each other by the use of clamps or clips. Pipelines subject to thermal expansion must be free to slide or roll.

2.23.1.6 Hangers

Hangers shall be fabricated of [malleable iron, ASTM A47/A47M] [or] [ASTM A36/A36M carbon steel] [_____]. All hangers shall be of a uniform type and material for a given pipe run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube or pipe. Hangers for pipe sizes 65 mm 2.5 inch or larger shall incorporate a means of vertical adjustment after erection while supporting the load. For piping systems with operating temperatures from 50 to 230 degrees C 122

to 446 degrees F the following shall be used: [MSS SP-58 Type [1] [or] [3 through 12] [_____] hangers with overhead support and appropriate saddle of MSS SP-58 Type [40] [_____] for insulated pipe;] [MSS SP-58 Types [41] [or] [43 through 46] [_____] hangers or supports with roller support and appropriate saddle of MSS SP-58 Type [39] [_____] on insulated pipe;] [MSS SP-58 Types [35 through 38] for sliding support]. For piping systems with liquid temperatures up to 50 degrees C 122 degrees F the following shall be used: MSS SP-58 [Types 1,3 through 12,] [Types 24 and 26 with overhead support,] [or] [Types 35 through 38 with support from below].

2.23.1.7 Hanger Rods

Hanger rods shall be carbon steel conforming to ASTM A576. The diameter of the rods for piping system support shall conform to [the contract drawings] [ASME B31.1].

2.23.2 Pipe Guides

2.23.2.1 Intermediate Guides

For piping [150 mm 6 inch] [[_____] mm inch] and smaller, a pipe clamp with an oversize pipe sleeve shall be provided for a minimum [4 mm 0.16 inch] [[_____] mm inch] clearance. For piping [200 mm 8 inch] [[_____] mm inch] and larger, U-bolts with double nuts that are manufactured for the purpose shall be used to provide a minimum [7 mm 0.28 inch] [[_____] mm inch] clearance around pipe. The stock sizes for the U-bolts are as follows: for a [200 mm 8 inch] [[_____] mm inch] pipe use a [16 mm 0.625 inch] [[_____] mm inch] U-bolt; for a [250 mm 10 inch] [[_____] mm inch] pipe, use a [19 mm 3/4 inch] [[_____] mm inch] U-bolt; for a [300 mm 12 inch] [[_____] mm inch] to [400 mm 16 inch] [[_____] mm inch] pipe, use a [24 mm 0.875 inch] [[_____] mm inch] U-bolt; and for [450 mm 18 inch] [[_____] mm inch] to [750 mm 30 inch] [[_____] mm inch] pipes use [25 mm 1 inch] [[_____] mm inch] U-bolts.

2.23.2.2 Alignment Guides

For piping, [200 mm 8 inch] [[_____] mm inch] and smaller, alignment guides shall be [galvanized steel] [_____], [spider] [or] [sleeve] [_____] type. For piping, [250 mm 10 inch] [[_____] mm inch] and larger, alignment guides shall be [galvanized steel] [_____], [roller] [_____] type guides.

2.23.3 Flashing Sleeves

[[Galvanized steel] [_____] flashing sleeves shall be installed wherever piping passes through concrete roof structures.] [Where piping penetrates roofs, [2 kg 4 lb.] [[_____] kg lb.] [lead] [_____] flashing shall be provided.] The flashing shall extend [200 mm 8 inches] [[_____] mm inches] from the pipe in all directions, extend up the pipe, and shall be fitted with double-threaded flashing for pipes [75 mm 3 inches] [[_____] mm inches] and smaller. Flashing shall turn down inside the pipe for [100 mm 4 inch] [[_____] mm inch] and larger pipes.

2.23.4 Wall Penetrations

2.23.4.1 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. Penetrations through an existing fire or fire barrier wall shall be sealed

with a fire stop system that has an "F" rating not less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems shall be [[a water based] [vibration resistant, polysiloxane (also known as silicone) based,] nonslumping, premixed sealant with intumescent properties] [_____], that is rated for [3] [_____] hours pursuant to ASTM E 814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems shall be a [polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties] [acrylic based, nonslumping, premixed sealant with intumescent properties] [_____], that is vibration and moisture resistant, and is rated for [3] [_____] hours pursuant to ASTM E 814 and UL requirements with metal collars. Vented plastic pipe penetrations shall be fitted with galvanized steel collars that have intumescent inlays.

2.23.4.2 Below Grade Wall Penetrations

****
NOTE: For critical systems, use the interlocking rubber link system. In other instances, a nonslumping water-resistant elastomeric based sealant with intumescent properties may be used.
****

Below-grade wall penetrations shall be provided with [hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. The seals shall be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening] [polysiloxane (also known as silicone) based, nonslumping, vibration and water resistant sealant with intumescent properties] [_____].

2.23.4.3 Galvanizing

Galvanizing shall be [hot-dip applied and meet the requirements of ASTM A153/A153M] [or] [zinc or cadmium plating]. Stainless steel components may be substituted where galvanizing is specified.

2.24 MISCELLANEOUS MATERIALS

****
NOTE: In cold climates, exposed pipe, valves, and equipment should be insulated and potentially heat traced to prevent freezing. Method of heat trace will be dictated by hazard classification and site conditions.
****

2.24.1 Pipe Insulation Material

Insulation for pipes, valves, instrumentation and controls, and other equipment shall [be in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS] [be 25 mm one inch ASTM C552 cellular glass and integral moisture barriers][_____].

2.24.2 Heat Trace

****
NOTE: Delete subparagraphs a. b. and c. below if steam heat trace is used.

****

Heat trace shall be [steam] [electrical] with materials selected for compatibility with transported liquids and ambient environment. The heat trace shall be capable of maintaining the liquid process design temperature at [27] [_____] degrees C [80] [_____] degrees F maximum when subjected to an exterior temperature of [-29] [_____] degrees C [-20] [_____] degrees F.[Steam piping shall be in accordance with Section 23 70 03.00 10 HEATING AND UTILITIES SYSTEMS, CENTRAL STEAM.][Electrical work shall be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and UL listed, and shall include all terminations, junction boxes, and automatic controls.] Work shall conform to hazard classifications indicated on the drawings[, and shall be implemented in accordance with NFPA 70, Section 427].

a. Provide UL listed parallel conduction type heat tape, with adjustable thermostat for outdoor aboveground winterized piping. The tape shall not be affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere. Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.

b. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

c. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at [1.1] [_____] degrees C [34] [_____] degrees F minimum during winter outdoor design temperature as indicated, but not less than the following: 80 mm 3 inch pipe and smaller with 25 mm one inch thick insulation, 4 watts/0.3 m 4 watts/feet; and 100 mm 4 inch pipe and larger 38 mm 1.5 inch thick insulation, 8 watts/0.3 m 8 watts/feet of pipe.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

3.2.1 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.

3.2.2 System Preparation

3.2.2.1 Pipe and Fittings

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

3.2.2.2 Damaged Coatings

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. Do not install damaged piping materials. Field repair of damaged and uncoated areas of galvanized piping shall conform to ASTM A780/A780M.

3.2.2.3 Field Fabrication

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 05 13.96 WELDING PROCESS PIPING. Welding electrodes shall be provided in accordance with [Table 3.1 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.

3.3 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.

3.3.1 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.

3.3.1.1 Drilled-In Expansion Anchors and Fasteners

****
NOTE: This subparagraph addresses anchors and fasteners that are used with concrete or masonry applications. The first option is used for masonry brick and precast concrete hollow-core block anchoring/fastening systems and the second is suitable for cast-in-place concrete and solid precast concrete structural elements.
****

[Anchors shall be designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield. The expander nut shall be fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom. The shield body shall consist of four legs, the inside of each shall be tapered toward shield bottom (or nut end). The end of one leg shall be elongated and turned across shield bottom. The outer surface of shield body shall be ribbed for grip-action. The expander nut shall be of square design with sides tapered inward from bottom to top. The anchor materials of construction shall be [zinc plated steel] [TP304 stainless steel] [_____] of [300 MPa 43,541 psi] [[_____] MPa

psi] minimum tensile strength. Fasteners shall be machine bolts for use with above anchors; nuts and washers shall conform to ASTM A194/A194M. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.] [The anchor/fastener assembly shall be UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers. [The stud shall be constructed of [TP304] [_____] stainless steel, and nut and washer of [TP304] [_____] stainless steel.] The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.]

3.3.1.2 Drilled-In Adhesive Anchors

[Drilled-in adhesive anchors shall not be used for overhead applications.] The anchors shall be composed of an anchor rod assembly and an anchor rod adhesive cartridge. The anchor rod assembly shall be a chamfered and threaded stud rod of [zinc plated ASTM A36/A36M steel] [TP304 stainless steel] [_____] with a nut and washer of [ASTM A194/A194M alloy-steel] [TP316 stainless steel] [_____]. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application. The adhesive cartridge shall be a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. The capsule ingredients shall be activated by the insertion procedure of the anchor rod assembly.

3.3.2 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].

3.3.3 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.

3.3.4 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.

3.3.5 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.] [The upstream and downstream lengths of undisturbed piping shall be in accordance with flow indicator manufacturer's recommendations.]

3.3.5.1 Backflow Preventers

****
NOTE: Discharge to an open drain with an air gap is required on potable water lines.
****

Backflow preventers shall be installed with nameplate and test cocks accessible from front of unit, and with a minimum clearance of [310 mm 12.2 inches] [[_____] mm inches] between the port and grade. The assemblies shall be installed in accordance with local codes [and shall discharge to an open drain with an air gap]; vertical installation [shall be avoided] [is prohibited].

3.3.5.2 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 all process equipment] [across the process equipment indicated in the contract drawings], in accordance with the manufacturer's recommendations, and arranged for easy observation.

3.3.6 Pipe Flanges

****
NOTE: Specify the requirement for bolting to straddle the vertical centerline of the pipe for the installation of orientation sensitive devices such as some types of flow meters.
****

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].

3.3.7 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.

3.3.8 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.

3.3.9 Plastic Pipe Installation

Submit a statement signed by the [reinforced thermosetting resin pipe] [and] [plastic pipe] manufacturer's representative certifying that the Contractor's personnel are capable of properly installing the piping system on the project. All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.

a. 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.

b. Pipe shall not be laid when the temperature is below [4.5 degrees C 40.1 degrees F] [[_____] degrees C degrees F], nor above [32 degrees C 90 degrees F] [[_____] degrees C degrees F] when exposed to direct sunlight. Any plastic pipe installed above grade and outdoors shall be ultraviolet (UV) protected or UV resistant.

c. 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.

d. 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 maximum operating pressures] [at the pressures listed in the Pipe Schedule shown on the contract drawings].

Submit [6] [_____] copies each of operation and maintenance manuals in indexed booklet form. Detail in the Operation Manuals the step-by-step procedures required for specialized startup, operation and shutdown of piping systems, and 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. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment, and include piping layout and valve locations.

3.3.9.1 PVC Piping

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

3.3.9.2 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.]

3.3.10 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].

3.3.11 Insulation

Insulation shall be installed on piping as indicated [on the Pipe Schedule] [in the contract drawings in accordance with the provisions of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.]

3.4 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.]

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

3.4.2 Fittings

Press connections shall be made in accordance with manufacturer's installation instructions using tools approved by the manufacturer. The tubing shall be fully inserted into the fitting and then marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully inserted before the joint is pressed. 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.

3.4.3 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. 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.

3.4.3.1 Thrust Blocks

Thrust blocking shall be concrete of a mix not leaner than [1] [_____] cement, [2.5] [_____] sand and [5] [_____] gravel, and have a compressive strength of not less than [14 MPa 2000 psi] [[_____] MPa psi] after [28] [_____] days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust blocks shall be poured against undisturbed earth. The sides of thrust blocks not subject to thrusts may be poured against forms. The area of bearing shall be as shown or directed. Blocking shall be placed so that fitting joints shall be accessible for repair. Steel rods and clamps, protected by galvanizing or a coating of bituminous paint shall be used to anchor vertical down bends into gravity thrust blocks.

3.4.3.2 Restrained Joints

****
NOTE: When the restrained pipe length is specified, this paragraph will be modified in accordance with the design requirement. Use UFC 3-230-10A for guidance.
****

[The restrained pipe length shall be [_____] m feet]. [For ductile iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA TRD.]

3.4.4 Marking Tape

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

3.4.5 Plastic Pipe Installation

****
NOTE: Thrust blocking should be used only where slip joints are used. Otherwise, piping will be designed to withstand compression or expansion forces imposed by trench conditions.
****

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.] [Concrete thrust blocks shall be constructed where shown in the contract drawings] [_____].

3.5 CONNECTING DISSIMILAR PIPE

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

3.6 EXTERNAL CORROSION PROTECTION

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

3.6.1 Underground Metallic Piping

Buried metallic piping shall be protected from corrosion using [protective coatings] [and] [cathodic protection]. Cathodic Protection shall be provided for metallic underground piping systems as specified in [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)]. 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.]

3.6.2 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.

3.6.2.1 Ferrous Piping

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by [power wire brushing] [commercial sand blasting conforming to SSPC SP 6/NACE No.3] and primed with a [ferrous metal primer] [vinyl type wash coat] [_____]. Primed surfaces shall be finished with two coats of exterior [oil] [vinyl] [_____] paint in accordance with Section 09 90 00 PAINTS AND COATINGS. Cathodic Protection shall be provided as shown in the contract drawings for above ground ferrous piping systems as specified in [Section 26 42 14.00 10 CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [Section 26 42 17.00 10 CATHODIC PROTECTION SYSTEM (IMPRESSED CURRENT)].

3.6.2.2 Aluminum Alloy Piping

Surfaces of aluminum alloy pipe and fittings shall be painted to protect against corrosion where they contact masonry, plaster, insulation, or are subject to repeated wettings by water, detergents or chemicals. The surfaces shall be solvent cleaned and treated with a [vinyl type wash coat] [_____]. A first coat of aluminum paint and a second coat of [alkyd gloss enamel] [silicone alkyd copolymer enamel] [_____] shall be applied in accordance with Section 09 90 00 PAINTS AND COATINGS.

3.7 DOUBLE CONTAINMENT PIPING LEAK DETECTION SYSTEM

a. Install the system 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. Take and record calibration points along the sensing string in accordance with the manufacturer's recommended procedures. Provide cable not in containment piping with cable tags every [15 m 49.2 feet] [[_____] m feet].

b. Perform tests 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.

3.8 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. Joints may be flush with the structure face or may be located up to [1] [_____] pipe diameter away from face [, but not further than [450 mm 17.7 inches] [[_____] mm inches] away from face]. [For pipelines larger than [450 mm 18 inch] [[_____] mm inch] in diameter the first joint shall be within [1] [_____] pipe diameter.]

3.9 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] [plain end pieces, with thickness matching the nominal wall thickness of the associated pipe, mounted on double flexible couplings], 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 [as shown in contract drawings].

3.10 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 PAINTS AND COATINGS. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09 90 00 PAINTS AND COATINGS. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires. Joints shall be [caulked with rubber sealant] [or] [sealed with a wall penetration seal]. For existing concrete walls, rotary drilled holes may be provided in lieu of sleeves.

3.11 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.

3.11.1 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 [1.37 m 4.5 feet] [[_____] m 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 [1.37 m 4.5 feet] [[_____] m feet] and [2.05 m 6.75 feet] [[_____] m 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].

3.11.1.1 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.

3.11.1.2 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.

3.11.2 Line Size Ball Valves

A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding [magnetic flowmeters] [_____], for isolation during maintenance.

3.11.3 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.

3.11.4 Operator Extension Stems

Where the depth of the valve is such that its centerline is more than [925 mm 3 feet] [[_____] mm feet] below grade, an operator extension stem shall be furnished with a [50 mm 2 inch] [[_____] mm inch] operating nut to bring the operating nut to a point [150 mm 5.9 inches] [[_____] mm inches] below the surface of the ground and/or box cover. The operating nut shall be located in a floor box.

3.11.5 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.

3.11.6 Chain Wheel and Guide

Chain wheel and guide assemblies or chain lever assemblies shall be installed on manually operated valves located over [2.05 m 6.73 feet] [[_____] m feet] above finished floor elevation. Where chains hang in normally traveled areas, appropriate ["L" type] [_____] tie-back anchors shall be used.

3.12 AIR RELEASE, DRAINS AND SAMPLE PORTS

Sample ports shall be provided where indicated on the contract drawings. 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.

3.13 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.

3.13.1 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 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. Piping [65 mm 2.5 inch] [[_____] mm inch] in diameter and larger shall be braced for seismic forces. Lateral supports for seismic loads shall be installed at all

changes in direction.

3.13.2 Support of Insulated Piping

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

3.13.3 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.

3.13.4 Support Spacing

****
NOTE: Calculate spans and rod sizes pursuant to MSS SP-58 and SP-69. Coordinate with manufacturers data and/or other standards for guidance in determining maximum support spans. Duplicate the following subparagraphs as required.
****

3.13.4.1 Acceptable Limits for Metallic Piping

[Stainless steel] [_____] [Schedule [10S] [_____]] with a wall thickness of [_____] mm inch, diameter [_____] mm inch, shall have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.4.2 Acceptable Limits for Thermoplastic Piping

[PVC] [_____], [Schedule [40] [_____]] [SDR [21] [_____]], diameter [_____] mm inch, shall have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.4.3 Acceptable Limits for Rubber/Elastomer Piping

[Chloroprene] [_____], internal diameter [_____] mm inch, shall have a maximum span of [_____] mm inch and a minimum rod size for single rod hangers of [_____] mm inch.

3.13.5 Support Methods

Piping support shall be provided as specified and as shown in the contract drawings. Single horizontal suspended piping shall be supported by [adjustable swivel-ring,] [split-ring,] [or] [clevis] [_____] hangers. Multiple horizontal suspended piping shall be supported by [trapeze hangers with channel type supports] [_____]. Horizontal pedestal mounted piping shall have [saddle] [_____] type supports. Horizontal wall mounted piping shall have [wall brackets] [_____]. Vertical piping shall be supported by [wall brackets,] [base elbows,] [or] [riser clamps on floor penetrations] [_____].

3.13.6 Supports and Hangers for Stainless Steel Piping

All hanger-pipe contact surfaces shall have a dielectric barrier consisting of [chloroprene rubber] [_____] wrapping [or plastic coated hangers]. The

load rating of universal concrete inserts shall not be less than that of the hanger rods they support.

3.14 PIPE IDENTIFICATION, PAINTING AND COLOR CODING

****
NOTE: Color coding for piping identification as required by the using agency will be developed and inserted in the Color Code Schedule (Table I) in Section 09 90 00 PAINTS AND COATINGS. For Air Force installations, piping will be color coded in accordance with Attachment 4 of Air Force Regulation 88-15.
****

Color, coating, and lettering requirements for exposed piping shall be in accordance with Section 09 90 00 PAINTS AND COATINGS. [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 [6 m 19.7 feet] [[_____] m feet] of straight run, upstream of valves, and within [1 m 3.3 feet] [[_____] m feet] of entrance to or exit from wall curtains, or other similar type barrier.]

3.15 FIELD QUALITY CONTROL

****
NOTE: The general pipe testing requirements are basically taken from ASME B31.3 for Chemical and Petroleum Refinery Piping. Test pressure for hydrostatic pressure and leakage tests will be the working pressure multiplied by 1.33. For a working pressure of 1.03 MPa (150 psig), the test pressure will be 1.38 MPa (200 psig). For other working pressures the test pressure will be adjusted accordingly.

Pneumatic testing should be avoided if possible. Specify pneumatic testing on systems where residual moisture in the lines could be a problem (such as with anhydrous liquid chlorine and hydraulic fluid), and where the use of another nontoxic liquid is not feasible. ASME B31.3 methods should be used.
****

3.15.1 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.

3.15.1.1 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 [of [_____] MPa psig] [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.

3.15.1.2 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 Pipe Schedule in the contract drawings) to demonstrate compliance. The test pressure shall not be less than [1.5] [_____] times the design pressure. [Water] [_____] shall be used as the hydrostatic test fluid. 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 [[0.075 m/s 0.25 fps] [[_____] m/s fps] applied over full area of pipe] [in accordance with the manufacturer's instructions]. [Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.] 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 for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. 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 [[0.075 m/s 0.25 fps] [[_____] m/s 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 [70 kPa 10.2 psi] [[_____] kPa psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for [8] [_____] hours before retesting.

3.15.1.3 Double Containment Primary Piping

The primary piping of a double containment piping system shall be tested in accordance with Subparagraph [Buried Piping] [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. pressure tested 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 [[0.075 m/s 0.25 fps] [[_____] m/s 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 [70 kPa 10.2 psi] [[_____] kPa psi]. If the hydrostatic pressure remains steady for [1] [_____] hour, then no leakage is indicated. Inspect for leaks, repair and retest if necessary. The piping system shall be allowed to relax for [8] [_____] hours before retesting.

3.15.1.4 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.

3.15.2 Pneumatic Tests

****
NOTE: Pneumatic tests shall not be used for primary piping of double containment piping systems.
****

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.

3.15.2.1 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 [350 kPa 50.8 psi] [[_____] kPa psi].

3.15.2.2 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 [170 kPa 25 psig] [[_____] kPa psig]. Examine piping joints for leakage. If no leakage is occurring, 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. Inspect for and repair leaks, and retest if necessary.

3.15.2.3 Double Containment Secondary Piping

The primary piping of a double containment piping system shall be hydrostatically tested in accordance with Subparagraph [Buried Piping] [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. Examine piping joints for leakage. If no leakage is occurring, 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.] Inspect for and repair leaks, and retest if necessary.

3.15.3 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 [1.38 MPa 200 psig] [[_____] MPa 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 [34.5 kPa 5 psi] [[_____] kPa 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 values listed in the Pipe Schedule in the contract drawings] [or, if applicable,] [the allowable leakage determined by the following formula:

L = Cf x N x D x P0.5
Cf = conversion factor = 10.786 0.0001351
L = allowable leakage, mm3 per hour gallons per hour
N = number of joints in the length of piping tested

D = nominal pipe diameter, mm inches
P = average test pressure during the test, MPa 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.

3.15.4 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. 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. Proceed. then, with the testing of new piping systems as specified herein.

3.15.5 Valve Testing

Submit copies of all field test reports within [24] [_____] hours of the completion of the test. 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. 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. 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.]

3.16 FINAL CLEANING

3.16.1 Interim Cleaning

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.

3.16.2 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. 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 [0.76 m/s 2.5 fps] [[_____] m/s 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.

3.16.3 Disinfection

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NOTE: Selectively require the Contractor to perform disinfection work for liquid process piping. This should be limited only to processes where bacteriological interferences could damage process equipment.
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Disinfect the [pipelines so noted in the Pipe Schedule in the contract drawings] [following pipelines: [_____]] [_____]. Before acceptance of piping system operation, each section of completed pipeline shall be disinfected [in accordance with AWWA C651] [as specified herein]. 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] [calcium hypochlorite] [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, [the Contracting Officer will take samples of water in sterilized containers for bacterial examination] [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.

3.17 WASTE WATER DISPOSAL

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

3.18 TABLES

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NOTE: The intention of the Table is to give the

designer a structure to specify the most suitable piping system materials for a project. The designer will edit or delete this table to fit the project. Verify that each pipeline designation is identified for the Contractor and the Contracting Officer on the drawings. Consult EM 1110-1-4008 Liquid Process Piping to determine acceptable materials for each application. Allow the Contractor selection of the most economical of the acceptable systems. Table may be shown on the drawings and deleted from this section of the specifications.

As indicated in paragraph 2.16, Double Containment pipe is supplied in different materials of construction. Selection of which depends upon the fluids being handled and other conditions of installation; i.e., underground, above ground, and temperature.

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TABLE I
PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS

Item No.	Pipe Material	SERVICE A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
2.2	DI Pipe	x	x	x	x												
2.3	CS Pipe	x	x	x	x	x	x			x		x		x		x	
2.4	Lined Steel Pipe	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
2.5	SS Pipe	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
2.6	Nickel/Nickel Alloys Pipe	x	x		x	x	x		x	x	x	x				x	x
2.7	Aluminum Pipe	x	x		x	x	x		x	x		x	x		x	x	x
2.8	Copper Pipe	x	x	x	x	x	x			x				x	x	x	x
2.9	PVC Pipe	x	x					x	x	x	x		x		x	x	
2.10	CPVC Pipe	x	x					x	x	x	x		x	x	x	x	
2.11	PVDF Pipe	x	x			x		x	x	x	x	x	x		x	x	x
2.12	ABS Pipe	x	x					x	x	x							
2.13	PE Pipe	x	x				x	x	x	x	x		x		x	x	x
2.14	Rubber/Elastomer Pipe	x	x		x				x	x							
2.15	FRP Pipe	x	x				x	x	x	x	x	x	x				
2.16	Double																

TABLE I
PIPE AND FITTING MATERIALS FOR COMMON PIPING SYSTEMS

Item No.	Pipe Material	SERVICE A	B1	B2	C	D1	D2	E1	E2	E3	E4	E5	E6	E7	F	G	H
	Containment Pipe	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

LEGEND:

A - Underground
B1 - Aboveground: with ambient temperature exposure -25 to plus 45 degrees C -13 to plus 113 degrees F and ultraviolet light exposure
B2 - Aboveground: with heat trace and insulated jacket
C - Temperature, Greater than 80 degrees C 176 degrees F
D1 - Solvents: non-polar
D2 - Solvents: polar
E1 - Chemical: [strong,][_____]% [sulfuric][hydrochloric][____] acid
E2 - Chemical: [weak,][_____]% [sulfuric][hydrochloric][____] acid
E3 - Chemical: [weak,][_____]% base
E4 - Chemical: [strong,][_____]% base
E5 - Chemical: [chlorine][_____]
E6 - Chemical: [oxidizing agents][_____]
E7 - Chemical: [sulfate][_____]
F - POLs
G - NAPLs
H - DNAPLs

3.19 MANUFACTURER'S FIELD SERVICES

Submit 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. Obtain manufacturer's technical assistance for Contractor training, installation inspection, start up, and owner operating and maintenance training. Follow manufacturer's instructions for installation.

-- End of Section --