UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025
****

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 31 23.00 10

SANITARY SEWER FORCE MAIN PIPING

08/18

****

USACE / NAVFAC / AFCEC | **UFGS-33 31 23.00 10 (August 2018)**

Preparing Activity: USACE | **Superseding UFGS-33 34 00 (April 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2025

****

SECTION 33 31 23.00 10

SANITARY SEWER FORCE MAIN PIPING
08/18

****

NOTE: This guide specification covers the requirements for force mains and inverted siphons for sewage systems.

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 item(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).

****

PART 1 GENERAL

****

NOTE: See UFC 3-240-01 for additional design information on force mains and inverted siphons.

****

1.1 REFERENCES

****

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 Reference Identifier (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.

****

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.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2023) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2023) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel

	and Tape - Hot-Applied
AWWA C207	(2023) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	(2024) Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C300	(2022) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C301	(2014; R 2019) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C303	(2024) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2017) Swing-Check Valves for Waterworks Service, 2 In. Through 48-In. (50-mm Through 1,200-mm) NPS
AWWA C600	(2023) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C909	(2022) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100 mm) and Larger

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2024) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2122	(2016) Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2774	(2021a) Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3035	(2022) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM D3350	(2021) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3754	(2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D4101	(2017) Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM D4161	(2014; R 2019) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F1483	(2023) Standard Specification for Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2016) Thrust Restraint Design for Ductile Iron Pipe

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

MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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 and Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Disposal of Waste Water

Final Test Report

1.3 DELIVERY, STORAGE, AND HANDLING

Do not damage pipe, fittings and accessories, and pipe coatings during delivery, handling, and storage.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

****

NOTE: No type of pipe specified in this section will be deleted except:

a. As described throughout these notes.

b. Upon specific approval of HQUSACE (CEMP-ET).

c. As stipulated in specific directives.

d. When a certain type is required by a railroad company for piping passing under its right-of-way.

Generally, force mains less than 100 mm 4 inches in diameter will not be recommended; however, circumstances may require smaller force mains; in those cases, cutter pumps or other shredding devices will be required.

Class 150 pipe will normally be specified for force mains and inverted siphons except where local conditions require a higher class. Class 150 pipe is furnished with wall thickness suitable for laying with a standard design depth of cover, using a flat-bottom trench without blocks and with compacted backfill. For other conditions, the class or pressure, and loading will be specified accordingly. Cast-iron fittings can be used with most of the pipe materials specified. Flanged joints will not be used for buried installation because a flanged joint requires special construction considerations when buried.

****

Provide piping in locations and sizes as specified in the following table. Also conform to the respective specifications and other requirements specified below

Location	Piping Size Range	Piping Material
Force Mains	Less than 100 mm 4 inches in diameter	Galvanized Steel, Polyvinyl Chloride (PVC) Plastic, Polyethylene (PE) Plastic or Polypropylene Plastic

Location	Piping Size Range	Piping Material
Inside Pump Stations	Less than 100 mm 4 inches	Galvanized Steel
[Force Mains][and][Inverted Siphons]	100 mm 4 inches in diameter and larger	Ductile Iron, Steel, Concrete Pressure Pipe, PVC Plastic, Oriented PVC PE Plastic, or Reinforced Thermosetting Resin Pipe (RTRP)
[Force Mains][and][Inverted Siphons]	200 mm 8 inches in diameter and larger	May be Reinforced Plastic Mortar Pressure (RPMP)
Inside Pump Stations	100 mm 4 inches in diameter and larger	Ductile Iron Pipe with Bolted Flange Joints

2.1.1 Concrete Pressure Pipe

****

NOTE: Use reinforced and prestressed concrete pipe for water supply distribution lines. AWWA Standards do not include sizes less than 254 mm 10 inches in diameter. Applicable size ranges for publications referenced in this paragraph are as follows:

Publications	mm Inches
AWWA C303 (Reinforced)	250 - 1050 10 - 42
AWWA C300 (Reinforced)	600 - 3600 24 - 144
AWWA C301 (Prestressed)	400 - 3600 16 - 144

In localities where 150 and 200 mm 6-and 8-inch pipe conforming to AWWA C303 is available, the following will be included in the contract specification as appropriate. In addition to the data in TABLE 1 of AWWA C303, the following will be applicable:

Nominal inside diameter of pipe	150 mm6 inches	200 mm8 inches
Nominal lining thickness	6 mm1/4 inch	6 mm1/4 inch
Nominal coating thickness	25 mm1 inch	25 mm1 inch
Class 150		
Total steel area per mm foot	1990 square mm0.94 square inch	1990 square mm0.94 square inch

Gauge cylinder number	**16**	**16**

****

Provide concrete pressure pipe and fittings that conform to [AWWA C300,][AWWA C301,][or][AWWA C303,]as applicable for the service requirements, with rubber gasket joints of the type using steel bell and spigot joint rings.

2.1.2 Plastic Pipe

2.1.2.1 PE Pipe

ASTM D3350 and ASTM D3035, minimum pressure rating of 689 kPa 100 psi at 23 degrees C 73.4 degrees F.

2.1.2.2 Polypropylene Pipe

ASTM D2122 and ASTM D4101.

2.1.2.3 PVC Pressure Pipe

****

NOTE: ASTM D1785 will be used for threaded joints. The SDR (Pressure rating) system and PC (Pressure class) system are not directly related. Reference should be made to the pertinent standards for clarification. Pressure rated plastic pipe should be derated because water hammer and surges are not included in the design. It is suggested that the operating pressure not exceed 2/3 of the rated working pressure. Pressure class plastic pipe, meeting AWWA C900 standards, will not require a derating for instantaneous velocity change not exceeding 0.61 meters per second 2 fps and for temperature range not exceeding 23 degrees C 72 degrees F.

****

a. PVC Pressure Pipe and Fittings Less Than 100 mm 4 inches Diameter: ASTM D1785, Schedule [40][80][120], or ASTM D2241, SDR [21][26][32.5], with screw joints, push-on joints, or solvent weld joints.

b. PVC Pressure Pipe and Fittings 100 mm 4 inches Diameter and Larger: ASTM D2241, SDR [21][26][32.5], or AWWA C900, Class [100][150][200], with push-on joints.

2.1.2.4 Oriented Polyvinyl Chloride (PVCO) Plastic Pipe

Provide pipe, couplings, and fittings manufactured of material conforming to ASTM D1784, Class 12454-B. Provide pipe conforming to AWWA C909, Class 150, and to ASTM F1483 with an outside diameter equal to cast iron outside diameter.

2.1.3 RPMP Pipe

Provide RPMP in accordance with ASTM D3754 produced by centrifugal casting and with an outside diameter equal to ductile iron pipe dimensions from

450 mm 18 inch to 1200 mm 48 inch. Provide a smooth uniform continuous resin-rich surface liner coating the entire inner surface of the pipe. Ensure the minimum pipe stiffness provided is 248 kPa 36 psi.

2.1.4 RTRP Lines

ASTM D2996, 2413 kPa 350 psi rated, cast iron pipe dimensions only, with elastomeric gasket joints. Fittings: AWWA C110/A21.10, rated 1034 kPa 150 psi. Use inside sleeves provided by the manufacturer when mechanical joint fittings are used.

2.1.5 Ductile Iron Pipe

****

NOTE: The use of cast-iron fittings and specials with ductile iron pipe is generally acceptable. However, when required by unusually severe loading conditions, ductile iron fittings and specials conforming to AWWA C110/A21.10 will be specified.

****

2.1.5.1 Ductile Iron Pipe

AWWA C151/A21.51, working pressure not less than 1034 kPa 150 psi, unless otherwise shown or specified.

2.1.5.2 River Crossing Pipe

AWWA C151/A21.51, minimum thickness Class 54 with joints in compliance with applicable requirements of AWWA C110/A21.10.

2.1.5.3 Fittings, Mechanical

AWWA C110/A21.10, rated for 1034 kPa 150 psi.

2.1.5.4 Fittings, Push-On

AWWA C110/A21.10 and AWWA C111/A21.11, rated for 1034 kPa 150 psi.

2.1.6 Steel Pipe

2.1.6.1 Steel Pipe, 150 mm 6 inches Diameter and Larger

AWWA C200.

2.1.6.2 Steel Pipe Less Than 150 mm 6 inches Diameter

ASTM A53/A53M, standard weight, threaded end, galvanized.

2.1.6.3 Fittings, 150 mm 6 inches Diameter and Larger

AWWA C200, fabricated in compliance with AWWA C208.

2.1.6.4 Fittings Less Than 150 mm 6 inches Diameter

ASME B16.3, galvanized.

2.2 JOINTS

2.2.1 PE Piping

2.2.1.1 Heat Fusion Joints

ASTM D2657.

2.2.1.2 Flanged Joints

ASME B16.1 or AWWA C207.

2.2.1.3 Mechanical Joints

ASME B16.1.

2.2.2 Polypropylene Piping

Heat Fusion Joints: ASTM D2657.

2.2.3 PVC Piping

Provide centering rings or stops to ensure couplings used with plain end pipe are centered on the joint.

2.2.3.1 Screw Joint Fittings

ASTM D2464, Schedule 80

2.2.3.2 Push-On Joint Fittings

ASTM D3139, with ASTM F477gaskets

2.2.3.3 Solvent Cement

ASTM D2564

2.2.4 PVCO Pipe

Provide joints conforming to ASTM D3139 and elastomeric gaskets conforming to ASTM F477.

2.2.5 Ductile Iron Piping

2.2.5.1 Push-on Joints

AWWA C111/A21.11.

2.2.5.2 Mechanical Joints

AWWA C111/A21.11 as modified by AWWA C151/A21.51.

2.2.5.3 Flanged Joints

AWWA C115/A21.15.

2.2.6 Steel Piping

2.2.6.1 Push-on Joints

AWWA C200.

2.2.6.2 Mechanical Joints

AWWA C200.

2.2.6.3 Flanged Joints

AWWA C207.

2.2.7 RPMP Piping

Provide bell and spigot gasket coupling joints utilizing an elastomeric gasket in accordance with ASTM D4161 and ASTM F477.

2.3 VALVES

2.3.1 Gate Valves

Provide gate valves 80 mm 3 inches and larger in compliance with AWWA C500. Provide non-rising stem (NRS) valves for buried service, 50 mm 2 inch square nut operated with joints applicable to the pipe or installation. Furnish buried valves with extension stems comprising socket, extension stem and operating nut, and of an appropriate length to bring operating nut to within 150 mm 6 inches of grade. Provide one 1200 mm 4 foot "T" handle valve wrench for each quantity of 6 buried valves. Provide outside screw and yoke (OS&Y), handwheel operated with flange ends for gate valves that are exposed or installed inside unless otherwise indicated. Cast an arrow and the word "OPEN" on all gate valve operating nuts and handwheels in raised letters to indicate the direction of opening. Equip gate valves 350 mm 14 inches and larger with gearing to reduce operating effort. Equip gate valves 350 mm 14 inches and larger, installed in horizontal lines in horizontal position with stems horizontal, with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Fit gate valves 350 mm 14 inches and larger installed in vertical pipe lines with stems horizontal with slides to assist the travel of the gate assembly.

2.3.2 Check Valves

****

NOTE: When the design requires the use of check valves with outside balance levers, an appropriate descriptive statement will be added. Several types of swing check valves are available for several different job requirements and the manufacturer should be consulted for specific job applications. These valves include horizontal, lever and weight, lever and spring, air cushion, oil hydraulic, etc. The operating pressure and force main velocity will determine the type of swing check valve needed.

****

Provide iron-bodied check valves that permit free flow of sewage forward and provide a positive check against backflow. Design check valves for a

minimum working pressure of 1034 kPa 150 psi or as indicated. Directly cast the manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow on the body.

2.3.2.1 Ball Check Valves

Provide iron-bodied ball check valves, with flanged ends, that are of the non-slam type. Provide Class 125 125 pound type flanges complying with ASME B16.1 with stainless steel ball unless otherwise specified.

2.3.2.2 Swing Check Valves

Comply with AWWA C508. Provide with iron body, bronze mounted, and flanged ends. Provide Class 125 125 pound type flanges, complying with ASME B16.1.

2.3.3 Plug Valves

Provide cast iron valves complying with MSS SP-78 or steel plug valves in compliance with API Spec 6D.

2.3.4 Pinch Valves

Provide double acting, jam-proof type pinch valves with unobstructed streamlined flows and built-in operator. Provide iron bodied valves with a non-rising handwheel. Provide a sleeve of pure gum rubber, neoprene, Buna N or hypalon as required for service. Provide a valve with flanged ends of Class 125125 pound type in compliances with ASME B16.1.

2.3.5 Air Release Valves

****

NOTE: When conditions indicate that vacuum conditions may exist in the line, the use of a sewage air and vacuum valve may be required. An appropriate paragraph will be added. Air vents will be specifically adapted for use with sewage.

****

Provide air release valves designed to permit release of air from an empty pipe during filling and capable of discharging accumulated air in the line while the line is in operation and under pressure. Attach valves by means of threaded pipe connections. Vent valves to the atmosphere.

2.3.5.1 Manual Air Release Valves

Consisting of an 80 mm 3 inch gate valve and 80 mm 3 inch ductile iron pipe and fittings. Install the valve with its line of flow in the horizontal position.

2.3.5.2 Automatic Air Release Valve

Compound lever type capable of withstanding operating pressures of 1034 kPa 150 psi, with a 13 mm 1/2 inch outlet. Provide with iron body and cover of the valve and a stainless steel float. Provide internal parts made entirely of stainless steel or bronze. Provide valve specifically adapted for use with sewage and complete with hose and blow-off valves to permit backflushing without dismantling the valve.

2.4 VALVE VAULTS

****
NOTE: Valve vaults will be required on all air vents installed on the buried force mains. Details will be shown on the drawings. When valve vaults are not required, this paragraph will be deleted.
****

Cast iron or concrete, except design concrete vaults installed in locations subject to vehicular traffic to withstand the following [_____] AASHTO load designation as outlined in AASHTO HB-17. Provide extension type cast iron vaults with slide type adjustment and flared base. Provide 5 mm 3/16 inch minimum metal. Ensure that the vault length is adaptable, without full extension, to the depth of cover over the pipe at the valve locations. Manufacture concrete vaults accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Cast the word "SEWER" in the cover. [Provide secure latch/lock mechanism to prevent unauthorized entry or tampering with the components within.]

2.5 MISCELLANEOUS MATERIALS

Provide miscellaneous materials in compliance with the following requirements:

2.5.1 Pipe Coatings and Linings

****
NOTE: UFC 3-240-01 includes conditions requiring lining and coating of pipes. Protective materials for galvanized pipe less than 80 mm 3 inches in diameter will be required only where the pipe is within the zone of influence of adjacent buried cathodic protection systems.
****

a. Steel, interior: AWWA C203 or AWWA C210.

b. Steel, exterior, buried: AWWA C203.

c. Steel, exterior, exposed: AWWA C210.

2.5.2 Joint Lubricants

Provide joint lubricants as recommended by the pipe manufacturer.

2.5.3 Bolts, Nuts and Glands

AWWA C111/A21.11.

2.5.4 Joint Compound

A stiff mixture of graphite and oil or inert filler and oil.

2.5.5 Joint Tape

ASTM D3308.

2.5.6 Bond Wire

Bond wire type RHW or USE, Size 1/0 AWG, neoprene jacketed copper conductor shaped to stand clear of the joint.

PART 3 EXECUTION

3.1 INSTALLATION

Install pipe, pipe fittings, and appurtenances at the locations indicated. Perform excavation, trenching, and backfilling as specified in Section 31 00 00 EARTHWORK.

3.1.1 Cutting

Cut pipe in a neat manner with mechanical cutters. Use wheel cutters where practicable. Grind sharp and rough edges smooth and remove loose material from the pipe before laying.

3.1.2 Laying

Except where otherwise authorized, lay pipe with bells facing the direction of laying. Before lowering and while suspended, inspect the pipe for defects. Reject defective material. Lay pipe in compliance with the following:

Ductile Iron	AWWA C600
Steel	AWWA C600
Concrete	Manufacturer's instructions
Polyvinyl Chloride	Manufacturer's instructions
Polyethylene	ASTM D2774
Polypropylene	ASTM D2774
Reinforced Thermosetting Resin	Manufacturer's instructions
Reinforced Plastic Mortar	Manufacturer's instructions

3.1.3 Jointing

3.1.3.1 Concrete Pressure Pipe

Follow the manufacturer's instructions when lubricating and installing rubber gaskets. Provide joints that comply with the manufacturer's instructions. Fill the external annular space with cement mortar or with a portland cement-filled polyurethane loop. For pipe 600 mm 24 inch diameter and larger, fill the internal annular space with cement mortar and struck off to ensure a smooth and continuous surface between pipe sections. Pipe less than 600 mm 24 inch diameter must have a rope or trowelable mastic affixed to the concrete face of the bell socket before joining the sections of pipe. Ensure the mastic provided causes no problems with the rubber gasket and ensure the gasket fills the interior

annular space when the pipe sections are pushed together.

3.1.3.2 Joints for PE Pipe

Provide heat fusion joints that comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Make flanged and mechanical joints in compliance with the manufacturer's instructions.

3.1.3.3 Joints for Polypropylene Pipe

Ensure heat fusion joints comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time.

3.1.3.4 Joints for PVC Pipe

a. Make threaded joints by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten the joint with strap wrenches taking care not to damage the pipe and fittings. Tighten the joint no more than 2 threads past hand-tight.

b. Bevel the ends of pipe for push-on joints to facilitate assembly. Mark pipe to indicate when the pipe is fully seated. Lubricate the gasket to prevent displacement. Ensure the gasket remains in proper position in the bell or coupling while the joint is made.

c. Ensure solvent-weld joints comply with the manufacturer's instructions.

3.1.3.5 Joints for RPMP Pipe

Use an elastomeric gasket in accordance with ASTM D4161.

3.1.3.6 Joints for RTRP Lines

Provide elastomeric gasket joints in compliance with the manufacturer's instructions.

3.1.3.7 Joints for Ductile Iron Pipe

Install mechanical and push-on type joints in compliance with AWWA C600 and the manufacturer's instructions. Install flanged joints in compliance with manufacturer's instructions.

3.1.3.8 Joints for Steel Pipe

Make screw joints tight with joint tape or joint compound applied with a brush to the male threads only. Install mechanical joints, push-on joints, and flanged joints in compliance with the manufacturer's instructions.

3.1.4 Coating and Lining

Field coat non-galvanized steel pipe in compliance with AWWA C203. Test the applied materials by means of a spark-type electrical device in compliance with AWWA C203. Repair flaws and holidays in the coating or lining of the pipe and the pipe joints; with the repaired areas at least equal in thickness to the minimum required for the pipe.

3.1.5 PE Pipe Encasement

****

NOTE: Loose polyethylene encasement is used in conjunction with ductile or cast iron pipe to protect the pipe from corrosive soils. Review AWWA 105 for design requirements and application.

****

[When installed underground, encase pipe with [_____] mm mil thick polyethylene in accordance with AWWA C105/A21.5.] [Encase in accordance with AWWA C105/A21.5.]

3.1.6 Installation of Valves

Prior to installation, clean valves of all foreign matter and inspect for damage and then fully open and close valves to ensure that all parts are properly operating. Install valves with the stem in the vertical position. [Install valves in valve vaults as indicated] [_____].

3.1.7 Installation of Valve Boxes

Install valve boxes over each outside gate valve, unless otherwise indicated. Center valve boxes over the valve. Carefully tamp fill around each valve box to a distance of 1.2 m 4 feet on all sides or to undisturbed trench face, if less than 1.2 m 4 feet.

3.1.8 Installation of Valve Vaults

Install valve vaults as indicated.

3.1.9 Drain Lines

Install drain lines where indicated. The drain line consists of a tee in the main line with a 100 mm 4 inch diameter branch, a 100 mm 4 inch diameter elbow, and a 100 mm 4 inch gate valve.

3.1.10 Thrust Restraint

[Provide thrust restraint as specified in Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.] [Provide plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, with thrust restraint.] Securely anchor valves or provide with thrust restraints to prevent movement. Install thrust restraints made from either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.10.1 Thrust Blocks

Provide concrete thrust blocking of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 14 MPa 2000 psi after 28 days. Place blocking between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, place the base and thrust bearing sides of thrust blocks directly against undisturbed earth. Place the side of thrust blocks not subject to thrust against forms, if applicable. Provide the area of bearing as shown or as directed. Place blocking so that the fitting joints are accessible for repair. Use steel rods and clamps, protected by galvanizing or by coating with bituminous paint, to anchor vertical down bends into gravity thrust blocks.

3.1.10.2 Restrained Joints

****
NOTE: When the restrained length is specified by the designer, this paragraph will be modified to delete the design requirement. The Government's designer should use UFC 3-230-01 for guidance.
****

For ductile iron pipe, design restrained joints in accordance with DIPRA TRD.

3.1.11 Grout

Provide grout mix for exterior joint protection on concrete pipes of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to flow into the joint recess beneath the diaper. Provide grout mix for interior joint protection of 1 part portland cement and 1 part sand. Substitute a polyurethane foam loop, impregnated with portland cement, in lieu of grout for exterior joints, if directed.

3.1.12 Bonded Joints

****
NOTE: Bonded joints will be used to maintain electrical continuity in metallic pipelines where cathodic protection is provided during construction or where it is anticipated that cathodic protection will be provided in the future.
****

Where indicated, provide a thermally welded metallic bond at each joint, including joints made with flexible couplings or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity.

3.2 FIELD QUALITY CONTROL

****
NOTE: Edit this paragraph to establish responsibility for tests.
****

Perform both a pressure test and a leakage test on all pipelines. [Obtain the Contracting Officer's approval of the method proposed for disposal of waste water from hydrostatic tests.] [The Contractor is responsible for all testing.] [Perform testing using an independent testing laboratory, subject to approval by the Contracting Officer.] [Contractor will coordinate all tests to ensure they are witnessed by the Contracting Officer.] Notify the Contracting Officer at least 7 days in advance of equipment tests. Submit the final test report to the Contracting Officer within 30 days after the test.

3.2.1 Pressure Test

After installing the pipe, joints, and thrust blocks, wait at least five days before pressure testing. For the pressure test, partially backfill the trench but leave the joints exposed for examination, then fill the pipe with water to expel all air. Subject the pipeline to a test pressure

of 700 kPa 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Open and close each valve several times during the test. Examine the exposed pipe, joints, fitting, and valves for leaks. Stop visible leaks or replace defective pipe, fittings, joints, or valves.

3.2.2 Leakage Test

****

NOTE: When the Contracting Officer determines that less stringent requirements would not have a detrimental impact on the environment, and would not violate Federal, state, or local requirements and would not contaminate any existing or potential water supply or habitable area, less stringent limits may be permitted. The maximum leakage permitted must not exceed 60 liters per 10 mm nominal diameter per kilometer 25 U.S. gallons per inch nominal diameter per mile of pipe per day, based on a pressure of 690 kPa 100 psi.

Allowable leakage at other test pressures will be the above limit multiplied by the product of the square root of the test pressure divided by 10. Inferior workmanship or defective material will not be accepted when less stringent requirements are allowed.

****

Conduct the leakage test subsequent to or concurrently with the pressure test. Place the amount of water permitted as leakage for the line in a sealed container attached to the supply side of the test pump. Apply no other source of supply to the pump or line under test. Pump the water into the line by the test pump as required to maintain the specified test pressure as described for a 2 hour period. The test will be considered a failure upon exhaustion of the supply or the inability to maintain the required pressure. PE pipe experiences diametric expansion and pressure elongation during initial testing. Consult the manufacturer prior to testing for special testing considerations. Determine allowable leakage by the following I-P formula:

L = NDP/K Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

At the conclusion of the test, measure the amount of water remaining in the container and record the results in the test report.

[Test ductile iron pressure lines in accordance with the requirements of AWWA C600.]

[Test concrete pressure lines in accordance with the recommendations of AWWA M9.]

[Test plastic pressure lines in accordance with the recommendations of AWWA C605.]

3.2.3 Retesting

If any deficiencies are revealed during any test, correct such deficiencies and repeat the tests until the results of the tests are within specified allowances, without additional cost to the Government.

-- End of Section --