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USACE / NAVFAC / AFCESA **UFGS-02532 (August 2004)**

Preparing Activity: USACE **Superseding UFGS-02532A (July 1998)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 22 December 2004
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SECTION TABLE OF CONTENTS

DIVISION 02 - SITE CONSTRUCTION

SECTION 02532

FORCE MAINS AND INVERTED SIPHONS; SEWER

08/04

-- End of Section Table of Contents --

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SECTION 02532

FORCE MAINS AND INVERTED SIPHONS; SEWER
08/04

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.
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PART 1 GENERAL

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NOTE: See TM 5-814-2 for additional design information on force mains and inverted siphons.
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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.
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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.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 6D	(2002) Specification for Pipeline Valves

AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C105	(1999) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	(1998) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1219 mm), for Water
AWWA C111	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	(1999) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151	(2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2002; A C203a-99) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C207	(2001) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
AWWA C208	(2001) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C210	(2003) Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C300	(2004) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C301	(1999) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C303	(2002) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(2002; A C500a-95) Metal-Seated Gate Valves for Water Supply Service
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS

AWWA C600	(1999) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C900	(1997) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA C909	(2002) Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 IN through 12 IN (100 mm Through 300 mm), for Water Distribution

ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.3	(1998) Malleable Iron Threaded Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A 53/A 53M	(2004a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM C 478	(2003a) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(2003a) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM D 1784	(2003) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2004a) Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2122	(1998; R 2004) Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D 2241	(2004b) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999e1) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2004) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(2003) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(2004) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2996	(2001) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

ASTM D 3035	(2003a) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3308	(2001) PTFE Resin Skived Tape
ASTM D 3350	(2002a) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 3754	(2004) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
ASTM D 4101	(2004a) Polypropylene Injection and Extrusion Materials
ASTM D 4161	(2001) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F 1483	(1998) Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe
ASTM F 477	(2002e1) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA TRD	(2002) Thrust Restraint Design for Ductile Iron Pipe

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

MSS SP-78	(1998) Cast Iron Plug Valves, Flanged and Threaded Ends

1.2 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for 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 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Hydrostatic Tests.

Copies of test results.

1.3 DELIVERY AND STORAGE

Pipe, fittings and accessories, and pipe coatings shall not be damaged 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. See TM 5-813-5 for additional criteria and requirements regarding pipe. 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.

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Piping for force mains less than 100 mm (4 inches) 4 inches in diameter shall be galvanized steel, polyvinyl chloride (PVC) plastic, polyethylene (PE) plastic or polypropylene plastic. Piping less than 100 mm (4 inches) 4 inches in diameter inside pump stations shall be galvanized steel. Piping for [force mains] [and] [inverted siphons] 100 mm (4 inches) 4 inches in diameter and larger shall be ductile iron, steel, concrete pressure pipe, PVC plastic, Oriented PVC PE plastic, or reinforced thermosetting resin pipe (RTRP). Piping 200 mm (8 inches) 8 inches in diameter and larger may also be reinforced plastic mortar pressure (RPMP) pipe. Piping 100 mm (4 inches) 4 inches in diameter and larger inside pump stations shall be ductile iron pipe with bolted flange joints. Pipe shall conform to the respective specifications and other requirements specified below.

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:

Publication	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 shall be applicable:

Nominal inside diameter of pipe,	mm	150	200
	(inches	6	8)

Nominal lining thickness, mm 6 6
(inch 1/4 1/4)

Nominal coating thickness, mm 25.4 25.4
(inch 1 1)

Class 150

Total steel area per mm, square mm 1990 1990
(per foot, square inch 0.94 0.94)

Gauge cylinder number 16 16

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Concrete pressure pipe and fittings shall 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 D 3350 and ASTM D 3035, minimum pressure rating of 689 kPa (100 psi) 100 psi at 23 degrees C (73.4 degrees F). 73.4 degrees F.

2.1.2.2 Polypropylene Pipe

ASTM D 2122 and ASTM D 4101.

2.1.2.3 PVC Pipe

****

NOTE: ASTM D 1785 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 Pipe and Fittings Less Than 100 mm (4 inches) 4 inches Diameter: ASTM D 1785, Schedule [40] [80] [120], or ASTM D 2241, SDR [21] [26] [32.5], with screw joints, push-on joints, or solvent weld joints.

b. PVC Pipe and Fittings 100 mm (4 inches) 4 inches Diameter and Larger: ASTM D 2241, 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

Pipe, couplings, and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454-B. Pipe shall conform to AWWA C909, Class 150, and to ASTM F 1483 and shall have an outside diameter equal to cast iron outside diameter.

2.1.3 RPMP Pipe

RPMP shall be produced by centrifugal casting and shall have an outside diameter equal to ductile iron pipe dimensions from 450 mm 18 inch to 1200 mm 48 inch. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness shall be 248 kPa 36 psi. RPMP shall be in accordance with ASTM D 3754.

2.1.4 RTRP Lines

ASTM D 2996, 2413 kPa (350 psi) 350 psi rated, cast iron pipe dimensions only, with elastomeric gasket joints. Fittings: AWWA C110, rated 1034 kPa (150 psi). 150 psi. When mechanical joint fittings are used, inside sleeves provided by the manufacturer shall be used.

2.1.5 Ductile Iron Pipe

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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 will be specified.

****

a. Ductile Iron Pipe: AWWA C151, working pressure not less than 1034 kPa (150 psi), 150 psi, unless otherwise shown or specified.

b. River Crossing Pipe: AWWA C151, minimum thickness Class 54 with joints in compliance with applicable requirements of AWWA C110.

c. Fittings, Mechanical: AWWA C110, rated for 1034 kPa (150 psi). 150 psi.

d. Fittings, Push-On: AWWA C110 and AWWA C111, rated for 1034 kPa (150 psi). 150 psi.

2.1.6 Steel Pipe

a. Steel Pipe, 150 mm (6 inches) 6 inches Diameter and Larger: AWWA C200.

b. Steel Pipe Less Than 150 mm (6 inches) 6 inches Diameter: ASTM A 53/A 53M, standard weight, threaded end, galvanized.

c. Fittings, 150 mm (6 inches) 6 inches Diameter and Larger: AWWA C200, fabricated in compliance with AWWA C208.

d. Fittings Less Than 150 mm (6 inches) 6 inches Diameter: ASME B16.3, galvanized.

2.2 JOINTS

2.2.1 PE Piping

a. Heat Fusion Joints: ASTM D 2657.

b. Flanged Joints: ASME B16.1 or AWWA C207.

c. Mechanical Joints: ASME B16.1.

2.2.2 Polypropylene Piping

Heat Fusion Joints: ASTM D 2657.

2.2.3 PVC Piping

a. Screw Joint Fittings: ASTM D 2464, Schedule 80.

b. Push-On Joint Fittings: ASTM D 3139, with ASTM F 477gaskets.

c. Solvent Cement: ASTM D 2564.

d. Couplings for use with plain end pipe shall have centering rings or stops to ensure the coupling is centered on the joint.

2.2.4 PVCO Pipe

Joints shall conform to ASTM D 3139. Elastomeric gaskets shall conform to ASTM F 477.

2.2.5 Ductile Iron Piping

a. Push-on Joints: AWWA C111.

b. Mechanical Joints: AWWA C111 as modified by AWWA C151.

c. Flanged Joints: AWWA C115.

2.2.6 Steel Piping

a. Push-on Joints: AWWA C200.

b. Mechanical Joints: AWWA C200.

c. Flanged Joints: AWWA C207.

2.2.7 RPMP Piping

Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D 4161 and ASTM F 477.

2.3 VALVES

2.3.1 Gate Valves

Gate valves 80 mm (3 inches) 3 inches and larger shall comply with AWWA C500. Valves for buried service shall be non-rising stem (NRS), 50 mm (2 inch) 2 inch square nut operated with joints applicable to the pipe or installation. Buried valves shall be furnished with extension stems

comprising socket, extension stem and operating nut, and shall be of an appropriate length to bring operating nut to within 150 mm 6 inches of grade. One 1200 mm 4 foot "T" handle valve wrench shall be furnished for each quantity of 6 buried valves. Gate valves that are exposed or installed inside shall be outside screw and yoke (OS&Y), handwheel operated with flange ends unless otherwise indicated. Gate valve operating nuts and handwheels shall have an arrow and the word "OPEN" cast in raised letters to indicate the direction of opening. Gate valves 350 mm (14 inches) 14 inches and larger shall be equipped with gearing to reduce operating effort. Gate valves 350 mm (14 inches) 14 inches and larger installed in horizontal lines in horizontal position with stems horizontal shall be equipped with bronze track, roller and scrapers to support the weight of the gate for its full length of travel. Gate valves 350 mm (14 inches) 14 inches and larger installed in vertical pipe lines with stems horizontal shall be fitted 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.

****

Check valves shall permit free flow of sewage forward and provide a positive check against backflow. Check valves shall be designed for a minimum working pressure of 1034 kPa (150 psi) 150 psi or as indicated. The body shall be iron. The manufacturer's name, initials, or trademark and also the size of the valve, working pressure, and direction of flow shall be directly cast on the body.

a. Ball Check Valves shall be iron body, shall have flanged ends, and shall be the non-slam type. Flanges shall be the Class 125 125 pound type complying with ASME B16.1. Ball shall be stainless steel unless otherwise specified.

b. Swing Check Valves shall comply with AWWA C508 and shall be iron body, bronze mounted, and shall have flanged ends. Flanges shall be the Class 125 125 pound type complying with ASME B16.1.

2.3.3 Plug Valves

Cast iron valves shall comply with MSS SP-78. Steel plug valves shall comply with API Spec 6D.

2.3.4 Pinch Valves

Pinch valves shall be double acting, jam-proof type with unobstructed streamlined flows and built-in operator. The body shall be iron with a non-rising handwheel. The sleeve shall be of pure gum rubber, neoprene, Buna N or hypalon as required for service. The valve shall have flanged ends. Flanges shall be of the Class 125 125 pound type complying 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.
****

Air release valves shall be designed to permit release of air from an empty pipe during filling and shall be capable of discharging accumulated air in the line while the line is in operation and under pressure. Valves shall be attached by means of threaded pipe connections. Valves shall be vented to the atmosphere.

a. Manual Air Release Valves: Manual air release valves shall consist of a 80 mm (3 inch) 3 inch gate valve and 80 mm (3 inch) 3 inch ductile iron pipe and fittings. The valve shall be installed with its line of flow in the horizontal position.

b. Automatic Air Release Valve: Automatic air release valves shall be of the compound lever type capable of withstanding operating pressures of 1034 kPa (150 psi).150 psi. The valves shall have a 13 mm (1/2 inch) 1/2 inch outlet. The body and cover of the valve shall be of iron with a stainless steel float. All internal parts shall be stainless steel or bronze. The valve shall be specifically adapted for use with sewage. Each valve shall be complete with hose and blow-off valves to permit backflushing without dismantling the valve.

2.4 VALVE BOXES

Valve boxes shall be cast iron or concrete, except that concrete boxes may be installed only in locations not subject to vehicular traffic. Cast iron boxes shall be the extension type with slide type adjustment and with flared base. The minimum thickness of metal shall be 5 mm.3/16 inch. The box length shall be adaptable, without full extension, to the depth of cover over the pipe at the valve locations. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "SEWER" shall be cast in the cover.

2.5 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.
****

Valve vaults shall be precast concrete units conforming to ASTM C 478M ASTM C 478.

2.6 MISCELLANEOUS MATERIALS

Miscellaneous materials shall comply with the following requirements:

2.6.1 Pipe Coatings and Linings

****
NOTE: TM 5-814-1/AFM 88-11, Vol. 1 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.

2.6.2 Joint Lubricants

Joint lubricants shall be as recommended by the pipe manufacturer.

2.6.3 Bolts, Nuts and Glands

AWWA C111.

2.6.4 Joint Compound

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

2.6.5 Joint Tape

ASTM D 3308.

2.6.6 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

Pipe, pipe fittings, and appurtenances shall be installed at the locations indicated. Excavation, trenching, and backfilling shall be as specified in Section 02300 EARTHWORK.

3.1.1 Adjacent Facilities

Installation of force mains and inverted siphons near adjacent facilities shall be as specified in Section 02531 SANITARY SEWERS.

3.1.2 Cutting

Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying.

3.1.3 Laying

Except where otherwise authorized, pipe shall be laid with bells facing the direction of laying. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Pipe shall be laid in compliance with the following:

a. Ductile Iron: AWWA C600.

b. Steel: AWWA C600.

c. Concrete: Manufacturer's instructions.

d. Polyvinyl Chloride: Manufacturer's instructions.

e. Polyethylene: ASTM D 2774.

f. Polypropylene: ASTM D 2774.

g. Reinforced Thermosetting Resin: Manufacturer's instructions.

h. Reinforced Plastic Mortar: Manufacturer's Instructions.

3.1.4 Jointing

3.1.4.1 Concrete Pressure Pipe

The manufacturer's instructions shall be followed when lubricating and installing rubber gaskets. Joints shall comply with the manufacturer's instructions. The external annular space shall be filled with cement mortar or with a portland cement-filled polyurethane loop. For pipe 600 mm (24 inch) 24 inch diameter and larger, the internal annular space shall be filled with cement mortar and struck off to ensure a smooth and continuous surface between pipe sections. Pipe less than 600 mm (24 inch) 24 inch diameter shall have a rope or trowelable mastic affixed to the concrete face of the bell socket before joining the sections of pipe. The mastic shall not be detrimental to the rubber gasket and shall fill the interior annular space when the pipe sections are pushed together.

3.1.4.2 Joints for PE Pipe

Heat fusion joints shall comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Flanged and mechanical joints shall be made in compliance with the manufacturer's instructions.

3.1.4.3 Joints for Polypropylene Pipe

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

3.1.4.4 Joints for PVC Pipe

a. Threaded joints shall be made by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. The joint shall be tightened with strap wrenches which will not damage the pipe and fittings. The joint shall be tightened no more than 2 threads past hand-tight.

b. Push-on joints: The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. The gasket shall remain in proper position in the bell or coupling while the joint is made.

c. Solvent-weld joints shall comply with the manufacturer's instructions.

3.1.4.5 Joints for RPMP Pipe

Joints shall be elastomeric gasket in accordance with ASTM D 4161.

3.1.4.6 Joints for RTRP Lines

Elastomeric gasket joints shall comply with the manufacturer's instructions.

3.1.4.7 Joints for Ductile Iron Pipe

Installation of mechanical and push-on type joints shall comply with AWWA C600 and the manufacturer's instructions. Installation of flanged joints shall comply with manufacturer's instructions.

3.1.4.8 Joints for Steel Pipe

Screw joints shall be made tight with joint tape or joint compound applied with a brush to the male threads only. Installation of mechanical joints, push-on joints, and flanged joints shall comply with the manufacturer's instructions.

3.1.5 Coating and Lining

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

3.1.6 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, pipe shall be encased with [_____] mm (mil) mil thick polyethylene in accordance with AWWA C105.] [Encasement shall be in accordance with AWWA C105.]

3.1.7 Installation of Valves

Prior to installation, valves shall be cleaned of all foreign matter and inspected for damage. Valves shall be fully opened and closed to ensure that all parts are properly operating. Valves shall be installed with the stem in the vertical position. [Valves shall be installed in valve vaults

as indicated] [_____].

3.1.8 Installation of Valve Boxes

Valve boxes shall be installed over each outside gate valve, unless otherwise indicated. Valve boxes shall be centered over the valve. Fill shall be carefully tamped 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.

3.1.9 Installation of Valve Vaults

Valve vaults shall be installed as indicated.

3.1.10 Drain Lines

Drain lines shall be installed where indicated. The drain line shall consist of a tee in the main line with a 100 mm (4 inch) 4 inch diameter branch, a 100 mm (4 inch) 4 inch diameter elbow, and a 100 mm (4 inch) 4 inch gate valve.

3.1.11 Thrust Restraint

[Thrust Restraint shall be as specified in Section 02510A WATER DISTRIBUTION SYSTEM.] [Plugs, caps, tees and bends deflecting 11-1/4 degrees or more, either vertically or horizontally, shall be provided with thrust restraint.] Valves shall be securely anchored or shall be provided with thrust restraints to prevent movement. Thrust restraints shall be either thrust blocks or, for ductile-iron pipes, restrained joints.

3.1.11.1 Thrust Blocks

Thrust blocking shall be concrete 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) 2000 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 thrust blocks shall be poured directly against undisturbed earth. The sides of thrust blocks not subject to thrust may be poured against forms. The area of bearing shall be as shown or as directed. Blocking shall be placed so that the fitting joints will be accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.11.2 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 TM 5-813-5 for guidance.
****

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

3.1.12 Grout

Grout for exterior joint protection on concrete pipes shall be a mix of 1 part portland cement, 2 parts sand, and of sufficient liquid consistency to

flow into the joint recess beneath the diaper. Grout for interior joint protection shall be a mix of 1 part portland cement and 1 part sand. A polyurethane foam loop, impregnated with portland cement, may be substituted for grout for exterior joints.

3.1.13 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.
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Where indicated, a metallic bond shall be provided at each joint, including joints made with flexible couplings or rubber gaskets, of ferrous-metallic piping to effect continuous conductivity. The bond shall be of the thermal-weld type.

3.2 HYDROSTATIC TESTS

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NOTE: Edit this paragraph to establish responsibility for tests.
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The pipeline shall be subjected to both a pressure test and a leakage test. [The method proposed for disposal of waste water from hydrostatic tests shall be approved by the Contracting Officer.] [Testing shall be the responsibility of the Contractor.] [Testing shall be performed by an approved independent testing laboratory or by the Contractor subject to approval.] [The test may be witnessed by the Contracting Officer.] The Contracting Officer shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the Contracting Officer within 30 days of the test.

3.2.1 Pressure Test

After the pipe has been installed, joints completed, thrust blocks have been in place for at least five days, and the trench has been partially backfilled, leaving the joints exposed for examination, the pipe shall be filled with water to expel all air. The pipeline shall be subjected to a test pressure of 700 kPa (100 psi) 100 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

3.2.2 Leakage Test

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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 shall 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.

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The leakage test may be conducted subsequent to or concurrently with the pressure test. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2 hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure. PE pipe can experience diametric expansion and pressure elongation during initial testing. The manufacturer shall be consulted prior to testing for special testing considerations. Allowable leakage shall be determined 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, the amount of water remaining in the container shall be measured and the results recorded in the test report.

3.2.3 Retesting

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

-- End of Section --