
USACE / NAVFAC / AFCEA UFGS-02510A (November 2004)

Preparing Activity: USACE Superseding
UFGS-02510A (December 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

SECTION 02510A

WATER DISTRIBUTION SYSTEM

11/04

NOTE: This guide specification covers the requirements for water supply, distribution, and service lines and connections to building service at a point approximately 1.5 m (5 feet) outside buildings and structures to which service is required.

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.

This guide specification includes tailoring options for service lines, distribution lines, fire hydrants, hose houses. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

PART 1 GENERAL

1.1 REFERENCES

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.

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 RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION
(AREMA)

AREMA Manual (2003) Manual for Railway Engineering

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(1999) Hypochlorites
AWWA B301	(1999) Liquid Chlorine
AWWA C104	(1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
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 C153	(2000) Ductile-Iron Compact Fittings for Water Service
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 C205	(2000) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop 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 C300	(1997) 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 C502	(1994) Dry-Barrel Fire Hydrants
AWWA C503	(1997) Wet-Barrel Fire Hydrants
AWWA C504	(2000) Rubber-Seated Butterfly Valves
AWWA C509	(2001) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(1999) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	(1997) Grooved and Shouldered Joints
AWWA C651	(1999) Disinfecting Water Mains
AWWA C700	(2002) Cold-Water Meters - Displacement Type, Bronze Main Case
AWWA C701	(2002) Cold-Water Meters - Turbine Type, for Customer Service
AWWA C702	(2001) Cold-Water Meters - Compound Type
AWWA C703	(1996) Cold-Water Meters - Fire Service Type
AWWA C704	(2002) Propeller-Type Meters for Waterworks Applications
AWWA C706	(1996; R 2001) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	(1982; R 1992) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(2001) Underground Service Line Valves and Fittings
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 C901	(2002) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service
AWWA C905	(1997) Polyvinyl Chloride (PVC) Pressure

Pipe and Fabricated Fittings 14 In.
Through 48 In. (350 mm through 1,200 mm)

AWWA C909 (2002) Molecularly Oriented Polyvinyl
Chloride (PVC) Pressure Pipe, 4 IN
through 12 IN (100 mm through 300 mm), for
Water Distribution

AWWA C950 (2001) Fiberglass Pressure Pipe

AWWA M23 (2002) Manual: PVC Pipe - Design and
Installation

ASBESTOS CEMENT PRODUCT PRODUCERS ASSOCIATION (ACPPA)

ACPPA 1344 (1988) Recommended Work Practices for A/C
Pipe

ASME INTERNATIONAL (ASME)

ASME B1.20.1 (1983; R 2001) Pipe Threads, General
Purpose, Inch

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

ASME B16.26 (1988) Cast Copper Alloy Fittings for
Flared Copper Tubes

ASME B16.3 (1998) Malleable Iron Threaded Fittings

ASME B36.10M (2001) Welded and Seamless Wrought Steel
Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A 36/A 36M (2003a) Carbon Structural Steel

ASTM A 53/A 53M (2002) Pipe, Steel, Black and Hot-Dipped,
Zinc-Coated, Welded and Seamless

ASTM B 88 (2002) Seamless Copper Water Tube

ASTM B 88M (1999) Seamless Copper Water Tube (Metric)

ASTM C 76 (2003) Reinforced Concrete Culvert, Storm
Drain, and Sewer Pipe

ASTM C 76M (2003) Reinforced Concrete Culvert, Storm
Drain, and Sewer Pipe (Metric)

ASTM D 1599 (1999) Resistance to Short-Time Hydraulic
Failure Pressure of Plastic Pipe, Tubing,
and Fittings

ASTM D 1784 (2003) Rigid Poly(Vinyl Chloride) (PVC)
Compounds and Chlorinated Poly(Vinyl
Chloride) (CPVC) Compounds

ASTM D 1785	(1999) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(2000) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	(1999) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2002) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2002) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	(2002) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(1997) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(2001) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1996; R 2002) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 2996	(2001) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 2997	(2001) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 3139	(1998) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3839	(2002) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
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
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MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-80 (2003) Bronze Gate, Globe, Angle and Check
Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1961 (2002) Fire Hose
NFPA 24 (2002) Installation of Private Fire
Service Mains and Their Appurtenances
NFPA 325-1 (1994) Fire Hazard Properties of Flammable
Liquids, Gases, and Volatile Solids
NFPA 49 (1994) Hazardous Chemicals Data
NFPA 704 (2001) Identification of the Hazards of
Materials for Emergency Response

NSF INTERNATIONAL (NSF)

NSF 14 (2003) Plastics Piping System Components
and Related Materials
NSF 61 (2003e) Drinking Water System Components -
Health Effects

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21 (1982; R 2000) White or Colored Silicone
Alkyd Paint (Type I, High Gloss and Type
II, Medium Gloss)
SSPC Paint 25 (1997; R 2000) Zinc Oxide, Alkyd, Linseed
Oil Primer for Use Over Hand Cleaned
Steel, Type I and Type II

1.2 PIPING

NOTE: All pipe materials specified will be retained
except under conditions where they would not be
suitable; see TM 5-813-5/AFM 88-10, Vol. 5. Where
it is determined that a pipe 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 shown on the contract drawings and stated in
the contract specifications. A study of the
conditions will be made to determine the suitability
of the materials. If doubt remains after the study,
because of exceptional conditions, a report should
be submitted to HQUSACE (CEMP-ET).

Ferrous metal piping should not be buried in the ground in the vicinity of switchyards or hydroelectric powerhouses. Experience has shown that rapid failure of the pipe occurs from galvanic corrosion due to the proximity of large copper ground mats.

The following definitions are established for use with this guide specification.

Water Supply Line: A pipeline from the source of supply to the treatment works or to the distribution system. For lines connected to the distribution system, only that portion which would not be subject to future tapping will be designated as water supply line. When a water supply line is connected so that it is subject to the same pressures as the distribution system, the working pressure will be not less than that required for the distribution system.

Water Distribution Line: A pipeline which is part of the distribution system. The distribution system comprises the network of piping throughout building areas and other areas of water use or fire demand, and includes hydrants, valves, and other appurtenances used to supply water for domestic and fire fighting purposes.

Water Service Line: Pipeline connecting building piping to water distribution lines.

This section covers water [supply] [distribution] [service] lines, and connections to building service at a point approximately 1.5 m 5 feet outside buildings and structures to which service is required. The Contractor shall have a copy of the manufacturer's recommendations for each material or procedure to be utilized available at the construction site at all times.

1.2.1 Service Lines

Piping for water service lines less than 80 mm 3 inches in diameter shall be galvanized steel, polyvinyl chloride (PVC) plastic, Oriented PVC plastic polyethylene, or copper tubing, unless otherwise shown or specified. Piping for water service lines 80 mm 3 inches and larger shall be ductile iron, polyvinyl chloride (PVC) plastic, filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe or steel, unless otherwise shown or specified.

1.2.2 Distribution Lines 80 mm (3 Inches) or Larger

Piping for water distribution lines 80 mm 3 inches or larger shall be ductile iron, polyvinyl chloride (PVC) through 900 mm 36 inch nominal diameter plastic, Oriented PVC plastic filament-wound or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, or reinforced concrete, unless otherwise shown or specified.

1.2.3 Supply Lines 80 mm (3 Inches) or Larger

Piping for water supply lines 80 mm 3 inches or larger shall be ductile iron, polyvinyl chloride (PVC) plastic, through 900 mm 36 inch nominal diameter, Oriented PVC plastic filament-wound reinforced or centrifugally cast reinforced thermosetting resin, reinforced plastic mortar pressure pipe, steel, or reinforced concrete, unless otherwise shown or specified.

1.2.4 Sprinkler Supply Lines

Piping for water lines supplying sprinkler systems for building fire protection shall conform to NFPA 24 from the point of connection with the water distribution system to the building 1.5 m 5 foot line.

1.2.5 Potable Water Lines

NOTE: Incorporate this paragraph only if it is a requirement of the state where the project will be constructed.

Piping and components of potable water systems which come in contact with the potable water shall conform to NSF 61.

1.2.6 Plastic Piping System

NOTE: Incorporate this paragraph only if it is a requirement of the state where the project will be constructed.

Plastic piping system components (PVC, polyethylene, thermosetting resin and reinforced plastic mortar pressure) intended for transportation of potable water shall comply with NSF 14 and be legibly marked with their symbol.

1.2.7 Excavation, Trenching, and Backfilling

Excavation, trenching, and backfilling shall be in accordance with the applicable provisions of Section 02300 EARTHWORK, except as modified herein.

1.3 UNIT PRICES

NOTE: When it is determined that lump sum contract is advisable, this paragraph will be deleted.

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. Payment will not be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 02300 EARTHWORK.

1.3.1 Measurement

The length of water lines to be paid for will be determined by measuring

along the centerlines of the various sizes of pipe furnished and installed.

Pipe will be measured from center of fitting to center of fitting, from center of water distribution line to end of service connection, and from center of water distribution line to center of hydrant. No deduction will be made for the space occupied by valves or fittings.

1.3.2 Payment

Payment will be made for water lines at the contract unit price per linear meter foot for the various types and sizes of water lines, and will be full compensation for all pipes, joints, specials, and fittings, complete in place. Payment for fire hydrants, gate valves, valve boxes, and standard valve manholes will be made at the respective contract unit price each for such items 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.

1.4 SUBMITTALS

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.

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

01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Installation

The manufacturer's recommendations for each material or procedure to be utilized.

Waste Water Disposal Plan[; G] [; G, [____]]

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

Satisfactory Installation

A statement signed by the principal officer of the contracting firm stating 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.

SD-06 Test Reports

Bacteriological Disinfection

Test results from commercial laboratory verifying disinfection.

SD-07 Certificates

Manufacturer's Representative

The name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified in all phases of PE, RTRP, and/or RPMP pipe laying and jointing and experienced to supervise the work and train the Contractor's field installers, prior to commencing installation.

Installation

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

Meters

Manufacturer's certificate stating that each meter furnished has been tested for accuracy of registration and compliance with the accuracy and capacity requirements of the appropriate AWWA standard.

1.5 MANUFACTURER'S REPRESENTATIVE

The Contractor shall have a manufacturer's field representative present at the jobsite during the installation and testing of PE, RTRP, and/or RPMP pipe to provide technical assistance and to verify that the materials are being installed in accordance with the manufacturer's prescribed procedures. When the representative feels that the Contractor is

installing and testing the PE, RTRP, and/or RPMP pipe in a satisfactory manner, certification shall be written to note which individuals employed by the Contractor are capable of properly installing the pipe. The field representative shall advise the Contractor of unsatisfactory conditions immediately when they occur. Such conditions include improper diameter of pipe ends, damaged interior liner, poorly prepared joints, improper curing of joints, moving pipe before joints are cured, bending pipe to follow abrupt changes in trench contours, leaving pipe ends open in trench overnight, not properly drying joints after rain storms, exceeding effective adhesive life, sharp objects in trench bed, backfill that could damage pipe, improper procedure for concrete encasement of pipe, omission of thrust blocks at changes in direction or any other condition which could have an adverse effect on the satisfactory completion and operation of the piping system.

1.6 HANDLING

Pipe and accessories shall be handled to ensure delivery to the trench in sound, undamaged condition, including no injury to the pipe coating or lining. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor in a satisfactory manner, at no additional cost to the Government. No other pipe or material shall be placed inside a pipe or fitting after the coating has been applied. Pipe shall be carried into position and not dragged. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool and dark place.

1.6.1 Coated and Wrapped Steel Pipe

Coated and wrapped steel pipe shall be handled in conformance with AWWA C203.

1.6.2 Polyethylene (PE) Pipe Fittings and Accessories

PE pipe, fittings, and accessories shall be handled in conformance with AWWA C901.

1.6.3 Miscellaneous Plastic Pipe and Fittings

Polyvinyl Chloride (PVC), Reinforced Thermosetting Resin Pipe (RTRP), and Reinforced Plastic Mortar Pressure (RPMP) pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1.

PART 2 PRODUCTS

2.1 PIPE

NOTE: Class 150 pipe will normally be specified for water distribution systems 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.

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 Reinforced and Prestressed Concrete Pipe

NOTE: AWWA Standards do not include reinforced and prestressed concrete pipe sizes less than 250 mm (10 inches) in diameter. Applicable size ranges for publications referenced in this paragraph are as follows:

Range of Diameter Size

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

In certain localities 150 mm and 200 mm (6 and 8 inch) prestressed concrete pipe is available. When such pipe is available, it should conform to AWWA C303 with the following exceptions:

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	25
(inch)	(1)	(1)

Class 150

Total steel area per meter, square mm (per foot, square inch)	1990 (0.94)	1990 (0.94)
Minimum cylinder thickness, mm (gauge)	1.519 16	1.519 16

Steel cylinder reinforced concrete pipe shall conform to AWWA C300, AWWA C301, or AWWA C303 and shall be designed to withstand a working pressure of not less than 1.03 MPa 150 psi unless otherwise shown or specified.

2.1.2 Plastic Pipe

2.1.2.1 PE Plastic Pipe

Pipe, tubing, and heat-fusion fittings shall conform to AWWA C901.

2.1.2.2 PVC Plastic Pipe

NOTE: Design stresses for pipe will meet the requirements of Appendix A of AWWA C900. SDR pipe manufactured and rated in accordance with ASTM D 2241, or any other referenced specification, will be rated and specified for working pressures in conformance with AWWA C900, Appendix A. PVC 1120 pipe, couplings and fittings will not be installed in a system subjecting the pipe to cyclic hoop stress in excess of 11.0 MPa (1600 psi). This rating is based on 23 degrees C (73.4 degrees F) or lower operating temperatures. Derating for higher operating temperature will be in accordance with AWWA C900, TABLE A1, Appendix A. The designer must evaluate the surge pressures that the system, in which pipe is to be installed, is capable of generating to assure the above requirement is met. Excessive surge pressures should be prevented by eliminating the causative condition or providing automatic surge-pressure relief. Plastic pipe shall not be used when it will be subject to temperature in excess of 37.8 degrees C (100 degrees F) in installed usage or exposed to a source of heat from adjacent lines or equipment.

Pipe, couplings and fittings shall be manufactured of material conforming to ASTM D 1784, Class 12454B.

a. Pipe Less Than 100 mm 4 inch Diameter:

(1) Screw-Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 80, with joints meeting requirements of 1.03 MPa 150 psi working pressure, 1.38 MPa 200 psi hydrostatic test pressure, unless otherwise shown or specified. Pipe couplings when used, shall be tested as required by ASTM D 2464.

(2) Elastomeric-Gasket Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 1.03 MPa 150 psi working pressure, 1.38 MPa 200 psi hydrostatic test pressure, unless otherwise shown or specified, or it may be pipe conforming to requirements of ASTM D 2241, elastomeric joint, with the following applications:

SDR	Maximum Working Pressure MPa	Minimum Hydrostatic Pressure MPa
26	0.689	0.917
21	0.827	1.103
17	1.034	1.379
13.5	1.379	1.834

SDR	Maximum Working Pressure psi	Minimum Hydrostatic Pressure psi
26	100	133
21	120	160
17	150	200
13.5	200	266

(3) Solvent Cement Joint: Pipe shall conform to dimensional requirements of ASTM D 1785 or ASTM D 2241 with joints meeting the requirements of 1.03 MPa 150 psi working pressure and 1.38 MPa 200 psi hydrostatic test pressure.

- b. Pipe 100 through 300 mm 4 through 12 inch Diameter: Pipe, couplings and fittings shall conform to AWWA C900, Class 150, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.
- c. Pipe 350 through 900 mm 14 through 36 inch Diameter: Pipe shall conform to AWWA C905 unless otherwise shown or specified.

2.1.2.3 Oriented Polyvinyl Chloride (PVC) 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 Reinforced Plastic Mortar Pressure (RPMP) Pipe

RPMP shall be produced by centrifugal casting and shall have an OD 304 to 1219 mm 12 to 48 inches equal to ductile-iron, with a 1034 kPa 150 psi pressure rating and with a minimum pipe stiffness of 248 kPa 36 psi. RPMP shall be in accordance with AWWA C950.

2.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

Pipe shall have a quick-burst strength greater than or equal to four times the normal working pressure of the pipe. The quick-burst strength test shall conform to the requirements of ASTM D 1599.

2.1.4.1 RTRP-I

RTRP-I shall conform to ASTM D 2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 1.03 MPa 150

psi at 23 degrees C 73 degrees F. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D 2996.

2.1.4.2 RTRP-II

RTRP-II shall conform to ASTM D 2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

2.1.5 Ductile-Iron Pipe

NOTE: Cement-mortar linings with twice the standard thickness may be specified for ductile-iron pipe conveying unusually aggressive waters. Consideration will be given to the service life of the pipe and the potential for changes in treatment methods.

Polyethylene encasement will apply where soil conditions warrant, in accordance with Appendix A of AWWA C105.

Ductile-iron pipe shall conform to AWWA C151, working pressure not less than 1.03 MPa 150 psi, unless otherwise shown or specified. Pipe shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard. When installed underground, pipe shall be coated in accordance with Section 13110A CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE). Flanged ductile iron pipe with threaded flanges shall be in accordance with AWWA C115.

2.1.6 Steel Pipe

2.1.6.1 Pipe 80 mm 3 Inches and Larger, Not Galvanized

NOTE: Use of nongalvanized steel pipe is restricted to water supply and service lines only where future tapping is not anticipated; use for sizes 80 mm (3 inches) in diameter and larger. Pipe sizes and minimum acceptable thickness required will be inserted in the blanks.

For high sulfate soils or waters, cement will be specified to conform to ASTM C 150, Portland Cement, Type II. When reactive aggregates are used, cement will be specified to conform to ASTM C 150, Portland Cement, low alkali. When specified, ASTM C 150, Portland Cement, will be added to paragraph REFERENCES.

Steel pipe, not galvanized, shall conform to AWWA C200 with dimensional requirements as given in ASME B36.10M for pipe 150 mm 6 inches in diameter and larger, and ASTM A 53/A 53M for smaller sizes. Pipe shall be welded or seamless with plain or shouldered and grooved ends in accordance with AWWA C606 for use with mechanical couplings or bell-and-spigot ends with rubber gaskets. Bell-and-spigot ends for sizes less than 150 mm 6 inches diameter

shall be as required by AWWA C200. The minimum wall thickness of the various sizes of pipe shall be as follows:

Pipe Sizes	Thickness
[_____]	[_____]

2.1.6.2 Galvanized Steel Pipe

Galvanized steel pipe shall conform to ASTM A 53/A 53M, standard weight.

2.1.6.3 Protective Materials for Steel Pipe

NOTE: 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.

Protective materials for steel pipe, except as otherwise specified, shall be mechanically applied in a factory or plant especially equipped for the purpose. The materials shall, unless otherwise indicated on the drawings, consist of [one of the following] [the following] for the indicated pipe material and size:

- a. Pipe and fittings less than 80 mm 3 inches in diameter shall be thoroughly cleaned of foreign material by wire brushing and solvent cleaning, and then given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203; threaded ends of pipe and fittings shall be adequately protected prior to coating.
- b. Pipe 80 mm (3 Inches) 3 Inches or Larger, Not Galvanized:
 - (1) Cement-mortar coating and lining shall conform to and shall be applied in conformance with AWWA C205. Cement-mortar coating and linings shall not be used for pipe less than 100 mm 4 inches in diameter.
 - (2) Coal-tar enamel lining, coating and wrapping shall conform to AWWA C203 for materials, method of application, tests and handling. Non-asbestos material shall be used for the outerwrap.
 - (3) Cement-mortar lining, in lieu of coal-tar enamel lining, may be used with coal-tar enamel coating and wrapping. Cement-mortar lining shall conform to and shall be applied in conformance with AWWA C205.

2.1.7 Copper Tubing

NOTE: Use copper tubing for water service lines. Joints are limited to pipe sizes less than 65 mm (2-1/2 inches) in diameter.

Copper tubing shall conform to ASTM B 88M ASTM B 88, Type K, annealed.

2.2 FITTINGS AND SPECIALS

2.2.1 Reinforced Concrete Pipe System

Fittings and specials required for closures, curves, bends, branches and connections to valves, pipe, or structures shall be approved by the Contracting Officer and conform to the details furnished by the manufacturer and to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.2.2 PVC Pipe System

- a. For pipe less than 100 mm 4 inch diameter, fittings for threaded pipe shall conform to requirements of ASTM D 2464, threaded to conform to the requirements of ASME B1.20.1 for use with Schedule 80 pipe and fittings; fittings for solvent cement jointing shall conform to ASTM D 2466 or ASTM D 2467; and fittings for elastomeric-gasket joint pipe shall be iron conforming to AWWA C110 or AWWA C111. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104.
- b. For pipe 100 mm 4 inch diameter and larger, fittings and specials shall be iron, bell end in accordance with AWWA C110, 1.03 MPa 150 psi pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer; or fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153.

2.2.3 RTRP and RPMP Pipe

Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm 6 inches shall conform to AWWA C950. Iron fittings shall be cement-mortar lined in accordance with AWWA C104 and shall conform to AWWA C110 and AWWA C111. Fittings shall be suitable for working and testing pressures specified for the pipe.

2.2.4 Ductile-Iron Pipe System

NOTE: The use of cast gray 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 may be specified.

Fittings and specials shall be suitable for 1.03 MPa 150 psi pressure rating, unless otherwise specified. Fittings and specials for mechanical joint pipe shall conform to AWWA C110. Fittings and specials for use with push-on joint pipe shall conform to AWWA C110 and AWWA C111. Fittings and specials for grooved and shouldered end pipe shall conform to AWWA C606. Fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Ductile iron compact fittings shall conform to AWWA C153.

2.2.5 Steel Pipe System

2.2.5.1 Not Galvanized Steel Pipe

Fittings and specials shall be made of the same material as the pipe. Specials and fittings may be made of standard steel tube turns or segmentally welded sections, with ends to accommodate the type of couplings or joints specified for the pipe. Dimensions of steel pipe fittings shall be in accordance with AWWA C208. The thickness and pressure rating of pipe fittings and specials shall be not less than the thickness specified and the pressure rating calculated for the pipe with which they are used. Protective materials for fittings and specials shall be as specified for the pipe. Specials and fittings that cannot be mechanically lined, coated, and wrapped shall be lined, coated, and wrapped by hand, using the same material used for the pipe with the same number of applications of each material, smoothly applied.

2.2.5.2 Galvanized Steel Piping

Steel fittings shall be galvanized. Screwed fittings shall conform to ASME B16.3. Flanged fittings shall conform to AWWA C207.

2.2.5.3 Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.2.6 Copper Tubing System

**NOTE: The maximum nominal pipe size of fittings and
specials in ASME B16.26 is 50 mm (2 inches).**

Fittings and specials shall be flared and conform to ASME B16.26.

2.3 JOINTS

2.3.1 Gaskets for Reinforced Concrete Pipe

Rubber-gasket joints shall be of the type using a bell-and-spigot joint design of steel. The gaskets shall conform to AWWA C300, AWWA C301, or AWWA C303, as applicable.

2.3.2 Plastic Pipe Jointing

2.3.2.1 PE Pipe

Joints for pipe fittings and couplings shall be strong tight joints as specified for PE in Paragraph INSTALLATION. Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendation, and as approved by the Contracting Officer.

2.3.2.2 PVC Pipe

Joints, fittings, and couplings shall be as specified for PVC pipe. Joints

connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer.

2.3.2.3 PVC Pipe

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

2.3.3 RPMP Pipe

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

2.3.4 RTRP Pipe

2.3.4.1 RTRP-I, Grade 1 and 2

Joints shall be bell and spigot with elastomeric gasket, mechanical coupling with elastomeric gasket, threaded and bonded coupling, or tapered bell and spigot with compatible adhesive. All RTRP-I materials shall be products of a single manufacturer.

2.3.4.2 RTRP-II, Grade 1 and 2

Joints shall be the bell and spigot type with elastomeric gasket, bell and spigot with adhesive, butt-jointed with adhesive bonded reinforced overlay, mechanical, flanged, threaded or commercially available proprietary joints, provided they are capable of conveying water at the pressure and temperature of the pipe.

2.3.5 Ductile-Iron Pipe Jointing

- a. Mechanical joints shall be of the stuffing box type and shall conform to AWWA C111.
- b. Push-on joints shall conform to AWWA C111.
- c. Rubber gaskets and lubricants shall conform to the applicable requirements of AWWA C111.

2.3.6 Steel Pipe Jointing

2.3.6.1 Steel Pipe, Not Galvanized

- a. Mechanical couplings shall be as specified.
- b. Bell-and-spigot joints for use with rubber gaskets shall conform to AWWA C200, as appropriate for the type of pipe. Rubber gaskets shall conform to applicable requirements of AWWA C200.
- c. Flanges shall conform to AWWA C207, and shall be used only in above ground installation or where shown on the drawings, or when approved.

2.3.6.2 Mechanical Couplings

Mechanical couplings for steel pipe shall be the sleeve type, or when approved, the split-sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by

expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

2.3.7 Bonded Joints

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

[Where indicated] [For all ferrous pipe], a metallic bond shall be provided at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. The bond wire shall be Size 1/0 copper conductor suitable for direct burial shaped to stand clear of the joint. The bond shall be of the thermal weld type.

2.3.8 Isolation Joints

Isolation joints shall be installed between nonthreaded ferrous and nonferrous metallic pipe, fittings and valves. Isolation joints shall consist of a sandwich-type flange isolation gasket of the dielectric type, isolation washers, and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with 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.

- a. Sleeve-type couplings shall be used for joining plain end pipe sections. The two couplings shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.
- b. Split-sleeve type couplings may be used in aboveground installations when approved in special situations and shall consist of gaskets and a housing in two or more sections with the necessary bolts and nuts.

2.3.9 Copper Tubing Jointing

Joints shall be compression-pattern flared and shall be made with the specified fittings.

2.4 VALVES

2.4.1 Check Valves

Check valves shall be designed for a minimum working pressure of 1.03 MPa 150 psi or as indicated. Valves shall have a clear waterway equal to the full nominal diameter of the valve. Valves shall open to permit flow when inlet pressure is greater than the discharge pressure, and shall close tightly to prevent return flow when discharge pressure exceeds inlet pressure. The size of the valve, working pressure, manufacturer's name, initials, or trademark shall be cast on the body of each valve. Valves 50 mm 2 inches and larger shall be [outside lever and spring] [outside lever

and weight] [_____] type.

- a. Valves 50 mm 2 inches and smaller shall be all bronze designed for screwed fittings, and shall conform to MSS SP-80, Class 150, Types 3 and 4 as suitable for the application.
- b. Valves larger than 50 mm 2 inches shall be iron body, bronze mounted, shall have flanged ends, and shall be the non-slam type. Flanges shall be the Class 125 type conforming to ASME B16.1.

2.4.2 Gate Valves

**Note: Delete reference to AWWA C500 if
resilient-seated gate valves are required.**

Gate valves shall be designed for a working pressure of not less than 1.03 MPa 150 psi. Valve connections shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening.

- a. Valves smaller than 80 mm 3 inches shall be all bronze and shall conform to MSS SP-80, Type 1, Class 150.
- b. Valves 80 mm 3 inches and larger shall be iron body, bronze mounted, and shall conform to AWWA C500. Flanges shall not be buried. An approved pit shall be provided for all flanged connections.
- c. Resilient-Seated Gate Valves: For valves 80 to 300 mm 3 to 12 inches in size, resilient-seated gate valves shall conform to AWWA C509.

2.4.3 Rubber-Seated Butterfly Valves

Rubber-seated butterfly valves shall conform to the performance requirements of AWWA C504. Wafer type valves conforming to the performance requirements of AWWA C504 in all respects, but not meeting laying length requirements will be acceptable if supplied and installed with a spacer providing the specified laying length. All tests required by AWWA C504 shall be met. Flanged-end valves shall be installed in an approved pit and provided with a union or sleeve-type coupling in the pit to permit removal. Mechanical-end valves 80 through 250 mm 3 through 10 inches in diameter may be direct burial if provided with a suitable valve box, means for manual operation, and an adjacent pipe joint to facilitate valve removal. Valve operators shall restrict closing to a rate requiring approximately 60 seconds, from fully open to fully closed.

2.4.4 Pressure Reducing Valves

Pressure reducing valves shall maintain a constant downstream pressure regardless of fluctuations in demand. Valves shall be suitable for [_____] MPa psi operating pressure on the inlet side, with outlet pressure set for [_____] MPa psi. The valves shall be of the hydraulically-operated, pilot controlled, globe or angle type, and may be actuated either by diaphragm or piston. The pilot control shall be the diaphragm-operated, adjustable,

spring-loaded type, designed to permit flow when controlling pressure exceeds the spring setting. Ends shall be [threaded] [flanged]. Valve bodies shall be bronze, cast iron or cast steel with bronze trim. Valve stem shall be stainless steel. Valve discs and diaphragms shall be synthetic rubber. Valve seats shall be bronze. Pilot controls shall be bronze with stainless steel working parts.

2.4.5 Vacuum and Air Relief Valves

Vacuum and air relief valves shall be of the size shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze trim and stainless steel float.

2.4.6 Indicator Post for Valves

Each valve shown on the drawings with the designation "P.I.V." shall be equipped with indicator post conforming to the requirements of NFPA 24. Operation shall be by a wrench which shall be attached to each post.

2.5 VALVE BOXES

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

2.6 VALVE PITS

Valve pits shall be constructed at locations indicated or as required above and in accordance with the details shown. Concrete shall have compressive strength of 21 MPa 3000 psi in accordance with Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE.

2.7 FIRE HYDRANTS

NOTE: Wet barrel hydrants will be allowed only in warm climates where freezing is not a problem. Where existing hydrants do not have American National standard fire-hose coupling threads, adapters with male threads conforming to local practice will be specified for the new hydrants. If adapters are to be permanently fixed to the hydrant, caps will be specified. If adapters are required for pumper outlet only, the appropriate deletions of words and brackets will be made.

Hydrants shall be [dry-barrel type conforming to AWWA C502 with valve opening at least 125 mm 5 inches in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed and reasonably tight against leakage and

with a breakable valve rod coupling and breakable flange connections located no more than 200 mm 8 inches above the ground grade] [wet-barrel type conforming to AWWA C503, with either an automatic breakoff check valve or an auxiliary gate valve on hydrant branch]. Hydrants shall have a 150 mm 6 inch bell connection, two 65 mm 2-1/2 inch hose connections and one 115 mm 4-1/2 inch pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with 1 coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25 and 2 finish coats of silicone alkyd paint conforming to SSPC Paint 21, [of the installation's standard colors or as directed by the Contracting Officer] [color in accordance with NFPA recommendations]. Suitable bronze adapter for [the 115 mm 4-1/2 inch] [each] outlet, with caps, shall be furnished.

2.8 FIRE-HYDRANT HOSE HOUSES

NOTE: The hydrant-hose house equipment listed is standard for areas such as family housing where mobile fire department response within approximately 15 minutes is unlikely. In other types of installations where lack of prompt fire department response necessitates fully equipped hydrant-hose houses for use by station personnel, the type and amount of equipment needed for individual hose houses will be adjusted depending on the needs of the immediate area. In salt water areas or other locations where there is a corrosive atmosphere, metal-hose houses will not be specified.

Hose houses conforming to the requirements of NFPA 24 shall be furnished at each fire hydrant indicated on the drawings to have a fire-hydrant hose house. The following equipment, in addition to that listed in NFPA 24, paragraph 5-6.1, shall be furnished with each hose house:

- a. 60 m 200 feet of 65 mm 2-1/2 inch, woven jacketed, rubber lined hose conforming to NFPA 1961 with a minimum service test pressure of 2.06 MPa 300 psi.
- b. 30 m 100 feet of 40 mm 1-1/2 inch, woven jacketed, rubber lined hose conforming to NFPA 1961 with a minimum service test pressure of 2.06 MPa 300 psi.
- c. One gated 65 by 40 by 40 mm 2-1/2 by 1-1/2 by 1-1/2 inch wye.
- d. One playpipe for 65 mm 2-1/2 inch hose with 25 mm 1 inch shutoff nozzle tip.
- e. One playpipe for 40 mm 1-1/2 inch hose with 13 mm 1/2 inch shutoff nozzle or combination nozzle.
- f. Two adapter fittings, 65 to 40 mm 2-1/2 to 1-1/2 inch.
- g. Two spanners for 40 mm 1-1/2 inch hose.

2.9 MISCELLANEOUS ITEMS

2.9.1 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be either the single or double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium plated straps and nuts. Clamps shall have a rubber gasket cemented to the body.

2.9.2 Corporation Stops

Corporation stops shall have standard corporation stop thread conforming to AWWA C800 on the inlet end, with flanged joints, compression pattern flared tube couplings, or wiped joints for connections to goosenecks.

2.9.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88M ASTM B 88, Type K, annealed. Length of cable requirement connections shall be in accordance with standard practice.

2.9.4 Service Stops

Service stops shall be water-works inverted-ground-key type, oval or round flow way, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings, and shall be designed for a hydrostatic test pressure not less than 1.375 MPa 200 psi.

2.9.5 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of [1.03] [_____] MPa [150] [_____] psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 67.8 Newton meters 50 foot-pound.

2.9.6 Service Boxes

Service boxes shall be cast iron or concrete and shall be extension service boxes of the length required for the depth of the line, with either screw or slide-type adjustment. The boxes shall have housings of sufficient size to completely cover the service stop or valve and shall be complete with identifying covers.

2.9.7 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

2.9.8 Meters

NOTE: Refer to the applicable AWWA standard and delete inappropriate wording. Delete types of meters not required. Where highly aggressive water is encountered, the manufacturers should be consulted for recommendations concerning materials of construction.

Meters shall be the type and size shown on the drawings or specified. Meters of each of the various types furnished and installed shall be supplied by one manufacturer.

2.9.8.1 Displacement Type

Displacement type meters shall conform to AWWA C700. Registers shall be straight-reading and shall read in cubic meters [U.S. gallons] [cubic feet]. Meters in sizes 13 through 25 mm 1/2 through 1 inch [shall] [shall not] be frost-protection design. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C700.

2.9.8.2 Turbine Type

NOTE: Turbine type main-line meters require a strainer.

Turbine type meters shall conform to AWWA C701 [Class I] [Class II]. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in cubic meters [U.S. gallons] [cubic feet]. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C701.

2.9.8.3 Compound Type

Compound type meters shall conform to AWWA C702 and [shall] [shall not] be furnished with strainers. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. The main casing shall be tapped for field testing purposes. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in cubic meters [U.S. gallons] [cubic feet]. The meter [shall] [shall not] be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote

register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C702.

2.9.8.4 Fire Service Type

Fire service type meters shall be [proportional type] [turbine type] conforming to AWWA C703 and [shall] [shall not] be furnished with strainers. The main casing shall be [bronze] [cast iron protected by corrosion resistant coating] with stainless steel external fasteners. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in cubic meters [U.S. gallons] [cubic feet]. The meter [shall] [shall not] be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct reading remote register designed in accordance with AWWA C706] [or] [an encoder type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C703. When turbine type main line meters are used, the meter shall be supplied with a separate check valve, as a unit.

2.9.8.5 Propeller Type

Propeller type meters shall conform to AWWA C704. Registers shall be straight-reading type, shall be [permanently sealed] [open] and shall read in cubic meters [U.S. gallons] [cubic feet]. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be [a direct-reading remote register designed in accordance with AWWA C706] [or] [an encoder-type remote register designed in accordance with AWWA C707]. Meters shall comply with the accuracy and capacity requirements of AWWA C703.

2.9.9 Meter Boxes

Meter boxes shall be of cast iron, concrete, or plastic. The boxes shall be of sufficient size to completely enclose the meter and shutoff valve or service stop. Meter boxes set in paved areas subject to vehicular traffic shall be cast iron, or concrete with cast iron lid and cast iron meter reader lid. Boxes set in sidewalks, not subject to vehicular traffic, [shall use concrete covers with cast iron meter reader lids] [shall be concrete with cast iron lid and cast iron meter reader lid]. Plastic boxes and lids [shall] [shall not] be used in unpaved areas or grass areas not subject to vehicular traffic. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

2.10 METER VAULTS

Note: The designer shall provide construction details of meter vaults on the drawings.

Large meters shall be installed in reinforced concrete vaults in accordance with the details shown on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the Contracting Officer, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Copper tubing shall be cut square and all burrs shall be removed. Squeeze type mechanical cutters shall not be used for ductile iron.

3.1.2 Adjacent Facilities

NOTE: It will be the Contractor's responsibility to maintain the proper clearances between water lines and sewers. Where the water main is to be laid near the route of an existing sewer, force main, or inverted siphon, the in-place location of the sewer will be checked before laying the water main and, where necessary to provide minimum horizontal or vertical separation, will be shown on the contract drawings.

3.1.2.1 Sewer Lines

Where the location of the water pipe is not clearly defined in dimensions on the drawings, the water pipe shall not be laid closer horizontally than 3 m 10 feet from a sewer except where the bottom of the water pipe will be at least 300 mm 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 1.8 m 6 feet from the sewer. Where water lines cross under gravity-flow sewer lines, the sewer pipe, for a distance of at least 3 m 10 feet each side of the crossing, shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 900 mm 3 feet horizontally of the crossing. Water lines shall in all cases cross above sewage force mains or inverted siphons and shall be not less than 600 mm 2 feet above the sewer main. Joints in the sewer main, closer horizontally than 900 mm 3 feet to the crossing, shall be encased in concrete.

3.1.2.2 Water Lines

Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines, or electric wiring.

3.1.2.3 Copper Tubing Lines

Copper tubing shall not be installed in the same trench with ferrous piping materials.

3.1.2.4 Nonferrous Metallic Pipe

Where nonferrous metallic pipe, e.g. copper tubing, crosses any ferrous piping material, a minimum vertical separation of 300 mm 12 inches shall be maintained between pipes.

3.1.2.5 Casing Pipe

Note: For casing pipe design , refer to AWWA Manual of Practice M-11 for design of steel pipe and to American Railway Engineering and Maintenance-of-Way Association (AREMA) Volume 1, Part 5, Section 5.3, or Concrete Pipe Handbook for design of concrete casing pipe.

The first blank in the paragraph should have the name of the railway company having jurisdiction inserted where applicable.

Water pipe shall be encased in a sleeve of rigid conduit for the lengths shown. Sleeves under railroads shall be in accordance with [the [_____] railroad company requirements] [the criteria contained in AREMA Manual, Part 5]. Where sleeves are required, in all other cases, the pipe sleeve shall be [steel, manufactured in accordance with AWWA C200, ASTM A 36/A 36M, [_____] , with a minimum wall thickness of [_____]] [reinforced concrete in accordance with ASTM C 76M and ASTM C 76, Class [V] [_____] as specified for storm drains in Section 02630 STORM DRAINAGE]. A minimum clearance of at least 50 mm 2 inches between the inner wall of the sleeve and the maximum outside diameter of the sleeved pipe and joints shall be provided. Sand bedding or suitable pipe support shall be provided for the water pipe through the sleeve. Sleeves of ferrous material shall be provided with corrosion protection as required in Section [13110A CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)] [_____] .

3.1.2.6 Structures

Where water pipe is required to be installed within 1 m 3 feet of existing structures, the water pipe shall be sleeved as required in Paragraph "Casing Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

3.1.3 Joint Deflection

3.1.3.1 Allowable for Reinforced Concrete Pipe

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for reinforced concrete pipe unless a lesser amount is recommended by the manufacturer. Long radius curves in reinforced concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflection does not exceed the maximum recommended by the pipe manufacturer. Short radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated specials specified.

3.1.3.2 Offset for Flexible Plastic Pipe

Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.

3.1.3.3 Allowable for Ductile-Iron Pipe

The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.

3.1.3.4 Allowable for Steel Pipe

For pipe with bell-and-spigot rubber-gasket joints, maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets shall be 5 degrees unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

3.1.3.5 Allowable for RPMP Pipe

For pipe with bell and spigot rubber gasket joints, maximum allowable deflections from a straight line or grade shall be 4 degrees determined by the diameter, unless a lesser amount is recommended by the manufacturer. Short-radius curves and closures shall be formed by short lengths of pipe or fabricated specials specified.

3.1.4 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other authorized equipment. Water-line materials shall not be dropped or dumped into the trench. Abrasion of the pipe coating shall be avoided. Except where necessary in making connections with other lines or as authorized by the Contracting Officer, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by and at the Contractor's expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

3.1.4.1 Reinforced Concrete Pipe Installation

Reinforced concrete pipe shall be installed in accordance with recommendations of the pipe manufacturer. Before laying reinforced concrete pipe, the outside surface of the spigot and the inside surface of the bell shall be cleaned and an acceptable vegetable-compound lubricant applied to the inside surface of the bell and to the rubber gasket. Where prescribed by the pipe manufacturer, the gasket shall be placed in the groove on the end of the pipe before the pipe is placed in the trench. After the pipe has been forced together, the position of the rubber gasket shall be checked with a feeler gauge in accordance with the pipe manufacturer's recommendations. Tapping of reinforced concrete cylinder pipe shall be done in accordance with the manufacturer's approved recommendations. Where the manufacturer recommends that the taps be made by attaching the rubber-gasketed saddle to the outside of the pipe using

U-bolts, the saddle shall be grouted in if necessary, the mortar coating shall be chipped away, even with the hole in the saddle plate. The exposed circumferential wires shall be removed and the cylinder and concrete core drilled out, and the steel saddle and U-bolts shall be protected by concrete encasement.

3.1.4.2 Plastic Pipe Installation

RTRP shall be installed in accordance with ASTM D 3839. RPMP shall be installed in accordance with the manufacturer's recommendations. PE Pipe shall be installed in accordance with ASTM D 2774. PVC pipe shall be installed in accordance with AWWA M23.

3.1.4.3 Piping Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. When made under pressure, these connections shall be installed using standard methods as approved by the Contracting Officer. Connections to existing asbestos-cement pipe shall be made in accordance with ACPPA 1344.

3.1.4.4 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.4.5 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.5 Jointing

3.1.5.1 Reinforced Concrete Pipe Requirements

The inside and outside annular spaces between abutting sections of concrete pipe shall be filled with rich cement mortar in accordance with the pipe manufacturer's recommendations. Excess mortar shall be removed from interior annular spaces, leaving a smooth and continuous surface between pipe sections. Exposed portions of steel joint rings shall be protected from corrosion by a metallic coating or by an approved nonmetallic coating. Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

3.1.5.2 PE Pipe Requirements

Jointing shall comply with ASTM D 2657, Technique I-Socket Fusion or Technique II-Butt Fusion.

3.1.5.3 PVC Plastic Pipe Requirements

- a. Pipe less than 100 mm 4 inch diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying an approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and/or fitting. To avoid excessive torque, joints shall be tightened no more than one thread past

hand-tight. Preformed rubber-ring gaskets for elastomeric-gasket joints shall be made in accordance with ASTM F 477 and as specified. Pipe ends for push-on joints shall be beveled to facilitate assembly and marked to indicate when the pipe is fully seated. The gasket shall be prelubricated to prevent displacement. The gasket and ring groove in the bell or coupling shall match. The manufacturer of the pipe or fitting shall supply the elastomeric gasket. Couplings shall be provided with stops or centering rings to assure that the coupling is centered on the joint. Solvent cement joints shall use sockets conforming to ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.

- b. Pipe 100 through 300 mm 4 through 12 inch diameter: Joints shall be elastomeric gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm 4 inch diameter with configuration using elastomeric ring gasket.
- c. Pipe 350 through 900 mm 14 through 36 inch diameter: Joints shall be elastomeric gasket push-on joints made in accordance with AWWA M23.

3.1.5.4 RTRP I, RTRP II and RPMP Pipe

- a. RTRP I: Assembly of the pipe shall be done in conformance with the manufacturer's written instruction and installation procedures. Field joints shall be prepared as specified by the pipe manufacturer. Several pipe joints having interference-fit type couplings may be field bonded and cured simultaneously. However, the pipe shall not be moved and additional joints shall not be made until the previously laid joints are completely cured. Joints not having interference-fit type coupling shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe when the clamp is tightened in place. The pipe manufacturer shall provide a device or method to determine when the joint is pulled against the pipe stop. Additionally, the pipe manufacturer shall furnish a gauge to measure the diameter of the spigot ends to ensure the diameter conforms to the tolerances specified by the manufacturer. All pipe ends shall be gauged. Factory certified tests shall have been satisfactorily performed to verify that short-term rupture strength is 10.3 MPa 1,500 psior greater when carried out in accordance with ASTM D 1599. At any ambient temperature, field bonded epoxy-cemented joints shall be cured with a self-regulating, thermostatically temperature controlled, electrical heating blanket for the time and temperature recommended by the manufacturer for the applicable size and type of joint, or by an alternate heating method recommended by the manufacturer and approved by the Contracting Officer. The joint sections shall not be moved during heating, or until the joint has cooled to ambient temperature.
- b. RTRP II: A reinforced overlay joint shall be used to join sections together through a placement of layers of reinforcement fiberglass roving, mat, tape or fabric thoroughly saturated with compatible catalyzed resin.

- c. RPMP: Bell and spigot gasket-sealing coupling shall be used to connect pipes. The spigot shall be lubricated prior to push-together assembly.
- d. Fittings and Specials for RTRP and RPMP Pipe: Metal to RTRP and RPMP pipe connections shall be made by bolting steel flanges to RTRP and RPMP pipe flanges. Cast-iron fitting with gasket bell or mechanical joint may be used with RTRP if pipe has cast iron outside diameter. Steel flanges shall be flat-faced type. Where raised-face steel flanges are used, spacer rings shall be used to provide a flat-face seat for RTRP and RPMP pipe flanges. A full-face Buna "N" gasket 3 mm 1/8 inch thick with a shore hardness of 50-60 shall be used between all flanged connections. The RTRP and RPMP pipe flange shall have raised sealing rings. Flat washers shall be used under all nuts and bolts on RTRP and RPMP pipe flanges. Bolts and nuts shall be of noncorrosive steel and torqued to not more than 135 Newton meters 100 foot pounds. Flanges shall not be buried. A concrete pit shall be provided for all flanged connections.

3.1.5.5 Ductile-Iron Pipe Requirements

Mechanical and push-on type joints shall be installed in accordance with AWWA C600 for buried lines or AWWA C606 for grooved and shouldered pipe above ground or in pits.

3.1.5.6 Not Galvanized Steel Pipe Requirements

- a. Mechanical Couplings: Mechanical couplings shall be installed in accordance with the recommendations of the couplings manufacturer.
- b. Rubber Gaskets: Rubber gaskets shall be handled, lubricated where necessary, and installed in accordance with the pipe manufacturer's recommendations.

3.1.5.7 Galvanized Steel Pipe Requirements

Screw joints shall be made tight with a stiff mixture of graphite and oil, inert filler and oil, or with an approved graphite compound, applied with a brush to the male threads only. Compounds shall not contain lead.

3.1.5.8 Copper Tubing Requirements

Joints shall be made with flared fittings. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

3.1.5.9 Bonded Joints Requirements

Bonded joints shall be installed in accordance with details specified for joints in paragraph JOINTS.

3.1.5.10 Isolation Joints and Dielectric Fittings

Isolation joints and dielectric fittings shall be installed in accordance with details specified in paragraph JOINTS. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm 1/8 inch thickness of coal tar over all fitting surfaces.

3.1.5.11 Transition Fittings

Connections between different types of pipe and accessories shall be made with transition fittings approved by the Contracting Officer.

3.1.6 Installation of Service Lines

Service lines shall include the pipeline connecting building piping to water distribution lines to the connections with the building service at a point approximately 1.5 m 5 feet outside the building where such building service exists. Where building services are not installed, the Contractor shall terminate the service lines approximately 1.5 m 5 feet from the site of the proposed building at a point designated by the Contracting Officer. Such service lines shall be closed with plugs or caps. All service stops and valves shall be provided with service boxes. Service lines shall be constructed in accordance with the following requirements:

3.1.6.1 Service Lines 50 mm 2 Inches and Smaller

Service lines 50 mm 2 inches and smaller shall be connected to the main by a directly-tapped corporation stop or by a service clamp. A corporation stop and a copper gooseneck shall be provided with either type of connection. Maximum sizes for directly-tapped corporation stops and for outlets with service clamps shall be as in TABLE I. Where 2 or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard branch connections. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply.

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

Pipe Size mm	Corporation Stops, mm For Ductile-Iron Pipe	Outlets w/Service Clamps, mm Single & Double Strap
80	--	25
100	25	25
150	32	40
200	40	50
250	40	50
300 & larger	50	50

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

Pipe Size Inches	Corporation Stops, Inches For Ductile-Iron Pipe	Outlets w/Service Clamps, Inches Single & Double Strap
3	--	1
4	1	1

TABLE I. SIZE OF CORPORATION STOPS AND OUTLET

Pipe Size Inches	Corporation Stops, Inches For Ductile-Iron Pipe	Outlets w/Service Clamps, Inches Single & Double Strap
6	1-1/4	1-1/2
8	1-1/2	2
10	1-1/2	2
12 & larger	2	2

NOTE:

- a. Service lines 40 mm 1-1/2 inches and smaller shall have a service stop.
- b. Service lines 50 mm 2 inches in size shall have a gate valve.

3.1.6.2 Service Lines Larger than 50 mm (2 Inches)

Service lines larger than 50 mm 2 inches shall be connected to the main by a tapped saddle, tapping sleeve and valve, service clamp or reducing tee, depending on the main diameter and the service line diameter, and shall have a gate valve. Lines 80 mm 3 inches and larger may use rubber-seated butterfly valves as specified above, or gate valves.

3.1.6.3 Service Lines for Sprinkler Supplies

Water service lines used to supply building sprinkler systems for fire protection shall be connected to the water distribution main in accordance with NFPA 24.

3.1.7 Field Coating and Lining of Pipe

3.1.7.1 Steel Pipe 80 mm 3 inch and Larger, Not Galvanized

- a. Cement-mortar coating and lining: Field jointing shall conform to Appendix, AWWA C205. Any defective area found in the coating and/or lining of pipe and joints shall be removed to the pipe wall and repaired. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe. Steel reinforcement in the coating shall be repaired or replaced as necessary to assure a complete and soundly reinforced coating.
- b. Coal-tar enamel coating, lining and wrapping: Field jointing shall conform to AWWA C203. The applied materials shall be tested by means of a spark-type electrical inspection device in accordance with the requirements of AWWA C203. Any flaws or holidays found in the coating and/or lining of pipe and joints shall be repaired by patching or other approved means. The repaired areas shall be at least equal in thickness to the minimum coating and/or lining required for the pipe.

3.1.7.2 Galvanized Steel Pipe, Field Coating

**NOTE: Field coating of joints for galvanized pipe
will normally be required only when coating is
specified for the pipe.**

Field joints shall be given 1 coat of coal-tar primer and 2 coats of coal-tar enamel conforming to AWWA C203. The tests of the coating shall conform to AWWA C203, and any flaws or holidays found in the coating of pipe and joints shall be repaired by patching or other approved means; the repaired areas shall be at least equal in thickness to the minimum coating required for the pipe.

3.1.8 Setting of Fire Hydrants, Meters, Valves and Valve Boxes

3.1.8.1 Location of Fire Hydrants

Fire hydrants shall be located and installed as shown. Each hydrant shall be connected to the main with a 150 mm 6 inch branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with pumper nozzle facing the roadway, with the center of the lowest outlet not less than 450 mm 18 inches above the finished surrounding grade, and the operating nut not more than 1.2 m 48 inches above the finished surrounding grade. Fire hydrants designated on the drawings as low profile shall have the lowest outlet not less than 450 mm 18 inches above the finished surrounding grade, the top of the hydrant not more than 600 mm 24 inches above the finished surrounding grade. Except where approved otherwise, the backfill around hydrants shall be thoroughly compacted to the finished grade immediately after installation to obtain beneficial use of the hydrant as soon as practicable. The hydrant shall be set upon a slab of concrete not less than 100 mm 4 inches thick and 400 mm 15 inches square. Not less than 0.2 cubic meters 7 cubic feet of free-draining broken stone or gravel shall be placed around and beneath the waste opening of dry barrel hydrants to ensure drainage.

3.1.8.2 Location of Meters

[Meters and meter boxes] [Vaults] shall be installed at the locations shown on the drawings. The meters shall be centered in the [boxes] [vaults] to allow for reading and ease of removal or maintenance.

3.1.8.3 Location of Valves

**NOTE: If valve wrenches are to be provided, add a
statement giving the number of valve wrenches to be
furnished by the Contractor.**

After delivery, valves, including those in hydrants, shall be drained to prevent freezing and shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and hydrants and valves shall be fully opened and fully closed to ensure that all parts are in working condition. Check, pressure reducing, vacuum, and air relief valves shall be installed in valve pits. Valves and valve boxes shall be installed where shown or specified, and shall be set plumb. Valve boxes shall be centered on the valves. Boxes shall be installed over each

outside gate valve unless otherwise shown. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be tamped around each valve box or pit to a distance of 1.2 m 4 feet on all sides of the box, or the undisturbed trench face if less than 1.2 m 4 feet.

3.1.8.4 Location of Service Boxes

Where water lines are located below paved streets having curbs, the boxes shall be installed directly back of the curbs. Where no curbing exists, service boxes shall be installed in accessible locations, beyond the limits of street surfacing, walks and driveways.

3.1.9 Tapped Tees and Crosses

Tapped tees and crosses for future connections shall be installed where shown.

3.1.10 Thrust Restraint

Plugs, caps, tees and bends deflecting 11.25 degrees or more, either vertically or horizontally, on waterlines 100 mm 4 inches in diameter or larger, and fire hydrants shall be provided with thrust restraints. 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.

3.1.10.1 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 2,000 psi after 28 days. Blocking shall be placed between solid ground and the hydrant or 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.

3.1.10.2 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 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.

3.2 HYDROSTATIC TESTS

NOTE: 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 psi), the test pressure will be 1.38 MPa

(200 psi). For other working pressures the test pressure will be adjusted accordingly.

Where any section of a water line is provided with concrete thrust blocking for fittings or hydrants, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved. The Contractor shall submit for approval a Waste Water Disposal Plan for this and other tests.

3.2.1 Pressure Test

After the pipe is laid, the joints completed, fire hydrants permanently installed, 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 pressure test of [1.38] [] MPa [200] [] psi. Water supply lines designated on the drawings shall be subjected for 1 hour to a hydrostatic pressure test of [1.38] [] MPa [200] [] psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, hydrants, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, hydrants and valves discovered in consequence of this pressure test shall be removed and replaced with sound material, and the test shall be 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 is encountered:

- a. Wet or unstable soil conditions in the trench.
- b. 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.
- c. Maintaining the trench in an open condition would delay completion of the project.

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 required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02300 EARTHWORK.

3.2.2 Leakage Test

Leakage test 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 water line shall be subjected to not less than [1.38] [] MPa [200] [] psi pressure. Water supply lines designated on the drawings shall be subjected to a pressure equal to [1.38] [] MPa [200] [] psi. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section, necessary to maintain pressure within 34.5 kPa 5 psi of the specified leakage test pressure after the pipe has been filled with water and the air expelled. Piping installation will not be accepted if leakage exceeds the allowable leakage which is determined by the following formula:

$L = 0.0001351ND(P \text{ raised to } 0.5 \text{ power})$

L = Allowable leakage in gallons per hour

N = Number of joints in the length of pipeline tested

D = Nominal diameter of the pipe in inches

P = Average test pressure during the leakage test, in psi gauge

Should any test of pipe disclose leakage greater than that calculated by the above formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Government.

3.2.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a 5-day delay, pipelines 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. Cement-mortar lined pipe may be filled with water as recommended by the manufacturer before being subjected to the pressure test and subsequent leakage test.

3.2.4 Concurrent Hydrostatic Tests

The Contractor may elect to conduct the hydrostatic tests using either or both of the following procedures. Regardless of the sequence of tests employed, the results of pressure tests, leakage tests, and disinfection shall be as specified. Replacement, repair or retesting required shall be accomplished by the Contractor at no additional cost to the Government.

- a. Pressure test and leakage test may be conducted concurrently.
- b. Hydrostatic tests and disinfection may be conducted concurrently, using the water treated for disinfection to accomplish the hydrostatic tests. If water is lost when treated for disinfection and air is admitted to the unit being tested, or if any repair procedure results in contamination of the unit, disinfection shall be reaccomplished.

3.3 BACTERIOLOGICAL DISINFECTION

NOTE: The option of having the Contracting Officer perform the sampling and testing will be selected only if Government laboratory facilities are available and with concurrence from appropriate laboratory personnel. At some locations, either county or installation health officers inspect the disinfection process. If this is required add a notification requirement and give the office to be notified, with a phone number.

3.3.1 Disinfection Procedure

Before acceptance of potable water operation, each unit of completed waterline shall be disinfected [as prescribed by AWWA C651.] [as specified.

After pressure tests have been made, the unit 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 either liquid chlorine, calcium hypochlorite, or sodium hypochlorite, conforming to paragraph MISCELLANEOUS ITEMS. The chlorinating material shall provide a dosage of not less than 50 ppm and shall be introduced into the water lines in an approved manner. Polyvinyl Chloride (PVC) pipe lines shall be chlorinated using only the above specified chlorinating material in solution. The agent shall not 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. 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 fire hydrant on the line shall be opened and closed several times.]

3.3.2 Sampling

From several points in the unit, [the Contracting Officer will take samples of water in proper sterilized containers for bacterial examination.] [personnel from the Contractor's commercial laboratory shall take at least [3] [_____] water samples from different points, approved by the Contracting Officer, in proper sterilized containers and perform a bacterial examination in accordance with state approved methods. The commercial laboratory shall be certified by the state's approving authority for examination of potable water.]

3.3.3 Acceptance Requirements

The disinfection shall be repeated until tests indicate the absence of pollution for at least 2 full days. The unit will not be accepted until satisfactory bacteriological results have been obtained.

3.4 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed. The Contractor shall submit a statement of Satisfactory Installation as specified in the Submittals paragraph.

-- End of Section --