
USACE / NAVFAC / AFCEA / NASA UFGS-33 11 00 (October 2006)

Preparing Activity: NAVFAC Superseding
 UFGS-33 11 00 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 19 March 2007

Latest change indicated by CHG tags

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10/06

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SECTION 33 11 00

WATER DISTRIBUTION 10/06

NOTE: This guide specification covers the requirements for potable and nonpotable (raw water and sea or salt water) systems, in which the largest size pipe is 600 mm 24 inches in diameter and the maximum working pressure does not exceed 1400 kPa 200 psi for pipelines 300 mm 12 inch size and smaller and 1000 kPa 150 psi for pipelines larger than 300 mm 12 inch size. This section covers exterior water distribution systems only, including water supply, distributing and service lines and connections to a point approximately 1.5 m (5 feet) outside of buildings and structures.

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.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

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

1. Cathodic protection should be considered where the anticipated degree of corrosion is so great that coating systems, including polyethylene encasement, are not adequate to protect the piping for the

desired life of the system.

2. When piping beneath open piers and other exposed locations is subject to freezing temperatures, include requirements for insulation and protective coverings in the project specification. Information on this subject related to open piers may be found in Technical Report R593, September 1968, "Freeze Protection for Freshwater and Sanitary Piping Under Open Piers," by the Naval Facilities Engineering Services Center, 560 Center Drive, Port Hueneme, California 93043-4328.

NOTE: The following information shall be shown on the project drawings:

1. Plan and location of all new pipelines, including size of pipe.
2. Maximum working pressure of the system.
3. Location, size, and type of service of existing connecting, intersecting, and adjacent pipelines and other utilities.
4. Paved areas and railroads which pass over new pipelines.
5. Profile, where necessary to show unusual conditions.
6. Class or thickness of pipe, including material identification, and limits for same where class or thickness will be different for different sections of pipeline.
7. Bedding conditions.
8. Location of flanged joints, joints made with sleeve-type mechanical couplings, grooved and shouldered type joints, and insulating joints.
9. Location of valves, hydrants (showing which are traffic type hydrants), and indicator posts; and details concerning valves, where necessary.
10. Size and shape of hydrant operating nut and cap nuts if nonstandard nuts are required; dimensions of threads (major diameter, minor diameter, pitch diameter, thread form, and number of threads per inch) on hydrant hose and pumper connections if nonstandard threads are required.
11. Connection of service line to water main, if different from that specified.
12. Location or size of thrust blocks, including

type; or location of and details of metal harness, when necessary (metal harness, when necessary, must be shown for PVC plastic water main pipe).

13. Design details of concrete thrust blocks.

14. Design details for fire hydrant installation.

PART 1 GENERAL

1.1 REFERENCES

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

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

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

AREMA Manual (2006) Manual for Railway Engineering

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300 (2004) Hypochlorites

AWWA B301 (2004) Liquid Chlorine

AWWA C104/A21.4 (2003) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C105/A21.5 (2005) Polyethylene Encasement for

Ductile-Iron Pipe Systems

AWWA C110/A21.10	(2003) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2005) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2002; Errata 2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/A21.53	(2006) Ductile-Iron Compact Fittings for Water Service
AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(2002) 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 C206	(2003) Field Welding of Steel Water Pipe
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 C209	(2000) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fitting for Steel Water Pipe
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; Errata 2000) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
AWWA C303	(2002) Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
AWWA C500	(2002) Metal-Seated Gate Valves for Water Supply Service
AWWA C502	(2005) Dry-Barrel Fire Hydrants

AWWA C503	(2005) Wet-Barrel Fire Hydrants
AWWA C504	(2006) Rubber-Seated Butterfly Valves
AWWA C508	(2001) Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS
AWWA C509	(2001) Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C606	(2004) Grooved and Shouldered Joints
AWWA C651	(2005) 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; R 2004) Cold-Water Meters - Fire Service Type
AWWA C704	(2002) Propeller-Type Meters for Waterworks Applications
AWWA C706	(1996; R 2005) Direct-Reading, Remote-Registration Systems for Cold-Water Meters
AWWA C707	(2005) Encoder-Type Remote-Registration Systems for Cold-Water Meters
AWWA C800	(2005) 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 C906	(1999) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In., (1,575 mm) for Water Distribution and Transmission
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 M11	(2004) Manual: Steel Pipe: A Guide for Design and Installation
AWWA M23	(2002) Manual: PVC Pipe - Design and Installation
AWWA M9	(1995) Manual: Concrete Pressure Pipe

ASME INTERNATIONAL (ASME)

ASME B16.1	(2005) Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.15	(1985; R 2004) Cast Bronze Threaded Fittings Classes 125 and 250
ASME B16.18	(2001; R 2005) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2001; R 2005) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2006) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1998) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(1998) Gray Iron Threaded Fittings, Classes 125 and 250
ASME B18.2.2	(1987; R 2005) Square and Hex Nuts (Inch Series)
ASME B18.5.2.1M	(2006) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2005) Metric Round Head Square Neck Bolts

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2004e1) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 47/A 47M	(1999; R 2004) Ferritic Malleable Iron Castings

ASTM A 48/A 48M	(2003) Gray Iron Castings
ASTM A 53/A 53M	(2006a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 536	(1984; R 2004) Ductile Iron Castings
ASTM A 563	(2004a) Carbon and Alloy Steel Nuts
ASTM A 563M	(2006) Carbon and Alloy Steel Nuts (Metric)
ASTM A 746	(2003) Ductile Iron Gravity Sewer Pipe
ASTM B 32	(2004) Solder Metal
ASTM B 42	(2002e1) Seamless Copper Pipe, Standard Sizes
ASTM B 61	(2002) Steam or Valve Bronze Castings
ASTM B 62	(2002) Composition Bronze or Ounce Metal Castings
ASTM B 88	(2003) Seamless Copper Water Tube
ASTM B 88M	(2005) Seamless Copper Water Tube (Metric)
ASTM C 150	(2005) Portland Cement
ASTM C 94/C 94M	(2006) Ready-Mixed Concrete
ASTM D 1527	(1999; R 2005) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D 1599	(2005) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D 1784	(2006a) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2235	(2004) Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2241	(2005) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2282	(1999; R 2005) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
ASTM D 2464	(2006) Threaded Poly(Vinyl Chloride) (PVC)

	Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(2006) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	(2006) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2468	(1996a) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(2004e1) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2657	(2003) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D 2774	(2004e1) 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; R 2005) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3839	(2002e1) Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D 4161	(2001; R 2005) "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 402	(1993; R 1999) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F 477	(2002e1) Elastomeric Seals (Gaskets) for Joining Plastic Pipe

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

MSS SP-80	(2003) Bronze Gate, Globe, Angle and Check Valves
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NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1961	(2002) Fire Hose
NFPA 24	(2006) Installation of Private Fire Service Mains and Their Appurtenances
NFPA 325	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 49	(2003) Hazardous Chemicals Data
NFPA 704	(2006) Identification of the Hazards of Materials for Emergency Response

UNDERWRITERS LABORATORIES (UL)

UL 246	(1993; Rev thru Dec 1998) Hydrants for Fire-Protection Service
UL 262	(2004) Gate Valves for Fire-Protection Service
UL 312	(2004) Check Valves for Fire-Protection Service
UL 789	(2004) Indicator Posts for Fire-Protection Service

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-3	(1992) Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch)
UBPPA UNI-B-8	(2000) Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 Inch)

[1.2 UNIT PRICES

NOTE: Delete this paragraph for lump sum type contract. DO not use on Navy projects.

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.

1.2.1 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.

1.2.2 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.

]1.3 DESIGN REQUIREMENTS

NOTE: Provide only those pipe sizes and materials applicable to the project requirements.

For Army projects, reference TM 5-813-5/ AFM 88-10, Vol. 5 for design, considerations in pipe material selection.

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.

1.3.1 Water Distribution Mains

NOTE: Choose one of the following options.

[Provide water distribution mains indicated as [] mm [] inch lines of [ductile-iron] [polyvinyl chloride (PVC) plastic] [molecularly oriented Polyvinyl Chloride (PVC) pressure] [filament-wound reinforced or centrifugally cast reinforced thermosetting resin] [reinforced plastic mortar pressure] [steel] or [] pipe. Provide water main accessories, gate valves [and check valves] as specified and where indicated. Submit design calculations of water piping.]

NOTE: Choose the option below for Navy projects.

[Provide water distribution mains indicated as 100 through 300 mm 4 through 12 inch diameter pipe sizes of [ductile-iron] [, molecularly oriented polyvinyl chloride pressure (PVC)] [or] [polyvinyl chloride (PVC) plastic] pipe. Provide [ductile iron] [or] [concrete] pipe for 300 mm 12 inch diameter or larger pipe sizes. Also provide water main accessories, gate valves [and check valves] as specified and where indicated.]

[1.3.2 Water Service Lines

NOTE: Provide only those pipe sizes and materials
applicable to the project requirements.

NOTE: Ductile-iron piping is available in 80 mm 3
inch size, but 100 mm 4 inch size is smallest for
PVC plastic water main pipe.

NOTE: Choose one of the following options.

[Provide water service lines indicated as [] mm [] inch lines
from water distribution main to building service at [a point approximately
1.5 m 5 feet from building] [the point[s] indicated]. Water service lines
shall be [copper pipe] [copper tubing] [polyvinyl chloride (PVC) plastic
pipe] [filament-wound or centrifugally cast reinforced thermosetting resin
pipe] [reinforced plastic mortar pressure pipe]
[acrylonitrile-butadiene-styrene (ABS) plastic pipe] [or] [steel pipe].
[[Ductile-iron] [or] [polyvinyl chloride (PVC) plastic] pipe appurtenances,
and valves as specified for water mains may also be used for service
lines.] Provide water service line appurtenances as specified [and where
indicated]. Submit design calculations of water piping.]

NOTE: Choose the option below for Navy projects.

[Provide water service lines indicated as less than 100 mm 4 inch lines
from water distribution main to building service at [a point approximately
1.5 m 5 feet from building] [the point[s] indicated]. Water service lines
shall be [copper tubing] [polyvinyl chloride (PVC) plastic pipe] [or]
[acrylonitrile-butadiene-styrene (ABS) plastic pipe]. Provide water
service line appurtenances as specified [and where indicated].]

]1.4 SUBMITTALS

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

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

For submittals requiring Government approval on Army

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

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

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

SD-03 Product Data

NOTE: Delete bracketed wording in the first sentence when steel pipe is not allowed.

Piping Materials

Water distribution main piping, fittings, joints, valves, and coupling

Water service line piping, fittings, joints, valves, and coupling

Hydrants

Indicator posts

Corporation stops

Valve boxes

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on [and rubber-gasketed bell-and-spigot] joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

Design calculations of water piping

SD-06 Test Reports

Bacteriological Disinfection; [____], [____].

Test results from commercial laboratory verifying disinfection

SD-07 Certificates

Water distribution main piping, fittings, joints, valves, and coupling

Water service line piping, fittings, joints, valves, and coupling

Shop-applied lining [and coating]

Lining

Fire hydrants

Displacement Type Meters

Compound Type Meters

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

SD-08 Manufacturer's Instructions

[Delivery, storage, and handling]

Installation procedures for water piping

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store [plastic piping, jointing materials and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, [valves] [and] [hydrants] free of dirt and debris.

1.5.2 Handling

NOTE: Delete coatings not allowed for the project.
AWWA M11 in the chapter on protective coatings
contains information on the relative merits of
cement mortar and coal-tar enamel coatings. See
Foreword to AWWA C210 for information on coal-tar
epoxy coating.

Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings;

make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. 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. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

1.5.2.1 Coated and Wrapped Steel Pipe

[Handle steel pipe with [coal-tar enamel] [coal-tar epoxy] coating in accordance with the provisions of [AWWA C203](#).]

1.5.2.2 Polyethylene (PE) Pipe, Fittings, and Accessories

Handle PE pipe, fittings, and accessories in accordance with [AWWA C901](#).

1.5.2.3 Miscellaneous Plastic Pipe and Fittings

Handle Polyvinyl Chloride (PVC), [Reinforced Thermosetting Resin Pipe (RTRP) and Reinforced Mortar Pressure (RPMP)] pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing materials that are not to be installed immediately under cover out of direct sunlight.

Storage facilities shall be classified and marked in accordance with [NFPA 704](#), with classification as indicated in [NFPA 49](#) and [NFPA 325](#).

PART 2 PRODUCTS

2.1 [WATER DISTRIBUTION MAIN MATERIALS](#)

NOTE: Allowable Piping Materials:

1. The project specification should allow all piping materials for water mains and for water service lines which are suitable for the project, each to be permitted as a Contractor's option.

2. Refer to the appropriate Design or Technical Manual on water supply systems for general information on piping materials suitable for use on water supply lines, water mains and water service lines for water distribution systems.

3. Pipe materials which are known to be unsuitable for particular local conditions (i.e., corrosion, deterioration, etc.) should not be permitted for the project. However, consider use of more effective protective coatings, etc., where economically feasible.

4. Approval of polyethylene water service line

piping, previously allowed by this guide specification, was withdrawn by Amendment 2 (September 1982) to TS-02713 (January 1981) because of widespread problems with the pipe. This withdrawal of approval remains in force until further notice.

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.

2.1.1 Piping Materials

2.1.1.1 Ductile-Iron Piping

NOTE: Insert the necessary Pressure Class/Thickness Class to meet project conditions, as determined from AWWA C151/A21.51, Tables for Pressure Class and Thickness Class.

When pipe is installed underground in a corrosive environment as determined by pH and resistivity tests, then include Section 26 42 13.00 20 CATHODIC PROTECTION BY GALVANIC ANODE.

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/A21.5.

- a. Pipe and Fittings: Pipe, [except flanged pipe,] AWWA C151/A21.51, [Pressure Class [____]] [Thickness Class [____]]. [Flanged pipe, AWWA C115/A21.15.] Fittings, AWWA C110/A21.10 or AWWA C153/A21.53 [; fittings with push-on joint ends conforming to the same requirements as fittings with mechanical-joint ends, except that the bell design shall be modified, as approved, for push-on joint]. Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the specified joints. Pipe and fittings shall have cement-mortar lining, AWWA C104/A21.4, [twice the] standard thickness.

- b. Joints and Jointing Material:

NOTE: Push-on joint or mechanical joint may be used except when the greater deflection afforded by the

mechanical joint (as compared to the push-on joint) is considered necessary for all joints in the distribution system. See AWWA C600 for allowable deflection on each type of joint. When mechanical joints, flanged joints, mechanically coupled type joints using sleeve-type mechanical couplings, grooved or shouldered type joints, and insulating joints are specified as exceptions to the basic jointing method, their location(s) should be either indicated on the project drawings or specified using terminology consistent with that on the project drawings.

NOTE: Do not locate flanged joints, grooved joints, and shouldered joints on buried pipelines unless they are in valve pits or chambers.

(1) Joints: Joints for pipe and fittings shall be [push-on joints] [or] [mechanical joints] [unless otherwise indicated]. [Provide mechanical joints where indicated.] [Provide flanged joints where indicated.] [Provide mechanically coupled type joints using a sleeve-type mechanical coupling where indicated.] [Provide [grooved] [or] [shouldered] type joints where indicated.] [Provide insulating joints where indicated.] [Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint, subject to the limitations specified in paragraph entitled "Sleeve-Type Mechanical Couplings."] [[Grooved] [or] [shouldered] type joints may be used in lieu of [flanged joint or] push-on joint, except where joint is buried.]

(2) Push-On Joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly, [AWWA C111/A21.11](#).

(3) Mechanical Joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets, [AWWA C111/A21.11](#).

(4) Flanged Joints: Bolts, nuts, and gaskets for flanged connections as recommended in the Appendix to [AWWA C115/A21.15](#). Flange for setscrewed flanges shall be of ductile iron, [ASTM A 536](#), Grade 65-45-12, and conform to the applicable requirements of [ASME B16.1](#), Class 250. Setscrews for setscrewed flanges shall be [1310 MPa 190,000 psi](#) tensile strength, heat treated and zinc-coated steel. Gasket and lubricants for setscrewed flanges, in accordance with applicable requirements for mechanical-joint gaskets specified in [AWWA C111/A21.11](#). Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

(5) Insulating Joints: Designed to effectively prevent metal-to-metal contact at the joint between adjacent sections of piping. Joint shall be of the flanged type with insulating gasket, insulating bolt sleeves, and insulating washers. Gasket shall be of the dielectric type, full face, and in other respects as recommended in the Appendix to [AWWA C115/A21.15](#). Bolts and nuts, as recommended in the Appendix to [AWWA C115/A21.15](#).

(6) Sleeve-Type Mechanical Coupled Joints: As specified in paragraph entitled "Sleeve-Type Mechanical Couplings."

NOTE: At the text below, do not use grooved and shouldered type joints for Navy projects.

(7) [Grooved] [and] [Shouldered] Type Joints: [Grooved] [and] [shouldered] pipe ends and couplings, [AWWA C606](#). Joint dimension shall be as specified in [AWWA C606](#) for rigid joints [, except that where joints are indicated to be flexible, joint dimensions shall be as specified for flexible joints].

2.1.1.2 Polyvinyl Chloride (PVC) Plastic Piping

NOTE: Use Pressure Class 150 (DR 18) except when Pressure Class 200 (DR 14) is necessary. See Appendix A to AWWA C900. Molecularly Oriented PVC pipe can only be specified for Pressure Class 150 and with cast-iron-pipe-equivalent OD. When due to external loading, pipe of greater strength than Class 200 is required, do not include PVC plastic water main pipe.

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.

- a. Pipe and Fittings: Pipe, [AWWA C900](#), shall be plain end or gasket bell end, Pressure Class [150 (DR 18)] [200 (DR 14)] with cast-iron-pipe-equivalent OD. [Molecularly Oriented Polyvinyl Chloride (PVC) pressure pipe, [AWWA C909](#), shall be plain end or gasket bell end, Pressure Class 150 with cast-iron-pipe-equivalent outside diameter.]
- b. Pipe [350 through 900mm](#) [14 through 36](#) diameter: [AWWA C905](#).]
- c. Fittings for PVC pipe: Fittings shall be gray iron or ductile iron, [AWWA C110/A21.10](#) or [AWWA C153/A21.53](#), and have cement-mortar lining, [AWWA C104/A21.4](#), standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with PVC plastic pipe specified in this paragraph. Iron fittings and specials shall be cement-mortar lined in accordance with [AWWA C104/A21.4](#). [Fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with [AWWA C605](#) and [AWWA C900](#).] [Pipe, couplings and fittings for PVC plastic pipe shall be manufactured of material conforming to [ASTM F 1483](#) and [ASTM D 1784](#), Class 12454-B.] [Schedule 80 PVC fittings shall conform to [ASTM D 2467](#).]
- d. Joints and Jointing Material: Joints for pipe shall be push-on joints, [ASTM D 3139](#). Joints between pipe and metal fittings, valves, and other accessories shall be push-on joints [ASTM D 3139](#),

or compression-type joints/mechanical joints, [ASTM D 3139](#) and [AWWA C111/A21.11](#). Provide each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe, [ASTM F 477](#). Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, [AWWA C111/A21.11](#), respectively, for push-on joints and mechanical joints. Mechanically coupled joints using a sleeve-type mechanical coupling, as specified in paragraph entitled "Sleeve-Type Mechanical Couplings," may be used as an optional jointing method in lieu of push-on joints on plain-end PVC plastic pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling and to the use of internal stiffeners as specified for compression-type joints in [ASTM D 3139](#).

[2.1.1.3 Polyethylene (PE) Plastic Piping

Pipe, tubing, and heat-fusion fittings shall conform to [AWWA C906](#).

] [2.1.1.4 Reinforced Thermosetting Resin Pipe (RTRP)

NOTE: For Navy projects, DO NOT USE RTRP.

Reinforced Thermosetting Resin Pipe (RTRP) is a type of fiberglass pipe. Fiberglass pipe can be used for potable water systems. Some advantages of fiberglass include durability, corrosion resistance, and eliminating the need for interior or exterior lining or coatings. However, special attention should be made to bedding and pipe support requirements. Pipe leaks are difficult to locate due to the manufacturing process. Refer to [AWWA M45](#) for design considerations.

Types refer to the method of manufacturing. Type I is filament bound. Type II is centrifugally cast.

Grade is determined by construction (glass-fiber-reinforced or glass-fiber-reinforced mortar) and bonding materials (epoxy or polyester). Grade 1 is glass-fiber reinforced epoxy. Grade 2 is glass-fiber-reinforced polyester.

- a. 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](#).
- b. 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.
- c. Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with [ASTM D 4161](#).

- d. RTRP-I, Grade 1 and 2 Pipe and Joints: RTRP-I pipe 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) 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**. 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.
- e. RTRP-II, Grade 1 and 2: RTRP-II shall conform to **ASTM D 2997**. Pipe shall have an outside diameter equal to standard weight steel pipe. 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.

] [2.1.1.5 Reinforced Plastic Mortar Pressure Pipe (RPMP)

NOTE: For Navy projects, DO NOT use RPMP.

Reinforced Plastic Mortar Pressure Pipe (RPMP) is a type of fiberglass pipe. Fiberglass pipe can be used for potable water systems. Some advantages of fiberglass include durability, corrosion resistance, and eliminating the need for interior or exterior lining or coatings. However, special attention should be made to bedding and pipe support requirements. Pipe leaks are difficult to locate due to the manufacturing process. Refer to AWWA M45 for design considerations.

- a. 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**.
- b. Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to **150 mm (6 inches) 6 inches** shall conform to **AWWA C950**. Iron fittings shall be cement-mortar lined in accordance with **AWWA C104/A21.4** and shall conform to **AWWA C110/A21.10** and **AWWA C111/A21.11**. Fittings shall be suitable for working and testing pressures specified for the pipe.
- c. Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with **ASTM D 4161**.

] [2.1.1.6 Reinforced and Prestressed Concrete Piping

NOTE: Reinforced and prestressed concrete pipe is

used for raw water (processed water). Delete paragraph for potable water. Verify pipe sizes required. In the Pacific Coast, Rocky Mountain, and Southwest States, concrete pipe is available in 250 mm 10 inch diameter and larger, pretensioned type only in sizes less than 400 mm 16 inches. In other parts of the country, concrete pipe may not be available in sizes below 400 mm 16 inch diameter.

NOTE: For projects in the Pacific Coast, Rocky Mountain, and Southwest states where only piping of less than 400 mm 16 inch size is involved, delete requirements which are referenced to AWWA C300 and AWWA C301.

NOTE: Use 1000 kPa 150 psi except when a higher pressure rating, up to 1400 kPa 200 psi is necessary.

NOTE: AWWA recommends a minimum of 1.8 m 6 feet of earth cover for ordinary conditions. Delete this information when depth is indicated on the drawings.

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)
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Minimum cylinder thickness, mm (gauge)	1.519 16	1.519 16
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- a. Piping and Fittings: [Prestressed steel cylinder type reinforced concrete pipe, [AWWA C301](#). Steel cylinder type reinforced concrete pipe, not prestressed, [AWWA C300](#).] Pretensioned steel cylinder type reinforced concrete pipe, [AWWA C303](#). Pipe shall be designed for the following minimum conditions:

Pressure rating - [_____] kPa psi

[Earth cover - [_____] mm feet.]

Water hammer - 40 percent of pressure rating

Live load - AASHTO H 20 truck loading

NOTE: In those parts of the United States where concrete pipe will be carrying sulfate-bearing waters or where concrete pipe will be buried in soils containing sulfates, specify concrete pipe manufactured using sulfate-resisting cement. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 and 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million sulfate. The availability of pipe made using Type V cement should be verified. In areas where reactive aggregates are known to occur, specify low alkali cement.

Do not order pipe until design calculations have been approved. Fittings shall conform to the same specification as that used for the pipe and shall be designed as specified for the pipe. [Cement used in the manufacture of the pipe and fittings shall be [Type II] [Type V] [low alkali cement] conforming to [ASTM C 150](#).] Identification marking for pipe and fittings shall include the pressure rating.

- b. Jointing Material: Gaskets shall be as specified in the referenced specification for the pipe. Rubber-gasket joints shall be of the type using a bell and spigot joint design of steel.

] [2.1.1.7 Steel Piping

NOTE: Delete requirements for steel pipe and
associated fittings for Navy projects.

NOTE: Verify availability of pipe sizes required.
In the Pacific Coast, Rocky Mountain, and Southwest
States, steel pipe is available in 125 mm 5 inch
diameter and larger. In other parts of the country,
steel pipe may not be available in sizes less than
600 mm 24 inch diameter since the major producer in
those areas has discontinued production of steel
water pipe.

NOTE: Delete coatings not allowed for the project.
AWWA M11 in the chapter on protective coatings
contains information on the relative merits of
cement-mortar and coal-tar enamel coatings. See
Foreword to AWWA C210 for information on coal-tar
epoxy coating.

NOTE: Delete requirements for lining of aboveground
piping when aboveground piping is not included in
project. When included, pipe and fittings for
aboveground lines will be furnished with lining
only. Exterior protection for aboveground piping
should be specified in Section 09 90 00, PAINTS AND
COATINGS.

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.

- a. Pipe and Fittings: Pipe, AWWA C200. Fittings, AWWA C208 and to
AWWA C200, with reference to the requirements specified therein
for "Special Sections." Pipe and fittings [for underground lines]
shall have cement-mortar lining and [cement-mortar] [coal-tar

enamel] [coal-tar epoxy] coating. [Pipe and fittings for aboveground lines shall have cement-mortar lining.] Ends of pipe and fittings shall be suitable for the joints and jointing materials used.

1. 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) 6 inches diameter shall be as required by AWWA C200.
2. 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. The thickness 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.

NOTE: Use 1000 kPa 150 psi except when a higher pressure rating, up to 1400 kPa 200 psi is necessary.

NOTE: A minimum earth cover of 1.5 m 5 feet is recommended for ordinary conditions. Delete this information when depth is indicated on the drawings.

- b. Wall Thickness for Pipe and Fittings: [The minimum metal thickness for steel pipe wall shall be [_____] mm inch, based on steel having a yield strength of [_____] kPa psi.] [Wall thickness of steel pipe and fittings shall be determined by the manufacturer of the pipe and calculated in the following manner. Design for the following minimum conditions:

Pressure rating.....[_____] kPa psi

[Earth cover.....[_____] mm feet]

Water hammer.....40 percent of pressure rating

Live load.....AASHTO H 20 truck loading

Allowable deflection.....2 percent of nominal pipe diameter

NOTE: In the calculation of wall thickness for

steel water main pipe, the value of E' (modulus of soil reaction) should be based on realistic expectations of sidefill compaction rather than theoretical ones.

Calculate pipe wall thickness on the basis of an allowable fiber stress in the steel equal to 50 percent of the minimum yield strength of the steel used in the manufacture of the pipe. Design procedure shall be in accordance with the methods given in AWWA M11, Chapter 4, "Determination of Pipe Wall Thickness," Chapter 5, "Water Hammer and Pressure Surge," and Chapter 6, "External Load." The value of E', modulus of soil reaction, shall be [____]. Do not order the pipe until calculations have been approved.] Wall thickness of fittings shall be not less than that required for the pipe. Fittings shall be designed to withstand the hydrostatic pressure test specified herein in paragraphs entitled "Testing Procedure," and "Special Testing Requirements." When necessary to meet the pressure test requirements, fittings shall be reinforced in accordance with methods given in AWWA M11, Chapter 13, "Supplementary Design Data and Details."

c. Joints and Jointing Materials

NOTE: At the text below, AWWA M11, Chapter 8, "Pipe Joints," contains detailed information on the various field jointing methods for steel piping.

NOTE: At the text below, delete requirements for and references to welded joints when not allowed for the project. Welded joints should not be allowed for piping less than 600 mm 24 inches in diameter, except when pipeline is to be cement-mortar lined in place after installation.

(1) Joints: Joints for pipe and fittings shall be rubber-gasketed bell-and-spigot joints [, welded joints,] or the mechanically coupled type using a sleeve-type mechanical coupling [, unless otherwise specified]. [Provide flanged joints where indicated.] [Provide mechanically coupled type joints using a sleeve type mechanical coupling where indicated.] [Joints shall be [grooved] [or] [shouldered] type where indicated.] [Provide insulating joints where indicated.] [[Grooved] [or] [shouldered] type joints may be used in lieu of flanged joints.]

(2) Rubber-Gasketed Bell-and-Spigot Joints: Design of joints and pipe ends shall be in accordance with the pipe manufacturer's standard for this type of joint, as approved, except that the joint shall also meet the requirements specified for rubber-gasketed joints and rubber gaskets in AWWA C200.

NOTE: At the text below, delete requirements for and references to welded joints when not allowed for the project. Welded joints should not be allowed

for piping less than 600 mm 24 inches in diameter,
except when pipeline is to be cement mortar lined in
place after installation.

(3) Welded Joints: Electrodes shall be of the quality specified
in AWWA C206.

(4) Sleeve-Type Mechanical Coupled Joints: As specified in
paragraph entitled "Sleeve-Type Mechanical Couplings."

(5) [Grooved] [and] [Shouldered] Type Joints: [Pipe ends shall
be grooved by roll grooving or shall have welded-on adapters with
cut grooves. Grooves made by roll grooving shall have dimensions
as recommended by the coupling manufacturer. Cut grooves in
adapters shall have dimensions conforming to AWWA C606.]
Couplings [and shouldered pipe ends], AWWA C606. Joint dimensions
shall be as specified in AWWA C606 for rigid joint [, except that
where joints are indicated to be flexible, joint dimensions shall
be as specified for flexible joints].

NOTE: At the text below, use Class D flanges when
maximum working pressure is 1200 kPa 175 psi or less
in lines 300 mm 12 inches in diameter and smaller, or
1000 kPa 150 psi or less in lines larger than 300 mm
12 inches in diameter. For higher working
pressures, use Class E flanges.

(6) Flanged Joints: Provide pipe ends with steel flanges,
AWWA C207; [Class D] [Class E]. Bolts and nuts for flanged
connections, AWWA C207. Rubber gaskets, AWWA C207; asbestos
gaskets will not be allowed.

(7) Insulating Joints: Design to prevent metal-to-metal contact
at the joint between adjacent sections of piping. Joint shall be
of the flanged type with insulating gasket, insulating bolt
sleeves, and insulating washers. Gasket shall be of the
dielectric type, full face, and in other respects as recommended
in the Appendix to AWWA C115/A21.15. Bolts and nuts shall be as
recommended in the Appendix to AWWA C115/A21.15.

d. Lining [and Coating]:

NOTE: Under ordinary conditions, steel water pipe
and fittings in the sizes included in water
distribution systems covered by this specification
are furnished with factory-applied cement-mortar
lining. In-place cement-mortar lining for new
construction would be required only under unusual
conditions. If required, specify as follows:

1. Substitute the following paragraph for d(1) of
paragraph entitled "Steel Piping."

"(1) Cement-Mortar Lining: Materials for in-place
cement-mortar lining shall be as specified in AWWA

C602."

2. Insert the following new paragraph in its appropriate place at paragraph entitled "Installation of Steel Piping."

"c. Cement-mortar Lining of Pipeline in Place: Pipeline shall be cement-mortar lined after installation. Procedure shall be in accordance with AWWA C602."

3. Insert the latest publication of AWWA C602 in paragraph entitled "References."

(1) Cement-Mortar Lining: AWWA C205, shop-applied.

(2) Cement-Mortar Coating: AWWA C205, shop-applied.

NOTE: Use coal-tar enamel coating with double felt wraps instead of single layer of felt wrap where soil in which pipe is to be buried as classified as Group IV, Unusually Corrosive (as defined in AWWA M11, Chapter 10, "Principles of Corrosion and Corrosion Control") or as Class 4, Extreme (as defined in Navy Design Manual on water supply systems; or where electrical resistivity of soil has been measured at less than 2,000 ohms/cc.

(3) Coal-Tar Enamel Coating: Except as otherwise specified, prepare, prime, and coat piping with hot-applied coal-tar enamel and a bonded [single layer of felt wrap in accordance with AWWA C203] [double felt wraps in accordance with AWWA C203]. Asbestos felt shall not be used; felt material shall be fibrous-glass mat as specified in Section 10 of AWWA C203. Shop-apply coating.

(4) Coal-Tar Epoxy Coating: Clean, prime, and topcoat piping with coal-tar epoxy coating system in accordance with AWWA C210. Shop-apply coating.

] [2.1.1.8 Piping Beneath Railroad Right-of-Way

Piping passing under the right-of-way of a commercial railroad shall conform to the specifications for pipelines conveying nonflammable substances in Chapter 1, Part 5 of the AREMA Manual, except for casing pipe, provide ductile-iron pipe in lieu of cast-iron pipe. Ductile-iron pipe shall conform to and have strength computed in accordance with ASTM A 746.

] 2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves [on Buried Piping]

NOTE: For UL 262 valves in systems on which pipe is pressure rated at 1000 kPa 150 psi, use a working

pressure of 1200 kPa 175 psi for valve sizes 300 mm 12 inches and smaller, and 1000 kPa 150 psi for valves larger than 300 mm 12 inches.

NOTE: Delete all requirements involving gearing when no valves 400 mm 16 inch size and larger as specified in this paragraph are included in the project. Indicator should be required for geared valves where valve is in location where gate position cannot readily be seen.

NOTE: Delete requirements for bypasses when no valves 400 mm 16 inch size and larger as specified in this paragraph are included in the project. Fill in blank with each valve size 400 mm 16 inches and larger included in the project.

NOTE: Add the following requirement in areas where it is known that the local water promotes galvanic corrosion in the form of dezincification or dealuminumization: "Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in" (for Water Main Gate Valves) "AWWA C500 or AWWA C509"; (for Water Main Check Valves) "AWWA C508"; (for Water Service Line Gate Valves 80 mm 3 Inch Size and Larger) "AWWA C500."

Add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Valves shall have a protective epoxy interior coating conforming to AWWA C550." Insert the latest publication of AWWA C550, "Protective Epoxy Interior Coatings for Valves and Hydrants" in paragraph entitled "References." Protective coating should be required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion.

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be nonrising stem type with double-disc gates and mechanical-joint ends or push-on joint ends as appropriate for the adjoining pipe, (2) AWWA C509 shall be nonrising stem type with mechanical-joint ends [or resilient-seated gate valves 80 to 300 mm 3 to 12 inches in size], and (3) UL 262 shall be inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of [_____] kPa psi, and shall have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have O-ring stem seals [, except for those valves for which gearing is specified, in which case use conventional

packing in place of O-ring seal]. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair. In lieu of mechanical-joint ends and push-on joint ends, valves may have special ends for connection to [cement piping or to] sleeve-type mechanical coupling. Valve ends and gaskets for connection to [cement piping or to] sleeve-type mechanical coupling shall conform to the applicable requirements specified [respectively] for the [joint or] coupling. [Where a post indicator is shown, the valve shall have an indicator post flange; indicator post flange for AWWA C500 valve shall conform to the applicable requirements of UL 262.] [Provide [] mm inch size valves with gearing [and indicators], AWWA C500.] [Provide [] mm inch size valves with bypasses, AWWA C500.] Valves shall be of one manufacturer.

2.1.2.2 Gate Valves [in Valve Pit(s)] [and] [Aboveground Location]

NOTE: For ordinary conditions,
outside-screw-and-yoke rising-stem type is preferred
to nonrising stem/inside-screw type.

NOTE: For ordinary conditions, the double-disc or
split-wedge type gate is preferred to the
solid-wedge/solid or one-piece gate.

NOTE: For UL 262 valves in system on which pipe is
pressure rated at 1000 kPa 150 psi, use a working
pressure of 1200 kPa 175 psi for valve sizes 300 mm
12 inches and smaller, and 1000 kPa 150 psi for
valves larger than 300 mm 12 inches.

NOTE: Delete all requirements involving gearing
when no valves 400 mm 16 inch size and larger as
specified in this paragraph are included in the
project. Indicator should be required for geared
valves where valve is in location where gate
position cannot readily be seen.

NOTE: Delete requirements for bypasses when no
valves 400 mm 16 inch size and larger as specified
in this paragraph are included in the project. Fill
in blank with each valve size 400 mm 16 inches and
larger included in the project.

NOTE: Add the following requirement in areas where
it is known that the local water promotes galvanic
corrosion in the form of dezincification or
dealuminumization: "Bronze used in valves shall be
Grade A, Grade D, or Grade E as specified in" (for
Water Main Gate Valves) "AWWA C500 or AWWA C509";

(for Water Main Check Valves) "AWWA C508"; (for Water Service Line Gate Valves 80 mm 3 Inch Size and Larger) "AWWA C500."

Add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Valves shall have a protective epoxy interior coating conforming to AWWA C550." Insert the latest publication of AWWA C550, "Protective Epoxy Interior Coatings for Valves and Hydrants" in paragraph entitled "References." Protective coating should be required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion.

AWWA C500, AWWA C509, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be [outside-screw-and-yoke rising-stem] [nonrising stem] type with [double-disc] [solid-wedge] gates and flanged ends, (2) AWWA C509 shall be [outside-screw-and-yoke rising-stem] [nonrising stem] type with flanged ends, and (3) UL 262 shall be [outside-screw-and-yoke] [inside-screw] type, shall have [double-disc or split-wedge] [solid or one-piece] type gate and flanged ends, and shall be designed for a hydraulic working pressure of [_____] kPa psi. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. [Valves [_____] mm inch size] shall be nonrising stem type or inside-screw type [where indicated].] [Valves [_____] mm inch size] shall have solid-wedge gates or solid or one-piece type gates [where indicated].] Provide valves with handwheels that open by counterclockwise rotation of the valve stem. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair. In lieu of flanged ends, valves may have [grooved] [or] [shouldered] ends suitable for [grooved] [or] [shouldered] type joints, as specified in paragraph entitled "Ductile-Iron Piping." [Valves [_____] mm inch size shall have gearing [and indicator], AWWA C500.] [Provide [_____] mm inch size valve with bypasses, AWWA C500.] Valves shall be of one manufacturer.

2.1.2.3 Check Valves

NOTE: Add the following requirement in areas where it is known that the local water promotes galvanic corrosion in the form of dezincification or dealuminization: "Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in" (for Water Main Gate Valves) "AWWA C500 or AWWA C509"; (for Water Main Check Valves) "AWWA C508"; (for Water Service Line Gate Valves 80 mm 3 Inch Size and Larger) "AWWA C500."

Add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Valves shall have a protective epoxy interior coating conforming to AWWA C550." Insert the latest publication of AWWA C550, "Protective Epoxy Interior Coatings for Valves and Hydrants" in paragraph entitled "References." Protective coating should be required on all valves

whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion.

Swing-check type, AWWA C508 or UL 312. Valves conforming to: (1) AWWA C508 shall have iron or steel body and cover and flanged ends, and (2) UL 312 shall have cast iron or steel body and cover, flanged ends, and designed for a working pressure of [_____] kPa psi. Materials for UL 312 valves shall conform to the reference standards specified in AWWA C508. Valves shall have clear port opening. [Valves shall be [spring-loaded] [weight-loaded] [where indicated].] [Flanges shall be Class 125 conforming to ASME B16.1.] In lieu of flanged ends, valves may have [grooved] [or] [shouldered] ends suitable for [grooved] [or] [shouldered] type joints, as specified in paragraph entitled "Ductile-Iron Piping." Valves shall be of one manufacturer.

2.1.2.4 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.

2.1.2.5 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.

2.1.2.6 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.

2.1.2.7 Fire Hydrants

NOTE: For projects in all parts of the United States except California and Hawaii, delete requirements for and references to wet-barrel type hydrants. For projects in California and Hawaii, ascertain from the local fire department serving the base or station (1) whether wet-barrel type hydrants are desired exclusively, (2) whether dry-barrel type hydrants are necessary (in areas having freezing temperatures), or (3) whether either type hydrant is acceptable. Only dry-barrel type hydrants have hydrant stem. For hose gate valves in dry-barrel fire hydrants, use UL 246 as the standard reference.

The fire hydrant in most prevalent use in the U.S. is the one conforming to AWWA C502 or UL 246. Standard for this hydrant are National Standard pipe threads on hose and pumper connections and operating nut and cap nuts of pentagonal shape measuring 40 mm 1 1/2 inches from point to opposite flat at base. These threads and nuts are also standard for Factory Mutual approved hydrants. For the purposes of this guide specification, these threads and nuts will be defined as standard threads and nuts. Thread dimensions other than National Standard and operating nut and cap nuts differing in size and shape from that described above will be defined as nonstandard threads and nuts.

[Dry-barrel type] [or] [wet-barrel type] [, except that flush-type hydrants shall be provided where indicated]. Paint hydrants with at least one coat of primer and two coats of yellow enamel paint, except use red enamel paint for tops of hydrants in non-potable water systems. Stencil hydrant number and main size on the hydrant barrel using black stencil paint.

NOTE: At the text below, add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Hydrants shall have a protective epoxy interior coating conforming to AWWA C550 on those portions continuously in contact with sea water or salt water." See Note H located at rear of text for guidance.

NOTE: Use "specified" wording under the following circumstances: (1) project at existing station where hydrants with standard threads and nuts are in use; (2) project at existing station where conversion to hydrants with standard threads and nuts is in progress; (3) project at new location where local fire department connects to hydrants with standard threads and nuts. Use "indicated" under the following circumstances: (1) project at existing station where hydrants with nonstandard threads and nuts are in use; (2) project at new location where local fire department connects to

hydrants with nonstandard threads and nuts.

- a. [Dry-Barrel Type] [and] [Wet-Barrel Type] Fire Hydrants:
[Dry-barrel type hydrants, AWWA C502 or UL 246, "Base Valve" design, shall have 150 mm 6 inch inlet, 135 mm 5 1/4 inch valve opening, one [115] [] mm [4 1/2] [] inch pumper connection, and two 65 mm 2 1/2 inch hose connections.]
[Wet-barrel type hydrants, AWWA C503 or UL 246, "Wet Barrel" design, shall have 150 mm 6 inch inlet, one [115] [] mm [4 1/2] [] inch pumper connection, and two 65 mm 2 1/2 inch hose connections. Pumper connection and hose connections shall be individually valved with independent nozzle gate valves.] Inlet shall have [mechanical-joint or push-on joint end] [mechanical-joint end only] [, except where flanged end is indicated]; end shall conform to the applicable requirements as specified for the joint. Size and shape of operating nut, cap nuts, and threads on hose and pumper connections shall be as [specified in [AWWA C502] [or] [AWWA C503] or UL 246] [indicated].
[Hydrants indicated as "traffic type," shall have [frangible sections as mentioned in AWWA C502] [breakable features as mentioned in AWWA C503]. The traffic type hydrant shall have special couplings joining upper and lower sections of hydrant barrel [and upper and lower sections of hydrant stem] and shall be designed to have the special couplings break from a force not less than that which would be imposed by a moving vehicle; hydrant shall operate properly under normal conditions.]

NOTE: At the text below, add the following requirement when a protective interior coating is considered necessary for corrosion protection:
"Hydrants shall have a protective epoxy interior coating conforming to AWWA C550 on those portions continuously in contact with sea water or salt water." See Note H located at rear of text for guidance.

NOTE: Use "specified" wording under the following circumstances: (1) project at existing station where hydrants with standard threads and nuts are in use; (2) project at existing station where conversion to hydrants with standard threads and nuts is in progress; (3) project at new location where local fire department connects to hydrants with standard threads and nuts. Use "indicated" under the following circumstances: (1) project at existing station where hydrants with nonstandard threads and nuts are in use; (2) project at new location where local fire department connects to hydrants with nonstandard threads and nuts.

- b. Flush-Type Fire Hydrants: Hydrants shall conform to the applicable requirements of AWWA C502, except that they shall be of a design that will permit placement of hydrant below surface of pavement. Hydrants shall have 150 mm 6 inch inlet, 108 mm 4 1/4

inch minimum valve opening, one [115] [_____] mm [4 1/2] [_____] inch pumper connection, and one 65 mm 2 1/2 inch hose connection. Hose and pumper connections and operating nuts shall be readily accessible, and enclosed in a cast iron box with top flush with pavement and having cast-iron cover with flush lifting handle. Inlet shall have mechanical-joint or push-on joint end [, except where flanged end is indicated]. Size and shape of operating nut and cap nuts and threads on hose and pumper connections shall be as [specified in AWWA C502] [indicated].

[2.1.2.8 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) 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).300 psi.
- b. 30 m 100 feet of 40 mm (1-1/2 inch), 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).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) 2-1/2 inch hose with 25 mm (1 inch) 1 inch shutoff nozzle tip.
- e. One playpipe for 40 mm (1-1/2 inch) 1-1/2 inch hose with 13 mm (1/2 inch) 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) 1-1/2 inch hose.

]2.1.2.9 Indicator Posts

UL 789. Provide for gate valves where indicated.

2.1.2.10 Valve Boxes

Provide a valve box for each gate valve [on buried piping] [, except where

indicator post is shown]. Valve boxes shall be of [cast iron] [or] [precast concrete] of a size suitable for the valve on which it is to be used and shall be adjustable. [Cast-iron boxes shall have a minimum cover and wall thickness of 5 mm3/16 inch.][Precast concrete boxes installed in locations subjected to vehicular traffic shall be designed to withstand the following [_____] AASHTO load designation as outline in AASHTO HB-17. Precast concrete boxes shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.] Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 135 mm 5 1/4 inches. [as indicated]. Cast-iron box shall have a heavy coat of bituminous paint.

2.1.2.11 Valve Pits

Valve pits shall be constructed at locations indicated or as required above and in accordance with the details shown.

2.1.2.12 Turbine Type Meters

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.

2.1.2.13 Propeller Type Meters

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.

2.1.2.14 Meter Vaults

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

Large meters shall be installed in reinforced concrete vaults manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. Large meters shall be installed in reinforced concrete vaults in accordance with the details shown on the drawings.

2.1.2.15 Sleeve-Type Mechanical Couplings

NOTE: Delete "or steel" when middle ring of cast iron only is considered necessary due to anticipated corrosion problems.

NOTE: Minimum numbers of bolts for each pipe size should be as follows: 80 mm 3 inch, 3; 100 mm 4 inch, 4; 150 mm 6 inch, 5; 200 mm 8 inch, 6; 250 mm 10 inch, 7; 300 mm 12 inch and 350 mm 14 inch, 8; 400 mm 16 inch, 9; 450 mm 18 inch, 10; 500 mm 20 inch, 12; 550 mm 22 inch, 13; 600 mm 24 inch, 14.

Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. [For [ductile iron] [and] [PVC plastic] pipe, the middle ring shall be of cast-iron [or steel; and the follower rings shall be of malleable or ductile iron].] [For steel piping, the middle ring shall be of steel and the follower rings shall be of steel or malleable iron.] [Cast iron, ASTM A 48/A 48M not less than Class 25.] Malleable and ductile iron shall, conform to ASTM A 47/A 47M and ASTM A 536, respectively. [Steel shall have a strength not less than that of the pipe.] Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type, ASTM A 307, Grade A, with nuts, ASTM A 563M ASTM A 563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Bolts shall be 16 mm 5/8 inch in diameter; minimum number of bolts for each coupling shall be [_____] [for [_____] mm inch pipe [, [_____] for [_____] mm inch pipe,] [and] [_____] for [_____] mm inch pipe]. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Mechanically coupled joints using a sleeve-type mechanical coupling shall not be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Mechanical couplings 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.

[2.1.2.16 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.

]2.1.2.17 Tracer Wire for Nonmetallic Piping

NOTE: As an option, warning tape as specified in Section 02302, "Excavation, Backfilling, and Compacting for Utilities," may be used.

Provide bare copper or aluminum wire not less than 2.5 mm 0.10 inch in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

2.2 WATER SERVICE LINE MATERIALS

NOTE: This specification does not contemplate maximum working pressures in service lines which would require piping and valves of pressure rating exceeding 1000 kPa 150 psi. However, should the need arise for small-diameter pipelines to operate at working pressures exceeding 1000 kPa 150 psi, consult the various pipe, fitting, and valve specifications used herein to determine the proper pressure rating designation for the given material at the higher pressure, and modify the appropriate paragraphs to the extent necessary.

2.2.1 Piping Materials

2.2.1.1 Copper Pipe and Associated Fittings

Pipe, ASTM B 42, regular, threaded ends. Fittings shall be brass or bronze, ASME B16.15, 825 kPa 125 pound.

2.2.1.2 Copper Tubing and Associated Fittings

Tubing, ASTM B 88M ASTM B 88, Type K. Fittings for solder-type joint, ASME B16.18 or ASME B16.22; fittings for compression-type joint, ASME B16.26, flared tube type.

2.2.1.3 Plastic Piping

Plastic pipe and fittings shall bear the seal of the National Sanitation Foundation (NSF) for potable water service. Plastic pipe and fittings shall be supplied from the same manufacturer.

NOTE: In the text below, delete bracketed wording where piping is to be installed at or exposed to

temperatures below 4.5 degrees C 40 degrees F.

- a. Polyvinyl Chloride (PVC) Plastic Piping with Screw Joints:
ASTM D 1785, Schedule 40; or ASTM D 2241, with SDR as necessary to provide 1000 kPa 150 psi minimum pressure rating. Fittings, ASTM D 2466 or ASTM D 2467. Pipe and fittings shall be of the same PVC plastic material and shall be one of the following pipe/fitting combinations, as marked on the pipe and fitting, respectively: [PVC 1120/PVC I; PVC 1220/PVC 12;] PVC 2120/PVC II; PVC 2116/PVC II. Solvent cement for jointing, ASTM D 2564. Pipe couplings, when used shall be tested as required by ASTM D 2464.
- b. Polyvinyl Chloride (PVC) Plastic Piping with Elastomeric-Gasket Joints:

Pipe shall conform to dimensional requirements of ASTM D 1785 Schedule 40, with joints meeting the requirements of 1.03 MPa (150 psi) 150 psi working pressure, 1.38 MPa (200 psi) 200 psi hydrostatic test pressure, unless otherwise shown or specified.
- c. Polyvinyl Chloride (PVC) Plastic Piping with Solvent Cement Joints:

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) 150 psi working pressure and 1.38 MPa (200 psi) 200 psi hydrostatic test pressure.
- d. Polyethylene (PE) Plastic Pipe: Pipe tubing, and heat fusion fitting shall conform to AWWA C901.
- e. Acrylonitrile-butadiene-styrene (ABS) Plastic Piping: ASTM D 1527 or ASTM D 2282, with pipe schedule or SDR as necessary to provide 1000 kPa 150 psi minimum pressure rating. Fittings, ASTM D 2468, as required to provide barrel wall thickness not less than that of the pipe. Solvent cement for jointing, ASTM D 2235.
- f. Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe: AWWA C909, plain end or gasket bell end, Pressure Class 150 with cast iron pipe equivalent outside diameter.

[2.2.1.4 Reinforced Thermosetting Resin Piping (RTRP)

NOTE: Do not use for Navy projects.

- a. 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.
- b. Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to 150 mm (6 inches) 6 inches shall conform to AWWA C950. Iron fittings shall be cement-mortar lined in accordance with AWWA C104/A21.4 and shall conform to AWWA C110/A21.10 and AWWA C111/A21.11. Fittings shall be suitable for working and testing pressures specified for the pipe.

- c. Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with **ASTM D 4161**.
- d. RTRP-I, Grade 1 and 2 Pipe and Joints: RTRP-I pipe 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) 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**. 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.
- e. RTRP-II pipe shall conform to **ASTM D 2997**. Pipe shall have an outside diameter equal to standard weight steel pipe. 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.

] [2.2.1.5 Reinforced Plastic Mortar Pressure Piping (RPMP)

NOTE: Do not use for Navy projects.

- a. RPMP pipe 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**.
- b. Fittings and specials shall be compatible with the pipe supplied. Filament wound or molded fittings up to **150 mm (6 inches) 6 inches** shall conform to **AWWA C950**. Iron fittings shall be cement-mortar lined in accordance with **AWWA C104/A21.4** and shall conform to **AWWA C110/A21.10** and **AWWA C111/A21.11**. Fittings shall be suitable for working and testing pressures specified for the pipe.
- c. Joints shall be bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with **ASTM D 4161**.

] [2.2.1.6 Steel Piping and Associated Fittings

NOTE: Delete requirements for and references to steel pipe and associated fittings for Navy projects.

Pipe, **ASTM A 53/A 53M**, Standard Weight, zinc-coated. Fittings, **ASME B16.4**, Class 125, zinc coated; or **ASME B16.3**, Class 150, zinc coated, threaded.

] [2.2.1.7 Protective Materials for Steel Pipe Less than **80 mm 3 Inches**

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) 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.

] 2.2.1.8 Ductile-Iron Piping

Comply with "Ductile-Iron Piping" subparagraph under paragraph "Water Distribution Main Materials."

] 2.2.1.9 Insulating Joints

Joints between pipe of dissimilar metals shall have a rubber-gasketed or other suitable approved type of insulating joint or dielectric coupling which will effectively prevent metal-to-metal contact between adjacent sections of piping.

2.2.2 Water Service Line Appurtenances

2.2.2.1 Corporation Stops

NOTE: Delete the paragraph when there is no water
service piping of 50 mm 2 inch diameter or less
included in the project.

Ground key type; bronze, ASTM B 61 or ASTM B 62; and suitable for the working pressure of the system. Ends shall be suitable for solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.

2.2.2.2 Curb or Service Stops

NOTE: Delete this paragraph when there is no water
service piping of 40 mm 1 1/2 inch diameter or less
included in the project.

Ground key, round way, inverted key type; made of bronze, ASTM B 61 or ASTM B 62; and suitable for the working pressure of the system. Ends shall be as appropriate for connection to the service piping. Arrow shall be cast into body of the curb or service stop indicating direction of flow.

[2.2.2.3 Service Clamps

Service clamps used for repairing damaged cast-iron, steel, PVC or asbestos-cement pipe 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.

]2.2.2.4 Goosenecks

Type K copper tubing. Joint ends for goosenecks shall be appropriate for connecting to corporation stop and service line. [Where multiple gooseneck connections are required for an individual service, goosenecks shall be connected to the service line through a suitable approved brass or bronze branch connection; the total clear area of the branches shall be at least equal to the clear area of the service line.] Length of goosenecks shall be in accordance with standard practice.

2.2.2.5 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.

2.2.2.6 Check Valves

Check valves shall be designed for a minimum working pressure of 1.03 MPa (150 psi) 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) 2 inches and larger shall be [outside lever and spring] [outside lever and weight] [_____] type.

- a. Valves 50 mm (2 inches) 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.

2.2.2.7 Gate Valves 80 mm 3 Inch Size and Larger [on Buried Piping]

NOTE: Add the following requirement in areas where it is known that the local water promotes galvanic corrosion in the form of dezincification or dealuminumization: "Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in" (for Water Main Gate Valves) "AWWA C500 or AWWA C509"; (for Water Main Check Valves) "AWWA C508"; (for Water Service Line Gate Valves 80 mm 3 Inch Size and Larger) "AWWA C500."

Add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Valves shall have a

protective epoxy interior coating conforming to AWWA C550." Insert the latest publication of AWWA C550, "Protective Epoxy Interior Coatings for Valves and Hydrants" in paragraph entitled "References." Protective coating should be required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion.

Gate valves 80 mm 3 inch size and larger [on buried piping] AWWA C500 or UL 262 and of one manufacturer. Valves, AWWA C500, nonrising stem type with double-disc gates. Valves, UL 262, inside-screw type with operating nut, split wedge or double disc type gate, and designed for a hydraulic working pressure of 1200 kPa 175 psi. Materials for UL 262 valves conforming to the reference standards specified in AWWA C500. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have O-ring stem seals and shall be bolted and constructed so as to permit easy removal of parts for repair. [Valves [on [] mm inch service lines] shall have threaded ends.] [Valves [on [] mm inch service lines] shall have ends suitable for joining to the pipe used; [push-on joint ends or mechanical-joint ends for joining to ductile-iron pipe] [or] [push-on joint ends or mechanical-joint ends for joining to PVC plastic water main pipe]; gaskets and pipe ends, AWWA C111/A21.11.]

2.2.2.8 Gate Valves Smaller than 80 mm 3 Inch in Size [on Buried Piping]

Gate valves smaller than 80 mm 3 inch size [on Buried Piping] MSS SP-80, Class 150, solid wedge, nonrising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve. Provide handwheel operators.

2.2.2.9 Gate Valve 80 mm 3 Inch Size and Larger

NOTE: Add the following requirement in areas where it is known that the local water promotes galvanic corrosion in the form of dezincification or dealuminization: "Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in" (for Water Main Gate Valves) "AWWA C500 or AWWA C509"; (for Water Main Check Valves) "AWWA C508"; (for Water Service Line Gate Valves 80 mm 3 Inch Size and Larger) "AWWA C500."

Add the following requirement when a protective interior coating is considered necessary for corrosion protection: "Valves shall have a protective epoxy interior coating conforming to AWWA C550." Insert the latest publication of AWWA C550, "Protective Epoxy Interior Coatings for Valves and Hydrants" in paragraph entitled "References." Protective coating should be required on all valves whose interiors are exposed to sea water or salt water, or where there is a serious corrosion problem other than galvanic corrosion.

The three optional bracketed wordings concerning gate type (double-disc or solid-wedge/one-piece) in

the second and the third sentences (referring, respectively, to AWWA C500 and UL 262) should be used as follows: first optional wording only, second optional wording only, or first and third optional wordings together, depending on the gate type(s) needed for the project (each third optional wording runs from "except" to end of sentence). When a gate valve is installed in an upside down position, the solid wedge type gate should be specified, since the double-disc type does not seat properly in this position.

Gate valves 80 mm 3 inch size and larger in [valve chambers] [valve pits] [and] [aboveground locations], AWWA C500 or UL 262 and of one make. Valves conforming to: (1) AWWA C500 shall be outside-screw-and-yoke rising-stem type with flanged ends and [double-disc] [solid-wedge] gates [, except that valves [] mm inch size] shall have solid-wedge gates [where indicated], and (2) UL 262 shall be outside-screw-and-yoke type, shall be designed for a hydraulic working pressure of 1200 kPa 175 psi, and shall have flanged ends and [double-disc or split-wedge] [solid or one-piece] type gate [, except that valves [] mm inch size] shall have solid or one-piece type gate [where indicated]. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Provide valves with handwheels that open by a counterclockwise rotation of the valve stem.

Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair.

2.2.2.10 Gate Valves Smaller Than 80 mm 3 Inch Size in Valve Pits

MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve and a handwheel operator.

2.2.2.11 Curb Boxes

Provide a curb box for each curb or service stop. Curb boxes shall be of cast iron of a size suitable for the stop on which it is to be used. Provide a round head. Cast the word "WATER" on the lid. Each box shall have a heavy coat of bituminous paint.

2.2.2.12 Valve Boxes

Provide a valve box for each gate valve [on buried piping]. Valve boxes shall be of [cast iron] [or] [precast concrete] [as indicated] of a size suitable for the valve on which it is to be used and shall be adjustable. [Precast concrete boxes installed in locations subjected to vehicular traffic shall be designed to withstand the following [] AASHTO load designation as outline in AASHTO HB-17. Precast concrete boxes shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION.] Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 135 mm 5 1/4 inches [as indicated]. [Cast-iron box shall have a heavy coat of bituminous paint.]

2.2.2.13 Tapping Sleeves

NOTE: Show size of tapping sleeve on drawings.

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).50 foot-pound.

2.2.2.14 Displacement Type Meters

Where highly aggressive water is encountered, the
manufacturers should be consulted for
recommendations concerning materials of construction.

Displacement type meters shall conform to AWWA C700. Registers shall be straight-reading and shall read in cubic meters [U.S. gallon] [cubic feet]. Meters in sizes 13 through 25 mm 1/2 through 1 [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.

2.2.2.15 Compound Type Meters

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.

2.2.2.16 Fire Service Type Meters

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.

2.2.2.17 Meter Boxes

Meter boxes shall be of cast iron, concrete, or plastic. Concrete meter boxes shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION. 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.

2.2.2.18 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Lines

NOTE: Choose one of the following options.

[Terminate the work covered by this section at a point approximately 1.5 m 5 feet from the building [, unless otherwise indicated]. [Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer horizontally than 3.0 m 10 feet from any sewer line.] [Where water lines cross under gravity sewer lines, encase sewer line fully in concrete for a distance of at least 3.0 m 10 feet on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 900 mm 3 feet horizontally of the crossing.] [Lay water lines which cross sewer force mains and inverted siphons at least 600 mm 2 feet above these sewer lines; when joints in the sewer line are closer than 900 mm 3 feet horizontally from the water line, encase these joints in concrete.] [Do not lay water

lines in the same trench with [gas lines] [fuel lines] [or] [electric wiring].] [Copper tubing shall not be installed in the same trench with ferrous piping materials.] [Where nonferrous metallic pipe, e.g. copper tubing, cross any ferrous piping, provide a minimum vertical separation of 300 mm 12 inches between pipes.]]

Where water piping is required to be installed within 1 m 3 feet of existing structures, the water pipe shall be sleeved as required in Paragraph "Casting 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.

NOTE: Choose the option below for Navy projects.

[Terminate the work covered by this section at a point approximately 1.5 m 5 feet from the building [, unless otherwise indicated]. [Do not lay water lines in the same trench with [gas lines] [fuel lines] [or] [electric wiring].]]

a. Water Piping Installation Parallel With Sewer Piping

(1) Normal Conditions: Lay water piping at least 3.0 m 10 feet horizontally from a sewer or sewer manhole whenever possible. Measure the distance edge-to-edge.

(2) Unusual Conditions: When local conditions prevent a horizontal separation of 3.0 m 10 feet, the water piping may be laid closer to a sewer or sewer manhole provided that:

(a) The bottom (invert) of the water piping shall be at least 450 mm 18 inches above the top (crown) of the sewer piping.

(b) Where this vertical separation cannot be obtained, the sewer piping shall be constructed of AWWA-approved water pipe and pressure tested in place without leakage prior to backfilling. Approved waste water disposal method shall be utilized.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of Water Piping Crossing Sewer Piping

(1) Normal Conditions: Water piping crossing above sewer piping shall be laid to provide a separation of at least 450 mm 18 inches between the bottom of the water piping and the top of the sewer piping.

(2) Unusual Conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sewer piping passing over or under water piping shall be constructed of AWWA-approved ductile iron water piping, pressure tested in place without leakage prior to backfilling.

(b) Water piping passing under sewer piping shall, in addition, be protected by providing a vertical separation of at least 450 mm 18 inches between the bottom of the sewer piping and the top of

the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on and breaking of the water piping; and that the length, minimum 6.1 m 20 feet, of the water piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer piping.

- c. Sewer Piping or Sewer Manholes: No water piping shall pass through or come in contact with any part of a sewer manhole.

3.1.1.2 Earthwork

NOTE: Earthwork requirements for pipe trenches, including bedding, are covered in Section 31 23 00.00 20, EXCAVATION AND FILL. The applicable requirements for exterior water distribution system which are set forth in Section 31 23 00.00 20 must be incorporated into the project specification, whether in Section 31 23 00.00 20 or in an all-inclusive earthwork section. The above referenced section number and title is subject to change. The specifier should verify the current appropriate specification and revise as necessary if different.

Perform earthwork operations in accordance with Section [_____].

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe in a neat workmanlike manner accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports [where indicated and] where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. [Depth of cover over top of pipe shall not be less than 760 mm 2 1/2 feet.]

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it

will not be displaced during construction operations.

3.1.1.5 Connections to Existing Water Lines

NOTE: Use the second paragraph for PWC PEARL'S projects.

[Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure [in accordance with the recommended procedures of the manufacturer of the pipe being tapped] [as indicated] [, except as otherwise specified, tap concrete pipe in accordance with **AWWA M9** for tapping concrete pressure pipe].]

[All connections to PWC PEARL'S potable water lines **300 mm 12 inches** in diameter and smaller using corporation stops or tapping sleeves and tapping valves shall only be made by PWC PEARL'S forces. Coordinate this work, via the Contracting Officer, with PWC PEARL'S and provide PWC PEARL, Utilities Department, Code 652, telephone 471-0542, 14 calendar days advance notification of the date of connection. The Government will furnish, install and operate the tapping machine. Equipment necessary for the installation and operation of the tapping machine as well as necessary cutting blades will be provided by the Government. Disinfection of the tapping machine will be done by the Government. Provide [corporation stops,] [tapping sleeves and tapping valves,] and all other material, labor, and equipment necessary for the connection. Perform all earthwork and disinfection work at the connection prior to installation of the tapping machine by the Government. Perform the disinfection work in the presence of the PWC PEARL Utilities Department personnel. All other connections, including wet tapping mains larger than **300 mm 12 inches** in diameter and installation of new pipe fittings in existing mains, shall be performed by the Contractor. Make connections to existing water lines in the presence of the PWC PEARL Utilities Department personnel. Provide PWC PEARL, Utilities Department, Code 652, telephone 471-0542, 14 calendar days advance notification of the date of connection.]

3.1.1.6 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.

3.1.1.7 Flanged Pipe

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

3.1.2 Special Requirements for Installation of Water Mains

3.1.2.1 Installation of Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the requirements of **AWWA C600** for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

**NOTE: At the text below, do not use grooved and
shouldered type joints for Navy projects.**

- a. Jointing: [Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of **AWWA C600** for joint assembly.] [Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of **AWWA C600** for joint assembly and the recommendations of Appendix A to **AWWA C111/A21.11**.] [Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other [equipment and] accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions. Use setscrewed flanges to make flanged joints where conditions prevent the use of full-length flanged pipe and assemble in accordance with the recommendations of the setscrewed flange manufacturer.] [Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.] [Make [grooved] [and] [shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint; assemble in accordance with the recommendations of the coupling manufacturer. [Groove pipe in the field only with approved groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.]] [Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts previously specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves shall be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.]
- b. Allowable Deflection: 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.
- c. Pipe Anchorage: Provide [concrete thrust blocks (reaction backing)] [metal harness] for pipe anchorage [, except where metal harness is indicated]. [Thrust blocks shall be in accordance with the requirements of **AWWA C600** for thrust restraint, except that size and positioning of thrust blocks shall be as indicated. Use concrete, **ASTM C 94/C 94M**, having a minimum compressive strength of **15 MPa 2,500 psi** at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.] [Metal harness shall be

in accordance with the requirements of [AWWA C600](#) for thrust restraint, using tie rods and clamps as shown in [NFPA 24](#) [, except as otherwise indicated].]

NOTE: Delete the following paragraph except when required. See the Design Manual on water supply systems for guidance.

NOTE: At the text below, see Foreword to AWWA C105/A21.5 for guidance on selecting Class of polyethylene film.

- d. Exterior Protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet, using [Class A] [Class C] polyethylene film, in accordance with [AWWA C105/A21.5](#).

3.1.2.2 Installation of PVC Plastic Water Main Pipe

Installation of PVC Plastic Water Main Pipe and Associated Fittings: Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines"; with the requirements of [UBPPA UNI-B-3](#) for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in [AWWA M23](#), Chapter 7, "Installation."

- a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of [UBPPA UNI-B-3](#) for laying the pipe and the recommendations in [AWWA M23](#), Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of [UBPPA UNI-B-3](#) for joining PVC pipe to fittings and accessories and with the applicable requirements of [AWWA C600](#) for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of [UBPPA UNI-B-3](#) for joining PVC pipe to fittings and accessories, with the applicable requirements of [AWWA C600](#) for joint assembly, and with the recommendations of Appendix A to [AWWA C111/A21.11](#). Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

- b. Offset: 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.
- c. Pipe Anchorage: Provide [concrete thrust blocks (reaction backing)] [metal harness] for pipe anchorage [, except where metal harness is indicated]. [Thrust blocks shall be in accordance with the requirements of UBPPA UNI-B-3 for reaction or thrust blocking and plugging of dead ends, except that size and positioning of thrust blocks shall be as indicated. Use concrete, ASTM C 94/C 94M, having a minimum compressive strength of 15 MPa 2,500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.] [Metal harness shall be as indicated.]
- d. Fittings: Install in accordance with AWWA C605.

3.1.2.3 Installation of Polyethylene (PE) Plastic Piping

- a. General Installation:
PE pipes shall be installed in accordance with ASTM D 2774.
- b. Jointing:
Jointing shall comply with ASTM D 2657, Technique I-Socket Fusion or Technique II-Butt Fusion.
- c. Offsets:
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.

3.1.2.4 Installation of Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Piping

- a. General Installation:
Install PVCO Pressure piping in accordance with AWWA C605.
- b. Jointing:
As required for PVC piping.
- c. Anchorage:
As required for PVC piping.
- d. Offsets:
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.

[3.1.2.5 Installation of RTRP I, RTRP II and RPMP Piping

NOTE: Do not use for Navy projects.

a. General:

RTRP shall be installed in accordance with [ASTM D 3839](#). RPMP shall be installed in accordance with the manufacturer's recommendations.

b. RTRP I Jointing: 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 \(1,500 psi\)](#) [1,500 psi](#) or 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.

c. RTRP II Jointing: 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.

d. RPMP Jointing: Bell and spigot gasket-sealing coupling shall be used to connect pipes. The spigot shall be lubricated prior to push-together assembly.

e. 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 \(1/8 inch\)](#) [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.

f. Allowable Offsets:

(1) RTRP

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.

(2) RPMP

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.

] [3.1.2.6 Installation of Reinforced and Prestressed Concrete Piping

Except as otherwise specified in the following subparagraphs, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines;" with the laying and joining requirements specified in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe"; and with the recommendations given in AWWA M9, Chapter 7, "Thrust Restraining Methods."

- a. Jointing: Make joints with the gaskets specified for concrete pipe joints, using an approved lubricant recommended by the manufacturer. Assemble joints in accordance with the joining requirements specified in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe," and with the recommendations given for laying the pipe in AWWA M9, Chapter 6, "Installation by Trenching or Tunneling--Methods and Equipment."
- b. Allowable Offsets: 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.
- c. Pipe Anchorage: Provide [concrete thrust blocks (reaction backing)] [metal harness] for pipe anchorage [, except where metal harness is indicated]. [Thrust blocks shall be in accordance with the recommendations of AWWA M9, Chapter 7, "Thrust Restraining Methods," except that size and positioning of thrust blocks shall be as indicated. Use concrete, ASTM C 94/C 94M, having a minimum compressive strength of 15 MPa 2,500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive

strength.] [Metal harness shall be in accordance with the recommendations for tied joints in AWWA M9, Chapter 7, "Thrust Restraining Methods."]

] [3.1.2.7 Installation of Steel Piping

NOTE: Delete requirements for and references to
steel pipe and associated fittings for
LANTNAVFACENGCOM projects.

Unless otherwise specified, install pipe and fittings in accordance with AWWA M11, Chapter 12, "Transportation, Installation, and Testing." [Apply protective coating for aboveground piping as specified in Section [____].]

NOTE: At the text below, delete requirements for
and references to welded joints when not allowed for
the project. Welded joints should not be allowed
for piping less than 600 mm 24 inches in diameter,
except when pipeline is to be cement-mortar lined in
place after installation.

Under ordinary conditions, steel water pipe and fittings in the sizes included in water distribution systems covered by this specification are furnished with factory-applied cement-mortar lining. In-place cement-mortar lining for new construction would be required only under unusual conditions. If required, specify as follows:

1. Substitute the following paragraph for d(1) of paragraph entitled "Steel Piping."

"(1) Cement-Mortar Lining: Materials for in-place cement-mortar lining shall be as specified in AWWA C602."

2. Insert the following new paragraph in its appropriate place at paragraph entitled "Installation of Steel Piping."

"c. Cement-mortar Lining of Pipeline in Place: Pipeline shall be cement-mortar lined after installation. Procedure shall be in accordance with AWWA C602."

3. Insert the latest publication of AWWA C602 in paragraph entitled "References."

- a. Jointing: Make rubber-gasketed bell-and-spigot joints with the gaskets previously specified for this type joint, using an approved lubricant recommended by the pipe manufacturer; assemble in accordance with the recommendations of the pipe manufacturer. [Make welded joints in accordance with AWWA C206 and with the recommendations given for installation of pipe in AWWA M11, Chapter 12, "Transportation, Installation, and Testing."]

Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer. [Make flanged joints with the gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other [equipment and] accessories. Align bolt holes for each flanged joint. Use full-size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without straining the flange. When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.] [[Make grooved type joints with the couplings specified for this type joint connecting pipe with roll-grooved ends or pipe with welded-on cut-grooved adapters, each with dimensions as previously specified for this type joint. Groove pipe ends in the field only with approved groove rolling equipment and groove adapters in the field only with approved groove cutting equipment; groove rolling and groove cutting equipment shall be designed especially for the purpose and produced by a manufacturer of grooved joint couplings. Obtain approval for field-cut grooves before assembling the joint.] [Make shouldered type joints with the couplings specified for this type joint connecting pipe with the shouldered ends specified for this type joint.] Assemble [grooved] [and] [shouldered] type joints in accordance with the recommendations of the coupling manufacturer.] [Make insulating joints with the gaskets, sleeves, washers, bolts, and nuts specified for this type joint. Assemble insulating joints as specified for flanged joints, except that bolts with insulating sleeves shall be full size for the bolt holes. Ensure that there is no metal-to-metal contact between dissimilar metals after the joint has been assembled.] Finish joints on piping with cement-mortar lining [and on piping with cement-mortar coating] as specified in Appendix on Field Joints in [AWWA C205](#). [Finish joints on piping with [coal-tar enamel] [or] [coal-tar epoxy] coating by cleaning, priming, coating, and wrapping with a cold-applied tape coating conforming to and applied in accordance with [AWWA C209](#).]

- b. Allowable Offsets: 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.
- c. Pipe Anchorage: Provide [concrete thrust blocks (reaction backing)] [metal harness] for pipe anchorage [, except where metal harness is indicated]. [Thrust blocks shall be in accordance with the recommendations for thrust restraint in [AWWA M11](#), Chapter 13, "Supplementary Design Data and Details," except that size and positioning of thrust blocks shall be as indicated. Use concrete, [ASTM C 94/C 94M](#), having a minimum compressive strength of [15 MPa 2500 psi](#) at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.] [Metal harness shall be in accordance with the recommendations for joint harnesses in [AWWA M11](#), Chapter 13, "Supplementary Design Data and Details" [, except as

otherwise indicated]. Metal harness shall be fabricated by the pipe manufacturer and furnished with the pipe.]

]3.1.2.8 Installation of Valves and Hydrants

- a. Installation of Valves: Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509. [Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation."] [Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation [, except as otherwise indicated].] Make and assemble joints to gate valves [and check valves] as specified for making and assembling the same type joints between pipe and fittings.
- b. Installation of Hydrants: Install hydrants [, except for metal harness,] in accordance with AWWA C600 for hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. [Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which hydrant is attached.] Install hydrants with the 115 mm 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, contact the Contracting Officer for further instructions.

[3.1.2.9 Installation Beneath Railroad Right-of-Way

Install piping passing under the right-of-way of a commercial railroad in accordance with the specifications for pipelines conveying nonflammable substances in Chapter 1, Part 5, of the AREMA Manual. [For PVC plastic water main pipe, also install in accordance with the recommendations of AWWA M23 for installation of casings.]

]3.1.3 Installation of Water Service Piping

3.1.3.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 1.5 m 5 feet from the building line at [a point directed by the Contracting Officer] [the point[s] indicated]; such water service lines shall be closed with plugs or caps.

3.1.3.2 Service Line Connections to Water Mains

NOTE: Use first optional sentence for service line piping less than 80 mm 3 inches in diameter. Use third optional sentence for service line piping 80 mm 3 inches in diameter or larger. Delete references to size except when more than one size range is

present.

**NOTE: Delete requirements for and references to
steel pipe and associated fittings for Navy projects.**

[Connect service lines [[_____] mm inch size] to the main [by a corporation stop and gooseneck and install a service stop below the frostline] [as indicated].] [Connect service lines 50 mm 2 inch size to the main [with a rigid connection or a corporation stop and gooseneck and install a gate valve on service line below the frostline] [as indicated].] [Connect service lines [[_____] mm inch size] to the main [with a rigid connection and install a gate valve on service line below the frostline] [as indicated].] [Connect service lines to ductile-iron water mains in accordance with AWWA C600 for service taps.] [Connect service lines to PVC plastic water mains in accordance with UBPPA UNI-B-8 and the recommendations of AWWA M23, Chapter 9, "Service Connections."] [Connect service lines to concrete water mains in accordance with the recommendations of AWWA M9, Chapter 12, "Tapping Concrete Pressure Pipe."] [Connect service lines to steel water mains in accordance with the recommendations of the steel water main pipe manufacturer and with the recommendations for special and valve connections and other appurtenances in AWWA M11, Chapter 13, "Supplementary Design Data and Details."]

3.1.4 Special Requirements for Installation of Water Service Piping

3.1.4.1 Installation of Metallic Piping

**NOTE: Delete requirements for and references to
steel pipe and associated fittings for Navy projects.**

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.

a. Jointing:

(1) Screwed Joints: Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or graphite compound; apply to male threads only. Threads shall be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.

(2) Joints for Copper Tubing: Cut copper tubing with square ends; remove fins and burrs. Handle tubing carefully; replace dented, gouged, or otherwise damaged tubing with undamaged tubing.

Make solder joints using ASTM B 32, 95-5 tin-antimony or Grade Sn96 solder. Solder and flux shall contain not more than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing.

(3) Flanged Joints: Make flanged joints up tight, taking care to avoid undue strain on flanges, valves, fittings, and accessories.

NOTE: At the text below, use coal-tar enamel coating with double felt wraps instead of single layer of felt wrap where soil in which pipe is to be buried is classified as Group IV, Unusually Corrosive (as defined in AWWA M11, Chapter 10, "Principles of Corrosion and Corrosion Control") or as Class 4, Extreme (as defined in Navy Design Manual on water supply systems); or where electrical resistivity of soil has been measured at less than 2,000 ohms/cc.

- b. Protection of Buried Steel Service Line Piping: [Unless otherwise specified,] prepare, prime, and coat exterior surface of zinc-coated steel pipe and associated fittings to be buried with hot-applied coal-tar enamel with a bonded [single layer of felt wrap in accordance with AWWA C203] [double felt wraps in accordance with AWWA C203]. For the felt wrap material, use fibrous-glass mat as specified in AWWA C203; use of asbestos felt will not be permitted. Use solvent wash only to remove oil, grease, and other extraneous matter from zinc-coated pipe and fittings.

3.1.4.2 Installation of Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the applicable requirements of ASTM D 2774 [and ASTM D 2855], unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F 402.

- a. Jointing: [Make solvent-cemented joints for PVC plastic piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D 2855.] [Make solvent-cemented joints for ABS plastic piping using the solvent cement previously specified for this material; assemble joints in accordance with the recommendations of the pipe manufacturer, as approved.] Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.
- b. Plastic Pipe Connections to Appurtenances: Connect plastic pipe service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.1.4.3 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.

3.1.4.4 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.

3.1.5 Disinfection

Prior to disinfection, obtain Contracting Officer approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with **AWWA C651**. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into service. Disinfection of systems supplying nonpotable water is not required.

[3.1.6 Optional Disinfection Method

NOTE: For Iceland projects, include the following option.

Disinfect new potable water lines and affected portions of existing potable water lines with geothermal water. Geothermal water shall be not less than 90 degrees Celsius and contact time shall be not less than 30 minutes. After disinfection, thoroughly flush new potable water lines and affected portions of existing potable water lines with the chlorinated base water supply for a minimum of two hours.

]3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain Contracting Officer approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing [, except that water and electric power needed for field tests will be furnished as set forth in Section [____]]. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. [Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.]

3.2.2 Testing Procedure

NOTE: Delete references to water service lines of these materials except when there is water service pipe of 80 mm 3 inch size or larger included in the project. Ductile-iron piping is available in 80 mm 3 inch size, but 100 mm 4 inch size is smallest for PVC plastic water main pipe.

NOTE: Delete requirements for and references to
steel pipe and associated fittings for Navy projects.

Test water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." [Test ductile-iron water mains [and water service lines] in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] shall not exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other method.] [Test PVC plastic water mains [and water service lines made with PVC plastic water main pipe] in accordance with the requirements of UBPPA UNI-B-3 for pressure and leakage tests. The amount of leakage on pipelines made of PVC plastic water main pipe shall not exceed the amounts given in UBPPA UNI-B-3, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed.] [Test concrete water mains in accordance with the recommendations in AWWA M9, Chapter 10, "Hydrostatic Testing and Disinfection of Mains." The amount of leakage on concrete pipelines shall not exceed 1.8 liters per 24 hours per millimeter 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline.] [Test steel water mains in accordance with applicable requirements of AWWA C600 for hydrostatic testing. The amount of leakage on steel pipelines with rubber-gasketed bell-and-spigot joints shall not exceed 1.8 liters per 24 hours per millimeter 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline; no leakage will be allowed at joints made by any other method. Repair of welded joints to stop leakage shall be done by welding only.] Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at [copper pipe joints] [copper tubing joints (soldered, compression type, brazed)] [plastic pipe joints] [flanged joints] [and] [screwed joints].

3.2.3 Special Testing Requirements

For pressure test, use a hydrostatic pressure 375 kPa 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 50 mm 2 inches in diameter, hydrostatic test pressure shall be not less than 1400 kPa 200 psi. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --