



6.1 General.

The requirements of Chapter 6 shall apply to the installation of underground piping used for private fire service mains and any underground piping installed in a sprinkler system.

6.2 * Piping. [24:10.1]

6.2.1 *

All piping used in private fire service mains shall be in accordance with 6.2.1.1, 6.2.1.2, or 6.2.1.3.

6.2.1.1 Use.

Piping manufactured in accordance with Table 6.2.1.1 shall be permitted to be used. [24:10.1.1.1]

Table 6.2.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	
Cement-mortar lining for ductile-iron pipe and fittings	AWWA C104/A21.4
Polyethylene encasement for ductile-iron pipe systems	AWWA C105/A21.5
Rubber-gasket joints for ductile-iron pressure pipe and fittings	AWWA C111/A21.11
Flanged ductile-iron pipe with ductile-iron or gray-iron threaded flanges	AWWA C115/A21.15
Thickness design of ductile-iron pipe	AWWA C150/A21.50
Ductile-iron pipe, centrifugally cast	AWWA C151/A21.51
Ductile iron water mains and their appurtenances	AWWA C600
Concrete	
Reinforced concrete pressure pipe, steel-cylinder type	AWWA C300
Prestressed concrete pressure pipe, steel-cylinder type	AWWA C301
Reinforced concrete pressure pipe, non-cylinder type	AWWA C302
Reinforced concrete pressure pipe, steel-cylinder type, pretensioned	AWWA C303
Cement-mortar lining of water pipe lines in place, 4 in. (100 mm) and larger	AWWA C602
Plastic	
Polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 4 in. through 60 in. (100 mm through 1500 mm)	AWWA C900
Polyethylene (PE) pressure pipe and fittings, 4 in. (100 mm) through 63 in. (1575 mm) for waterworks	AWWA C906
Molecularly oriented polyvinyl chloride (PVCO), 4 in. through 24 in. (100 mm through 600 mm) for water, wastewater, and reclaimed water service	AWWA C909
Brass	
Seamless red brass pipe, standard sizes	ASTM B43
Copper	
Seamless copper tube	ASTM B75/B75M

Materials and Dimensions	Standard
Seamless copper water tube	ASTM B88
Wrought seamless copper and copper-alloy tube	ASTM B251/B251M
Stainless Steel	
Seamless, welded, and heavily cold worked austenitic stainless steel pipes	ASTM A312/312M

[24:Table 10.1.1.1]

6.2.1.2

Piping specifically listed for use in private fire service mains shall be permitted to be used. [24:10.1.1.2]

6.2.1.2.1

Where listed pipe is used, it shall be installed in accordance with the listing limitations including installation instructions. [24:10.1.1.2.1]

6.2.1.2.2

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.1.1.2.2]

6.2.1.3

Steel piping manufactured in accordance with Table 6.2.1.3 that is externally coated and wrapped and internally galvanized shall be permitted to be used between the hose coupling(s) on the fire department connection and the check valve installed in the fire department connection piping. [24:10.1.1.3]

Table 6.2.1.3 Steel Piping for Fire Department Connections

Materials and Dimensions	Standard
Black and hot-dipped zinc-coated (galvanized) welded and seamless steel pipe for fire protection use	ASTM A795/A795M
Pipe, steel, black and hot-dipped, zinc-coated, welded and seamless	ASTM A53/A53M
Electric-resistance-welded steel pipe	ASTM A135/A135M

[24:Table 10.1.1.3]

6.2.1.3.1

External coating and wrapping as required by 6.2.1.3 shall be approved. [24:10.1.1.3.1]

6.2.1.3.2

The requirements of 6.2.1.3 shall not apply to listed stainless steel piping. [24:10.1.1.3.2]

6.2.1.4 Dry Pipe Underground.

6.2.1.4.1

Where necessary to place pipe that will be under air pressure underground, the pipe shall be protected against corrosion.

6.2.1.4.2

Unprotected cast-iron or ductile-iron pipe shall be permitted where joined with a gasketed joint listed for air service underground.

6.2.2 *

All piping used in private fire service mains shall be rated for the maximum system working pressure to which the piping is exposed to but shall not be rated at less than 150 psi (10.3 bar). [24:10.1.2]

6.2.3 *

When lined piping is used, the manufacturer's literature for internal diameter shall be used for all hydraulic calculations. [24:10.1.3]

6.2.4 *

Regardless of pipe type, underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm). [24:10.1.4]

6.2.4.1

Underground piping extended vertically into the building through the slab shall be installed plumb. [24:10.1.4.1]

6.3 Fittings. [24:10.2]

6.3.1

All fittings used in private fire service mains shall be in accordance with 6.3.1.1 or 6.3.1.2. [24:10.2.1]

6.3.1.1

Fittings manufactured in accordance with Table 6.3.1.1 shall be permitted to be used. [24:10.2.1.1]

Table 6.3.1.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray iron threaded fittings, classes 125 and 250	ASME B16.4
Gray iron pipe flanges and flanged fittings, classes 25, 125, and 250	ASME B16.1
Ductile Iron	
Ductile-iron and gray-iron fittings	AWWA C110/A21.10
Ductile-iron compact fittings	AWWA C153/A21.53
Malleable Iron	
Malleable iron threaded fittings, classes 150 and 300	ASME B16.3
Copper	
Wrought copper and copper alloy solder joint pressure fittings	ASME B16.22
Cast copper alloy solder joint pressure fitting	ASME B16.18
Bronze Fittings	
Cast copper alloy threaded fittings, classes 125 and 250	ASME B16.15
Stainless Steel	
Wrought austenitic stainless steel pipe fittings	ASTM A403/A403M

[24:Table 10.2.1.1]

6.3.1.2 Special Listed Fittings.

Fittings specifically listed for use in private fire service mains shall be permitted to be used. [24:10.2.1.2]

6.3.1.2.1

Where listed fittings are used, they shall be installed in accordance with their listing limitations including installation instructions. [24:10.2.1.2.1]

6.3.1.2.2

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.2.1.2.2]

6.3.2

All fittings used in private fire service mains shall be rated for the maximum system working pressure to which the fittings are exposed, but shall not be rated at less than 150 psi (10.3 bar). [24:10.2.2]

6.3.3

Where fittings installed in a private fire service main must be installed above grade, the fittings shall conform to NFPA 13. [24:10.2.3]

6.3.3.1

Fittings in accordance with 6.3.1 shall be permitted for the transition to the above ground piping or fittings. [24:10.2.3.1]

6.4 Connection of Pipe, Fittings, and Appurtenances. [24:10.3]**6.4.1 ***

Connection of all fittings and appurtenances to piping shall be in accordance with Section 6.4. [24:10.3.1]

6.4.2

Connections of pipe and fittings indicated in Table 6.2.1.1 and Table 6.3.1.1 shall be in accordance with the referenced standard in the table. [24:10.3.2]

6.4.3 Listed Connections.

Connections utilizing listed products shall be in accordance with the listing limitations and the manufacturer's installation instructions. [24:10.3.3]

6.4.3.1

Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.3.3.1]

6.4.4 Threaded Pipe and Fittings.

Where pipe, fittings or appurtenances are connected using threads, all threads shall be in accordance with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*. [24:10.3.4]

6.4.5 Grooved Connections.

Where pipe, fittings, or appurtenances are connected using grooves, they shall be connected in accordance with 6.4.5.1 through 6.4.5.3. [24:10.3.5]

6.4.5.1

Pipe, fittings, and appurtenances to be joined with grooved couplings shall contain cut, rolled, or cast grooves that are dimensionally compatible with the couplings. [24:10.3.5.1]

6.4.5.2

Pipe, fittings, and appurtenances that are connected with grooved couplings and are part of a listed assembly shall be permitted to be used. [24:10.3.5.2]

6.4.5.3 *

Pipe joined with grooved fittings shall be joined by a listed combination of fittings, gaskets, and grooves. [24:10.3.5.3]

6.4.6 Connection of Plain End Pipe.

Plain end pipe, fittings, and appurtenances joined with couplings shall be joined by a listed combination of fittings, gaskets, and couplings. [24:10.3.6]

6.4.7 Copper Tube.

All joints for the connection of copper tube shall be brazed or joined using pressure fittings as specified in Table 6.3.1.1. [24:10.3.7]

6.5 Protection of Private Fire Service Mains. [24:10.4]**6.5.1 Protection from Corrosion. [24:10.4.1]****6.5.1.1 Coatings.**

All bolted joint accessories shall be cleaned and thoroughly coated with asphalt, bituminous, or other corrosion-retarding material after installation. [24:10.4.1.1]

6.5.1.2

The requirements of 6.5.1.1 shall not apply to stainless steel or epoxy-coated fittings, valves, glands, or other accessories. [24:10.4.1.2]

6.5.1.3 *

Where it is necessary to join metal pipe with pipe of dissimilar metal, the joint shall be insulated against the passage of an electric current using an approved method. [24:10.4.1.3]

6.5.2 * Protection of Piping. [24:10.4.2]

6.5.2.1 Protection from Freezing.

The depth of cover for private fire service mains and their appurtenances to protect against freezing shall be in accordance with 6.5.2. [24:10.4.2.1]

6.5.2.1.1 *

The top of the pipe shall be buried not less than 1 ft (300 mm) below the frost line for the locality. [24:10.4.2.1.1]

6.5.2.1.2

The depth of piping shall be measured from the top of the piping to the final grade. [24:10.4.2.1.2]

6.5.2.1.3

Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [24:10.4.2.1.3]

6.5.2.1.4

Where private fire service mains are installed above ground, they shall be protected from freezing in accordance with NFPA 13. [24:10.4.2.1.4]

6.5.2.1.5

Private fire service mains installed in water raceways or shallow streams shall be installed so that the piping will remain in the running water throughout the year. [24:10.4.2.1.5]

6.5.2.1.6

Where piping is installed adjacent to a vertical face, it shall be installed from the vertical face at the same distance as if the piping were buried. [24:10.4.2.1.6]

6.5.2.1.7

Protection of private fire service mains from freezing using heat tracing shall be permitted when the heat tracing is specifically listed for underground use. [24:10.4.2.1.7]

6.5.2.1.7.1

Heat tracing not listed for underground use shall be permitted when piping is installed in accordance with 6.2.4. [24:10.4.2.1.7.1]

6.5.2.2 Protection from Mechanical Damage.

The depth of cover for private fire service mains and their appurtenances to protect against mechanical damage shall be in accordance with 6.5.2.2. [24:10.4.2.2]

6.5.2.2.1

The depth of piping shall be measured from the top of the piping to the final grade. [24:10.4.2.2.1]

6.5.2.2.2

In locations where freezing is not a factor, the depth of cover shall not be less than 30 in. (750 mm) below grade to prevent mechanical damage. [24:10.4.2.2.2]

6.5.2.2.2.1

Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [24:10.4.2.2.2.1]

6.5.2.2.3

Private fire service mains installed under driveways or roadways shall be buried at a minimum depth of 36 in. (900 mm). [24:10.4.2.2.3]

6.5.2.2.3.1

Sidewalks, walkways, and other paved or concrete pedestrian passageways shall not be required to comply with 6.5.2.2.3. [24:10.4.2.2.3.1]

6.5.2.2.4

Private fire service mains installed under railroad tracks shall be buried at a minimum depth of 4 ft (1.2 m). [24:10.4.2.2.4]

6.5.2.2.4.1

Where railroad operators require a greater depth of bury, the greater depth shall apply. [24:10.4.2.2.4.1]

6.5.2.2.5

Private fire service mains installed under large piles of heavy commodities or subject to heavy shock and vibrations shall be buried at a minimum depth of 4 ft (1.2 m). [24:10.4.2.2.5]

6.5.2.2.6

Where private fire service mains are installed above ground, they shall be protected with bollards or other means as approved by the AHJ when subject to mechanical damage. [24:10.4.2.2.6]

6.5.3 Private Fire Service Mains Beneath Buildings.

Except as permitted by 6.5.3, private fire service mains shall not be installed beneath buildings. [24:10.4.3]

6.5.3.1 *

Private fire service mains supplying fire protection systems within the building shall be permitted to extend horizontally no more than 10 ft (3.0 m) cumulatively, as measured from the outside of the building, under the building to the riser location. [24:10.4.3.1]

6.5.3.1.1 *

Pipe joints shall not be located directly under foundation footings. [24:10.4.3.1.1]

6.5.3.1.2 *

Piping shall be installed a minimum of 12 in. (300 mm) below the bottom of building foundations or footers. [24:10.4.3.1.2]

6.5.3.1.2.1

The requirements of 6.5.3.1.2 shall not apply when the piping is sleeved with an approved material. [24:10.4.3.1.2.1]

6.5.3.2 *

Private fire service mains shall not be permitted to extend more than 10 ft (3 m) under the building except as allowed in 6.5.3.2.1. [24:10.4.3.2]

6.5.3.2.1 *

Where private fire service mains extend more than 10 ft (3 m) into the building, they shall be run in a covered trench. [24:10.4.3.2.1]

6.5.3.2.1.1 *

The trench shall be accessible from within the building. [24:10.4.3.2.1.1]

6.5.3.2.1.2

The trench shall have rigid walls and a base. [24:10.4.3.2.1.2]

6.5.3.2.1.3

The trench shall be constructed of noncombustible materials. [24:10.4.3.2.1.3]

6.5.3.2.1.4 *

Provisions for draining water shall be provided for the trench. [24:10.4.3.2.1.4]

6.5.3.2.1.5

Where the piping in the trench is installed under foundations or footers, clearance shall be provided in accordance with 6.5.3.1.2 or 6.5.3.1.2.1. [24:10.4.3.2.1.5]

6.5.3.2.2

Piping in the trench shall be permitted to be in accordance with 6.2.1. [24:10.4.3.2.2]

6.5.3.2.2.1

Aboveground piping in accordance with NFPA 13 shall be permitted to be used. [24:10.4.3.2.2.1]

6.5.3.2.2.2

Where piping installed in the trench is in accordance with 6.2.1, all joints shall be restrained in accordance with 6.7.2 or 6.7.3. [24:10.4.3.2.2.2]

6.5.3.2.3 *

Where piping is installed in a trench as permitted by 6.5.3.2.1, a valve shall be provided where the underground piping enters the trench. [24:10.4.3.2.3]

6.5.3.2.4

When piping is installed in a trench, bury depths of 6.5.2.2 shall not apply. [24:10.4.3.2.4]

6.5.3.2.4.1

Piping in the trench shall be protected from freezing in accordance with 6.5.2.1.4. [24:10.4.3.2.4.1]

6.6 Grounding and Bonding. [24:10.5]

6.6.1 *

In no case shall the underground piping be used as a grounding electrode for electrical systems. [24:10.5.1]

6.6.1.1 *

The requirement of 6.6.1 shall not preclude the bonding of the underground piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure. [24:10.5.1.1]

6.7 * Restraint.

Private fire service mains shall be restrained against movement at changes in direction in accordance with 6.7.1, 6.7.2, or 6.7.3. [24:10.6]

6.7.1 * Thrust Blocks.

6.7.1.1

Thrust blocks shall be permitted where soil is stable and capable of resisting the anticipated thrust forces. [24:10.6.1.1]

6.7.1.1.1

The anticipated thrust forces shall be based on the test pressure. [24:10.6.1.1.1]

6.7.1.2

Thrust blocks shall be concrete of a mix not leaner than one part cement, two and one-half parts sand, and five parts stone. [24:10.6.1.2]

6.7.1.3

Thrust blocks shall be placed between undisturbed earth and the fitting to be restrained and shall be capable of resisting the calculated thrust forces. [24:10.6.1.3]

6.7.1.4

Wherever possible, thrust blocks shall be located so that the joints are accessible for repair. [24:10.6.1.4]

6.7.2 * Restrained Joint Systems.

Private fire service mains using restrained joint systems shall include one or more of the following:

- (1) Listed locking mechanical or push-on joints
- (2) Listed mechanical joints utilizing setscrew retainer glands
- (3) Listed bell joint restraints
- (4) Bolted flange joints
- (5) Pipe clamps and tie rods in accordance with 6.7.2.1
- (6) Other approved methods or devices

[24:10.6.2]

6.7.2.1 * Sizing Clamps, Rods, Bolts, and Washers. [24:10.6.2.1]

6.7.2.1.1 Clamps. [24:10.6.2.1.1]

6.7.2.1.1.1

Clamps shall have the following dimensions:

- (1) $\frac{1}{2}$ in. \times 2 in. (13 mm \times 50 mm) for 4 in. (100 mm) to 6 in. (150 mm) pipe
- (2) $\frac{5}{8}$ in. \times 2 $\frac{1}{2}$ in. (16 mm \times 65 mm) for 8 in. (200 mm) to 10 in. (250 mm) pipe
- (3) $\frac{5}{8}$ in. \times 3 in. (16 mm \times 75 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.1.1]

6.7.2.1.1.2

The diameter of a bolt hole shall be $\frac{1}{8}$ in. (3.2 mm) larger than that of the corresponding bolt. [24:10.6.2.1.1.2]

6.7.2.1.2 Rods. [24:10.6.2.1.2]**6.7.2.1.2.1**

Rods shall be not less than $\frac{5}{8}$ in. (16 mm) in diameter. [24:10.6.2.1.2.1]

6.7.2.1.2.2

Table 6.7.2.1.2.2 provides the numbers of various diameter rods that shall be used for a given pipe size. [24:10.6.2.1.2.2]

Table 6.7.2.1.2.2 Rod Number — Diameter Combinations

Nominal Pipe Size		$\frac{5}{8}$ in.	$\frac{3}{4}$ in.	$\frac{7}{8}$ in.	1 in.
in.	mm	(16 mm)	(20 mm)	(22 mm)	(25 mm)
4	100	2	—	—	—
6	150	2	—	—	—
8	200	3	2	—	—
10	250	4	3	2	—
12	300	6	4	3	2
14	350	8	5	4	3
16	400	10	7	5	4

Note: This table has been derived using pressure of 225 psi (15.5 bar) and design stress of 25,000 psi (172.4 MPa).

[24:Table 10.6.2.1.2.2]

6.7.2.1.2.3

When using bolting rods, the diameter of mechanical joint bolts shall limit the diameter of rods to $\frac{3}{4}$ in. (20 mm). [24:10.6.2.1.2.3]

6.7.2.1.2.4

Threaded sections of rods shall not be formed or bent. [24:10.6.2.1.2.4]

6.7.2.1.2.5

Where using clamps, rods shall be used in pairs for each clamp. [24:10.6.2.1.2.5]

6.7.2.1.2.6

Assemblies in which a restraint is made by means of two clamps canted on the barrel of the pipe shall be permitted to use one rod per clamp if approved for the specific installation by the AHJ. [24:10.6.2.1.2.6]

6.7.2.1.2.7

Where using combinations of rods, the rods shall be symmetrically spaced. [24:10.6.2.1.2.7]

6.7.2.1.3 Clamp Bolts.

Clamp bolts shall have the following diameters:

- (1) $\frac{5}{8}$ in. (16 mm) for pipe 4 in. (100 mm), 6 in. (150 mm), and 8 in. (200 mm)
- (2) $\frac{3}{4}$ in. (20 mm) for 10 in. (250 mm) pipe
- (3) $\frac{7}{8}$ in. (22 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.3]

6.7.2.1.4 Washers. [24:10.6.2.1.4]**6.7.2.1.4.1**

Washers shall be permitted to be cast iron or steel and round or square. [24:10.6.2.1.4.1]

6.7.2.1.4.2

Cast-iron washers shall have the following dimensions:

- (1) $\frac{5}{8}$ in. \times 3 in. (16 mm \times 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{3}{4}$ in. \times $3\frac{1}{2}$ in. (20 mm \times 90 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.4.2]

6.7.2.1.4.3

Steel washers shall have the following dimensions:

- (1) $\frac{1}{2}$ in. \times 3 in. (12 mm \times 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{1}{2}$ in. \times $3\frac{1}{2}$ in. (12 mm \times 90 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.4.3]

6.7.2.1.4.4

The diameter of holes shall be $\frac{1}{8}$ in. (3 mm) larger than that of bolts or rods. [24:10.6.2.1.4.4]

6.7.2.2 Sizes of Restraint Straps for Tees. [24:10.6.2.2]**6.7.2.2.1**

Restraint straps for tees shall have the following dimensions:

- (1) $\frac{5}{8}$ in. (16 mm) thick and $2\frac{1}{2}$ in. (65 mm) wide for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{5}{8}$ in. (16 mm) thick and 3 in. (75 mm) wide for 12 in. (300 mm) pipe

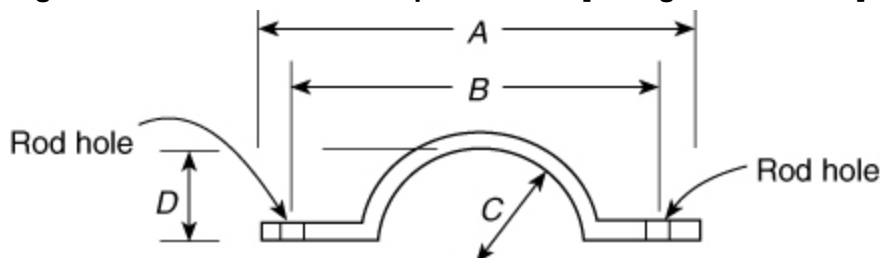
[24:10.6.2.2.1]

6.7.2.2.2

The diameter of rod holes shall be $\frac{1}{16}$ in. (1.6 mm) larger than that of rods. [24:10.6.2.2.2]

6.7.2.2.3

Figure 6.7.2.2.3 and Table 6.7.2.2.3 shall be used in sizing the restraint straps for both mechanical and push-on joint tee fittings. [24:10.6.2.2.3]

Figure 6.7.2.2.3 Restraint Straps for Tees. [24:Figure 10.6.2.2.3]**Table 6.7.2.2.3 Restraint Straps for Tees**

Nominal Pipe Size		A		B		C		D	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
4	100	12½	315	10⅛	255	2½	65	1¾	45
6	150	14½	365	12⅛	305	3⅞	90	2⅜	70
8	200	16¾	420	14⅜	360	4⅜	115	3⅞	100
10	250	19⅛	475	16⅛	415	5¾	145	5	125
12	300	22⅝	560	19⅜	480	6¾	170	5⅞	145

[24:Table 10.6.2.2.3]

6.7.2.3 Sizes of Plug Strap for Bell End of Pipe. [24:10.6.2.3]

6.7.2.3.1

The strap shall be ¾ in. (20 mm) thick and 2½ in. (65 mm) wide. [24:10.6.2.3.1]

6.7.2.3.2

The strap length shall be the same as dimension A for tee straps as shown in Figure 6.7.2.2.3. [24:10.6.2.3.2]

6.7.2.3.3

The distance between the centers of rod holes shall be the same as dimension B for tee straps as shown in Figure 6.7.2.2.3. [24:10.6.2.3.3]

6.7.2.4 Material.

Clamps, rods, rod couplings or turnbuckles, bolts, washers, restraint straps, and plug straps shall be of a material that has physical and chemical characteristics that indicate its deterioration under stress can be predicted with reliability. [24:10.6.2.4]

6.7.2.5 Corrosion Resistance.

After installation, rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a corrosion-retarding material. [24:10.6.2.5]

6.7.2.5.1

The requirements of 6.7.2.5 shall not apply to stainless steel or epoxy-coated fittings, valves, glands, or other accessories. [24:10.6.2.5.1]

6.7.3 *

Private fire service mains utilizing one or more of the following connection methods shall not require additional restraint, provided that such joints can pass the hydrostatic test of 6.11.2.2 without shifting of piping.

- (1) Threaded connections
- (2) Grooved connections
- (3) Welded connections
- (4) Heat-fused connections
- (5) Chemical or solvent cemented connections

[24:10.6.3]

6.8 Steep Grades. [24:10.7]

6.8.1

On steep grades, mains shall be additionally restrained to prevent slipping. [24:10.7.1]

6.8.1.1

Pipe shall be restrained at the bottom of a hill and at any turns (lateral or vertical). [24:10.7.1.1]

6.8.1.1.1

The restraint specified in 6.8.1.1 shall be to natural rock or to piles or piers built on the downhill side of the bell. [24:10.7.1.1.1]

6.8.1.2

Bell ends shall be installed facing uphill. [24:10.7.1.2]

6.8.1.3

Straight runs on hills shall be restrained as determined by a design professional. [24:10.7.1.3]

6.9 Installation Requirements. [24:10.8]**6.9.1**

Piping, valves, hydrants, gaskets, and fittings shall be inspected for damage when received and shall be inspected prior to installation. [24:10.8.1]

6.9.2

The tightness of bolted joints shall be verified by the bolt torque or by the method described in the listing information or manufacturer's installation instructions. [24:10.8.2]

6.9.3

Pipe, valves, hydrants, and fittings shall be clean and free from internal debris. [24:10.8.3]

6.9.4

When work is stopped, the open ends of piping, valves, hydrants, and fittings shall be plugged or covered to prevent foreign materials from entering. [24:10.8.4]

6.9.5

All piping, fittings, valves, and hydrants shall be examined for cracks or other defects while suspended above the trench and lowered into the trench using equipment designed for such use. [24:10.8.5]

6.9.6

Plain ends shall be inspected for signs of damage prior to installation. [24:10.8.6]

6.9.7

Piping, fittings, valves, hydrants, and appurtenances shall not be dropped, dumped or rolled or skidded against other materials. [24:10.8.7]

6.9.8

Pipes shall be supported in the trench throughout their full length and shall not be supported by the bell ends only or by blocks. [24:10.8.8]

6.9.9

If the ground is soft, other means shall be provided to support the pipe. [24:10.8.9]

6.9.10

Valves and fittings used with nonmetallic pipe shall be supported and restrained in accordance with the manufacturer's installation instructions. [24:10.8.10]

6.10 Backfilling. [24:10.9]**6.10.1**

Backfill material shall be tamped in layers or in puddles under and around pipes to prevent settlement or lateral movement and shall contain no ashes, cinders, refuse, organic matter, or other corrosive materials. [24:10.9.1]

6.10.2

Backfill material shall not contain ash, cinders, refuse, organic matter or other corrosive materials. [24:10.9.2]

6.10.3 *

In the absence of specific guidelines or specifications, the maximum allowable particle size for backfill within 1 ft (300 mm) of the pipe shall not be larger than 1½ in. (40 mm). [24:10.9.3]

6.10.3.1

Nominal pipe sizes of 4 in. (100 mm) or smaller shall not exceed $\frac{1}{2}$ in. (13 mm) maximum particle size. [24:10.9.3.1]

6.10.3.2

Nominal pipe sizes of 6 in. to 12 in. (150 mm to 300 mm) shall not exceed $\frac{3}{4}$ in. (19 mm) maximum particle size. [24:10.9.3.2]

6.10.4

Frozen earth shall not be used as backfill material. [24:10.9.4]

6.10.5

In trenches cut through rock, tamped backfill shall be used for at least 6 in. (150 mm) under and around the pipe and for at least 2 ft (600 mm) above the pipe. [24:10.9.5]

6.10.6

Where using piping listed for private fire service mains, the manufacturer's installation instructions for backfill shall be followed. [24:10.9.6]

6.11 Testing and Acceptance. [24:10.10]

6.11.1 Approval of Underground Piping. [24:10.10.1]

6.11.1.1

The installing contractor shall be responsible for the following:

- (1) Notifying the AHJ and the owner's representative of the time and date testing is to be performed
- (2) Performing all required acceptance tests
- (3) Completing and signing a contractor's material and test certificate(s) shown in Figure 6.11.1.1

[24:10.10.1.1]

Figure 6.11.1.1 Sample of Contractor's Material and Test Certificate for Underground Piping. [24:Figure 10.10.1.1]

Contractor's Material and Test Certificate for Underground Piping

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

Property name		Date	
Property address			
Plans	Accepted by approving authorities (names)		
	Address		
	Installation conforms to accepted plans		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Equipment used is approved If no, state deviations		<input type="checkbox"/> Yes <input type="checkbox"/> No
Instructions	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Have copies of appropriate instructions and care and maintenance charts been provided to the owner or owner's representative? If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
Location	Supplies buildings		
Underground pipes and joints	Pipe types and class		Type joint
	Pipe conforms to _____ standard		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Fittings conform to _____ standard If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
Test description	<p><u>Flushing:</u> Flow the required rate until water is verified to be clear of debris at outlets such as hydrants and blow-offs. Flush at one of the flow rates as specified in 6.11.2.1.3.</p> <p><u>Hydrostatic:</u> All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure ± 5 psi (0.34 bar) for 2 hours.</p> <p><u>Hydrostatic Testing Allowance:</u> Where additional water is added to the system to maintain the test pressures required by 6.11.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 6.11.2.2.6):</p> $L = \frac{SD\sqrt{P}}{148,000}$ <p> L = testing allowance (makeup water), in gallons per hour (lpm) S = length of pipe tested, in feet (m) D = nominal diameter of the pipe, in inches (mm) P = average test pressure during the hydrostatic test, in pounds per square inch (gauge) (bar) </p>		
Flushing tests	New underground piping flushed according to _____ standard by (company) If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
	How flushing flow was obtained <input type="checkbox"/> Public water <input type="checkbox"/> Tank or reservoir <input type="checkbox"/> Fire pump		Through what type opening <input type="checkbox"/> Hydrant butt <input type="checkbox"/> Open pipe
	Lead-ins flushed according to _____ standard by (company) If no, explain		<input type="checkbox"/> Yes <input type="checkbox"/> No
	How flushing flow was obtained <input type="checkbox"/> Public water <input type="checkbox"/> Tank or reservoir <input type="checkbox"/> Fire pump		Through what type opening <input type="checkbox"/> Y connection to flange and spigot <input type="checkbox"/> Open pipe

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Hydrostatic test	All new underground piping hydrostatically tested at _____ psi (bar) for _____ hours		Joints covered <input type="checkbox"/> Yes <input type="checkbox"/> No	
Leakage test	Total amount of leakage measured _____ gallons (liters) _____ hours			
	Allowable leakage _____ gallons (liters) _____ hours			
Forward flow test of backflow preventer	Forward flow test performed in accordance with 6.11.2.5.2: <input type="checkbox"/> Yes <input type="checkbox"/> No			
Hydrants	Number installed	Type and make	All operate satisfactorily <input type="checkbox"/> Yes <input type="checkbox"/> No	
Control valves	Water control valves left wide open If no, state reason		<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm		<input type="checkbox"/> Yes <input type="checkbox"/> No	
Remarks	Date left in service			
Signatures	Name of installing contractor			
	Tests witnessed by			
	For property owner (signed)	Title	Date	
	For installing contractor (signed)	Title	Date	
Additional explanation and notes				
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6.11.1.2

Alternate forms or electronic records providing at minimum the required information found in Figure 6.11.1.1 shall be permitted.

[24:10.10.1.2]

6.11.2 Acceptance Requirements. [24:10.10.2]

6.11.2.1 * Flushing of Piping. [24:10.10.2.1]**6.11.2.1.1**

Underground piping, from the water supply to the system riser, and lead-in connections to the system riser, including all hydrants, shall be completely flushed before connection is made to downstream fire protection system piping. [24:10.10.2.1.1]

6.11.2.1.2

The flushing operation shall continue until water flow is verified to be clear of debris. [24:10.10.2.1.2]

6.11.2.1.3 *

The minimum rate of flow shall be in accordance with Table 6.11.2.1.3. [24:10.10.2.1.3]

Table 6.11.2.1.3 Flow Required to Produce Velocity of 10 ft/sec (3.0 m/sec) in Pipes

Nominal Pipe Size (in.)	Flow Rate (gpm)	Nominal Pipe Size (mm)	Flow Rate (L/min)
2	100	50	380
2½	150	65	570
3	220	75	833
4	390	100	1,500
5	610	125	2,300
6	880	150	3,350
8	1,560	200	5,900
10	2,440	250	9,250
12	3,520	300	13,300

[24:Table 10.10.2.1.3]

6.11.2.1.3.1

Where the flow rates established in Table 6.11.2.1.3 are not attainable, the maximum allowable flow rate at the minimum allowable residual pressure to the system shall be acceptable. [24:10.10.2.1.3.1]

6.11.2.1.3.2

When connected to a fire pump, piping shall be flushed at a flow rate not less than indicated in Table 6.11.2.1.3.2 or at the hydraulically calculated water demand rate of the system, whichever is greater. [24:10.10.2.1.3.2]

Table 6.11.2.1.3.2 Minimum Flow Rates for Flushing Suction Piping

Nominal Pipe Size (in.)	Flow rate (gpm)	Nominal Pipe Size (mm)	Flow Rate (L/min)
1	37	25	140
1½	85	38	330
2	150	50	570
2½	229	65	870
3	330	75	1,250
3½	450	85	1,710
4	590	100	2,240
5	920	125	3,490
6	1,360	150	5,150
8	2,350	200	8,900
10	3,670	250	13,900

Nominal Pipe Size (in.)	Flow rate (gpm)	Nominal Pipe Size (mm)	Flow Rate (L/min)
12	5,290	300	20,100
14	7,200	350	27,300
16	9,400	400	35,600

[20:Table 14.1.1.1]

(A)

Flushing shall occur prior to hydrostatic test. [20:14.1.1.2]

(B)

Where the maximum flow available from the water supply cannot provide the flow rate provided in Table 6.11.2.1.3.2, the flushing flow rate shall be equal to or greater than 150 percent of rated flow of the connected fire pump. [20:14.1.1.3]

(C)

Where the maximum flow available from the water supply cannot provide a flow of 150 percent of the rated flow of the pump, the flushing flow rate shall be the greater of 100 percent of rated flow of the connected fire pump or the maximum flow demand of the fire protection system. [20:14.1.1.3.1]

(D)

A reduced flushing flow capacity in accordance with 6.11.2.1.3.2(C) shall constitute an acceptable test, provided that the flow rate is as much as can be safely achieved and it exceeds the fire protection system design flow rate. [20:14.1.1.3.2]

6.11.2.1.4 *

In lieu of flushing with the waterflow rates prescribed in 6.11.2.1.3 and 6.11.2.1.3.1, water main cleaning of the piping by the forceful introduction of swabs through the pipe shall be permitted. [24:10.10.2.1.4]

6.11.2.1.4.1

Water main swabbing shall be repeated, as necessary, until the last swab that has fully penetrated the pipe is clean and the discharge water is clear. [24:10.10.2.1.4.1]

6.11.2.1.5

Provision shall be made for the disposal of water used for flushing or testing to minimize any water damage caused by the discharge. [24:10.10.2.1.5]

6.11.2.2 Hydrostatic Test. [24:10.10.2.2]

6.11.2.2.1 *

All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at gauge pressure of 200 psi (14 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure at gauge pressure of ± 5 psi (0.3 bar) for 2 hours. [24:10.10.2.2.1]

6.11.2.2.2

Successful test results shall be determined by indication of either a pressure loss less than gauge pressure of 5 psi (0.3 bar) or by no visual leakage. [24:10.10.2.2.2]

6.11.2.2.3

The test pressure shall be read from one of the following, located at the lowest elevation of the system or the portion of the system being tested:

- (1) A gauge located at one of the hydrant outlets
- (2) A gauge located at the lowest point where no hydrants are provided

[24:10.10.2.2.3]

6.11.2.2.4 *

The trench shall be backfilled between joints before testing to prevent movement of pipe. [24:10.10.2.2.4]

6.11.2.2.5

Where required for safety measures presented by the hazards of open trenches, the pipe and joints shall be permitted to be backfilled, provided the installing contractor takes the responsibility for locating and correcting leakage. [24:10.10.2.2.5]

6.11.2.2.6 * Hydrostatic Testing Allowance.

Where additional water is added to the system to maintain the test pressures required by 6.11.2.2.1, the amount of water shall be measured and shall not exceed the limits of Table 6.11.2.2.6, which are based upon the following equations:

US Customary Units:

$$L = \frac{SD\sqrt{P}}{148,000} \quad [6.11.2.2.6a]$$

where:

L = testing allowance (makeup water) [gph (gal/hr)]

S = length of pipe tested (ft)

D = nominal diameter of pipe (in.)

P = average test pressure during hydrostatic test (gauge psi)

Metric Units:

$$L = \frac{SD\sqrt{P}}{794,797} \quad [6.11.2.2.6b]$$

where:

L = testing allowance (makeup water) (L/hr)

S = length of pipe tested (m)

D = nominal diameter of pipe (mm)

P = average test pressure during hydrostatic test (kPa)

[24:10.10.2.2.6]

Table 6.11.2.2.6 Hydrostatic Testing Allowance at 200 psi (14 bar)

Nominal Pipe Diameter		Testing Allowance	
in.	mm	gal/hr/100 ft	L/hr/100 m
2	50	0.019	0.236
4	100	0.03	0.472
6	150	0.057	0.708
8	200	0.076	0.944
10	250	0.096	1.19
12	300	0.115	1.43
14	350	0.134	1.66
16	400	0.153	1.90
18	450	0.172	2.14
20	500	0.191	2.37
24	600	0.229	2.84

Notes:

(1) For other length, diameters, and pressures, utilize Equation 6.11.2.2.6a or 6.11.2.2.6b to determine the appropriate testing allowance.

(2) For test sections that contain various sizes and sections of pipe, the testing allowance is the sum of the testing allowances for each size and section.

[24:Table 10.10.2.2.6]

6.11.2.3 * Other Means of Hydrostatic Tests.

Where acceptable to the AHJ, hydrostatic tests shall be permitted to be completed in accordance with the guidelines provided in AWWA C600, *Installation of Ductile-Iron Water Mains and Their Appurtenances*, AWWA M9, *Concrete Pressure Pipe*, AWWA M23, *PVC Pipe — Design and Installation*, or AWWA M55, *PE Pipe — Design and Installation*, as long as the test pressure and test duration requirements of 6.11.2.2.1 are still employed. [24:10.10.2.3]

6.11.2.3.1 *

For existing system modifications or repairs that cannot be isolated, hydrostatic testing shall be limited to visual evidence of leakage at system working pressure. [24:10.10.2.3.1]

6.11.2.4 Operating Test. [24:10.10.2.4]

6.11.2.4.1

Each hydrant shall be fully opened and closed under system water pressure. [24:10.10.2.4.1]

6.11.2.4.2

Dry barrel hydrants shall be checked for drainage. [24:10.10.2.4.2]

6.11.2.4.3

All control valves shall be fully closed and opened under system water pressure to ensure operation. [24:10.10.2.4.3]

6.11.2.4.4

Where fire pumps supply the private fire service main, the operating tests required by 6.11.2.4 shall be completed with the pumps running. [24:10.10.2.4.4]

6.11.2.5 Backflow Prevention Assemblies. [24:10.10.2.5]

6.11.2.5.1

The backflow prevention assembly shall be forward flow tested. [24:10.10.2.5.1]

6.11.2.5.2

The minimum flow rate tested in 6.11.2.5.1 shall be the system demand, including hose stream demand where applicable. [24:10.10.2.5.2]