

CHAPTER 6

WATER SUPPLY AND DISTRIBUTION

601.0 Hot and Cold Water Required.

601.1 General. Each plumbing fixture shall be provided with an adequate supply of potable running water piped to it in an approved manner, so arranged as to flush and keep the fixture in a clean and sanitary condition without danger of backflow or cross-connection. Water closets and urinals shall be flushed by means of an approved flush tank or flushometer valve.

Exception: Listed fixtures that do not require water for their operation and are not connected to the water supply.

601.1.1 Hot Water Required. In occupancies where plumbing fixtures are installed for private use, hot water shall be required for bathing, washing, laundry, cooking purposes, dishwashing, and maintenance. In occupancies where plumbing fixtures are installed for public use, hot water shall be required for bathing and washing purposes. This requirement shall not supersede the requirements for individual temperature control limitations for public lavatories, bidets, bathtubs, whirlpool bathtubs and shower control valves.

601.1.2 Hot Water Recirculation. Hot water supply systems in four-story buildings or higher, or buildings where the developed length of hot water piping from the source of hot water supply to the farthest fixture supplied exceeds 100 feet, shall be of the return circulation type.

601.2 Identification of a Potable and Nonpotable Water System. In buildings where potable water and nonpotable water systems are installed, each system shall be clearly identified in accordance with Section 601.2.1 through Section 601.2.4.

601.2.1 Potable Water. Green background with white lettering.

601.2.2 Color and Information. Each system shall be identified with a colored pipe or band and coded with paints, wraps, and materials compatible with the piping.

Except as required in Section 601.2.2.1, nonpotable water systems shall have a yellow background with black uppercase lettering, with the words "CAUTION: NONPOTABLE WATER, DO NOT DRINK." Each nonpotable system shall be identified to designate the liquid being conveyed, and the direction of normal flow shall be clearly shown. The minimum size of the letters and length of the color field shall comply with Table 601.2.2.

The background color and required information shall be indicated every 20 feet (6096 mm) but not less than once per room, and shall be visible from the floor level.

601.2.2.1 Alternate Water Sources. Alternate water source systems shall have a purple (Pantone color No. 512, 522C, or equivalent) background with uppercase lettering and shall be field or factory marked as follows:

- (1) Gray water systems shall be marked in accordance with this section with the words "CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).
- (2) Reclaimed (recycled) water systems shall be marked in accordance with this section with the words: "CAUTION: NONPOTABLE RECLAIMED (RECYCLED) WATER, DO NOT DRINK" in black letters.
- (3) On-site treated water systems shall be marked in accordance with this section with the words: "CAUTION: ON-SITE TREATED NONPOTABLE WATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).
- (4) Rainwater catchment systems shall be marked in accordance with this section with the words: "CAUTION: NONPOTABLE RAINWATER WATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).

601.2.3 Fixtures. Where vacuum breakers or backflow preventers are installed with fixtures listed in Table 1401.1, identification of the discharge side shall be permitted to be omitted.

601.2.4 Outlets. Each outlet on the nonpotable water line that is used for special purposes shall be posted with black uppercase lettering as follows: "CAUTION: NONPOTABLE WATER, DO NOT DRINK."

602.0 Unlawful Connections.

602.1 Prohibited Installation. No installation of potable water supply piping, or part thereof, shall be made in such a

TABLE 601.2.2
MINIMUM LENGTH OF COLOR FIELD AND SIZE OF LETTERS

OUTSIDE DIAMETER OF PIPE OR COVERING (inches)	MINIMUM LENGTH OF COLOR FIELD (inches)	MINIMUM SIZE OF LETTERS (inches)
½ to 1¼	8	½
1½ to 2	8	¾
2½ to 6	12	1¼
8 to 10	24	2½
Over 10	32	3½

For SI units: 1 inch = 25.4 mm

manner that it will be possible for used, unclean, polluted, or contaminated water, mixtures, or substances to enter a portion of such piping from a tank, receptor, equipment, or plumbing fixture by reason of backsiphonage, suction, or other cause, either during normal use and operation thereof, or where such tank, receptor, equipment, or plumbing fixture is flooded or subject to pressure exceeding the operating pressure in the hot or cold water piping.

602.2 Cross-Contamination. Unless there is provided a backflow prevention device approved for the potential hazard and maintained in accordance with this code, no person shall make a connection or allow one to exist between pipes or conduits carrying domestic water supplied by a public or private building supply system, and (1) pipes, conduits, or fixtures containing or carrying water from any other source or containing or carrying water that has been used for any purpose whatsoever, or (2) any piping carrying chemicals, liquids, gases, or substances whatsoever. Each point of use shall be separately protected where potential cross-contamination of individual units exists. Water used for cooling or heating of equipment or other purposes shall not be returned to the potable water system. Such water shall be discharged into the drainage system through an air-gapped indirect waste or other approved method of disposal.

602.3 Backflow Prevention. No plumbing fixture, device, or construction shall be installed or maintained, or shall be connected to a domestic water supply, where such installation or connection provides a possibility of polluting such water supply or cross-connection between a distributing system of water for drinking and domestic purposes and water that becomes contaminated by such plumbing fixture, device, or construction unless there is provided a backflow prevention device approved for the potential hazard.

602.4 Approval by Authority. No water piping supplied by a private water supply system shall be connected to any other source of supply without the approval of the Authority Having Jurisdiction.

603.0 Cross-Connection Control.

603.1 General. Cross-connection control shall be provided in accordance with the provisions of this chapter.

No person shall install a water-operated equipment or mechanism, or use a water-treating chemical or substance, where it is found that such equipment, mechanism, chemical, or substance causes pollution or contamination of the domestic water supply. Such equipment or mechanism shall be permitted where equipped with an approved backflow prevention device or assembly.

603.2 Approval of Devices or Assemblies. Before a device or an assembly is installed for the prevention of backflow, it shall have first been approved. Devices or assemblies shall be tested in accordance with recognized standards or other approved standards. Backflow prevention devices and assemblies shall comply with Table 603.2, except for specific applications and provisions as stated in Sections 603.5.1 through 603.5.23.

Devices or assemblies installed in a potable water supply system for protection against backflow shall be maintained in good working condition by the person or persons having control of such devices or assemblies. The devices or assemblies shall be tested at the time of installation, repair, or relocation and not less than on an annual schedule thereafter, or more often where required by the Authority Having Jurisdiction. Where found to be defective or inoperative, the device or assembly shall be repaired or replaced. No device or assembly shall be removed from use or relocated, or other device or assembly substituted, without the approval of the Authority Having Jurisdiction.

Testing shall be performed by a certified backflow assembly tester in accordance with ASSE Series 5000.

603.3 Backflow Prevention Devices, Assemblies, and Methods.

603.3.1 Air Gap. The minimum air gap to afford backflow protection shall be in accordance with Table 603.3.1.

603.3.2 Atmospheric Vacuum Breaker (AVB). An atmospheric vacuum breaker consists of a body, a checking member, and an atmospheric port.

603.3.3 Hose Connection Backflow Preventer. A hose connection backflow preventer consists of two independent check valves with an independent atmospheric vent between and a means of field testing and draining.

603.3.4 Double Check Valve Backflow Prevention Assembly (DC). A double check valve backflow prevention assembly consists of two independently acting internally loaded check valves, four properly located test cocks, and two isolation valves.

603.3.5 Pressure Vacuum Breaker Backflow Prevention Assembly (PVB). A pressure vacuum breaker backflow prevention assembly consists of a loaded air inlet valve, an internally loaded check valve, two properly located test cocks, and two isolation valves. This device shall be permitted to be installed indoors where provisions for spillage are provided.

603.3.6 Spill-Resistant Pressure Vacuum Breaker (SVB). A pressure-type vacuum breaker backflow prevention assembly consists of one check valve force-loaded closed and an air inlet vent valve force-loaded open to atmosphere, positioned downstream of the check valve, and located between and including two tightly closing shutoff valves and test cocks.

603.3.7 Reduced-Pressure Principle Backflow Prevention Assembly (RP). A reduced-pressure principle backflow prevention assembly consists of two independently acting internally loaded check valves, a differential pressure-relief valve, four properly located test cocks, and two isolation valves.

603.3.8 Double Check Detector Fire Protection Backflow Prevention Assembly. A double check valve backflow prevention assembly with a parallel

**TABLE 603.2
BACKFLOW PREVENTION DEVICES, ASSEMBLIES, AND METHODS**

DEVICE, ASSEMBLY, OR METHOD ¹	APPLICABLE STANDARDS	DEGREE OF HAZARD				INSTALLATION ^{2,3}
		POLLUTION (LOW HAZARD)		CONTAMINATION (HIGH HAZARD)		
		BACK-SIPHONAGE	BACK-PRESSURE	BACK-SIPHONAGE	BACK-PRESSURE	
Air gap	ASME A112.1.2	X	—	X	—	See Table 603.3.1 in this chapter.
Air gap fittings for use with plumbing fixtures, appliances and appurtenances	ASME A112.1.3	X	—	X	—	Air gap fitting is a device with an internal air gap and typical installation includes plumbing fixtures, appliances and appurtenances. The critical level shall not be installed below the flood level rim.
Atmospheric vacuum breaker (consists of a body, checking member and atmospheric port)	ASSE 1001 or CSA B64.1.1	X	—	X	—	Upright position. No valve downstream. Minimum of 6 inches or listed distance above all downstream piping and flood-level rim of receptor. ^{4,5}
Antisiphon fill valve (ball-cocks) for gravity water closet flush tanks and urinal tanks	ASSE 1002 or CSA B125.3	X	—	X	—	Installation on gravity water closet flush tank and urinal tanks with the fill valve installed with the critical level not less than 1 inch above the opening of the overflow pipe. ^{4,5}
Vacuum breaker wall hydrants, hose bibbs, frost resistant, automatic draining type	ASSE 1019 or CSA B64.2.1.1	X	—	X	—	Installation includes wall hydrants and hose bibbs. Such devices are not for use under continuous pressure conditions (means of shutoff downstream of device is prohibited). ^{4,5}
Backflow preventer for Carbonated Beverage Dispensers (two independent check valves with a vent to the atmosphere)	ASSE 1022	X	—	—	—	Installation includes carbonated beverage machines or dispensers. These devices operate under intermittent or continuous pressure conditions.
Spill-Resistant Pressure Vacuum Breaker (single check valve with air inlet vent and means of field testing)	ASSE 1056	X	—	X	—	Upright position. Minimum of 12 inches or listed distance above all downstream piping and flood-level rim of receptor. ⁵
Double Check Valve Backflow Prevention Assembly (two independent check valves and means of field testing)	ASSE 1015; AWWA C510; CSA B64.5 or CSA B64.5.1	X	X	—	—	Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. Does not discharge water.
Double Check Detector Fire Protection Backflow Prevention Assembly (two independent check valves with a parallel detector assembly consisting of a water meter and a double check valve backflow prevention assembly and means of field testing)	ASSE 1048	X	X	—	—	Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. Does not discharge water. Installation includes a fire protection system and is designed to operate under continuous pressure conditions.

**TABLE 603.2
BACKFLOW PREVENTION DEVICES, ASSEMBLIES, AND METHODS (continued)**

DEVICE, ASSEMBLY, OR METHOD ¹	APPLICABLE STANDARDS	DEGREE OF HAZARD				INSTALLATION ^{2,3}
		POLLUTION (LOW HAZARD)		CONTAMINATION (HIGH HAZARD)		
		BACK-SIPHONAGE	BACK-PRESSURE	BACK-SIPHONAGE	BACK-PRESSURE	
Pressure Vacuum Breaker Backflow Prevention Assembly (loaded air inlet valve, internally loaded check valve and means of field testing)	ASSE 1020 or CSA B64.1.2	X	—	X	—	Upright position. May have valves downstream. Minimum of 12 inches above all downstream piping and flood-level rim of receptor. May discharge water.
Reduced Pressure Principle Backflow Prevention Assembly (two independently acting loaded check valves, a differential pressure relief valve and means of field testing)	ASSE 1013; AWWA C511; CSA B64.4 or CSA B64.4.1	X	X	X	X	Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. May discharge water.
Reduced Pressure Detector Fire Protection Backflow Prevention Assembly (two independently acting loaded check valves, a differential pressure relief valve, with a parallel detector assembly consisting of a water meter and a reduced-pressure principle backflow prevention assembly, and means of field testing)	ASSE 1047	X	X	X	X	Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. May discharge water. Installation includes a fire protection system and is designed to operate under continuous pressure conditions.

For SI units: 1 inch = 25.4 mm

Notes:

- ¹ See description of devices and assemblies in this chapter.
- ² Installation in pit or vault requires previous approval by the Authority Having Jurisdiction.
- ³ Refer to general and specific requirement for installation.
- ⁴ Not to be subjected to operating pressure for more than 12 hours in a 24 hour period.
- ⁵ For deck-mounted and equipment-mounted vacuum breaker, see Section 603.5.14.

detector assembly consisting of a water meter and a double check valve backflow prevention assembly (DC).

603.3.9 Reduced Pressure Detector Fire Protection Backflow Prevention Assembly. A reduced-pressure principle backflow prevention assembly with a parallel detector assembly consisting of a water meter and a reduced-pressure principle backflow prevention assembly (RP).

603.4 General Requirements. Assemblies shall comply with listed standards and be acceptable to the Authority

Having Jurisdiction, with jurisdiction over the selection and installation of backflow prevention assemblies.

603.4.1 Backflow Prevention Valve. Where more than one backflow prevention valve is installed on a single premise, and the valves are installed in one location, each separate valve shall be permanently identified by the permittee in a manner satisfactory to the Authority Having Jurisdiction.

603.4.2 Testing. The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the

**TABLE 603.3.1
MINIMUM AIR GAPS FOR WATER DISTRIBUTION⁴**

FIXTURES	WHERE NOT AFFECTED BY SIDEWALLS¹ (inches)	WHERE AFFECTED BY SIDEWALLS² (inches)
Effective openings ³ not greater than 1/2 of an inch in diameter	1	1 1/2
Effective openings ³ not greater than 3/4 of an inch in diameter	1 1/2	2 1/4
Effective openings ³ not greater than 1 inch in diameter	2	3
Effective openings ³ greater than 1 inch in diameter	Two times diameter of effective opening	Three times diameter of effective opening

For SI units: 1 inch = 25.4 mm

Notes:

- ¹ Sidewalls, ribs, or similar obstructions do not affect air gaps where spaced from the inside edge of the spout opening a distance exceeding three times the diameter of the effective opening for a single wall, or a distance exceeding four times the effective opening for two intersecting walls.
- ² Vertical walls, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening other than specified in Footnote 1 above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the air gap shall be measured from the top of the wall.
- ³ The effective opening shall be the minimum cross-sectional area at the seat of the control valve or the supply pipe or tubing that feeds the device or outlet. Where two or more lines supply one outlet, the effective opening shall be the sum of the cross-sectional areas of the individual supply lines or the area of the single outlet, whichever is smaller.
- ⁴ Air gaps less than 1 inch (25.4 mm) shall be approved as a permanent part of a listed assembly that has been tested under actual backflow conditions with vacuums of 0 to 25 inches of mercury (85 kPa).

time of installation, repair, or relocation and not less than on an annual schedule thereafter, or more often where required by the Authority Having Jurisdiction. The periodic testing shall be performed in accordance with the procedures referenced in Table 1401.1 by a tester qualified in accordance with those standards.

603.4.3 Access and Clearance. Access and clearance shall be provided for the required testing, maintenance, and repair. Access and clearance shall be in accordance with the manufacturer’s instructions, and not less than 12 inches (305 mm) between the lowest portion of the assembly and grade, floor, or platform. Installations elevated that exceed 5 feet (1524 mm) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

603.4.4 Connections. Direct connections between potable water piping and sewer-connected wastes shall not be permitted to exist under any condition with or without backflow protection. Where potable water is discharged to the drainage system, it shall be by means of an approved air gap of two pipe diameters of the supply inlet, but in no case shall the gap be less than 1 inch (25.4 mm). Connection shall be permitted to be made to the inlet side of a trap provided that an approved vacuum breaker is installed not less than 6 inches (152 mm), or the distance according to the device’s listing, above the flood-level rim of such trapped fixture, so that at no time will such device be subjected to backpressure.

603.4.5 Hot Water Backflow Preventers. Backflow preventers for hot water exceeding 110°F (43°C)

shall be a type designed to operate at temperatures exceeding 110°F (43°C) without rendering a portion of the assembly inoperative.

603.4.6 Integral Backflow Preventers. Fixtures, appliances, or appurtenances with integral backflow preventers or integral air gaps manufactured as a unit shall be installed in accordance with their listing requirements and the manufacturer’s installation instructions.

603.4.7 Freeze Protection. In cold climate areas, backflow assemblies and devices shall be protected from freezing with an outdoor enclosure or by a method acceptable to the Authority Having Jurisdiction.

603.4.8 Drain Lines. Drain lines serving backflow devices or assemblies shall be sized in accordance with the discharge rates of the manufacturer’s flow charts of such devices or assemblies.

603.4.9 Prohibited Locations. Backflow prevention devices with atmospheric vents or ports shall not be installed in pits, underground, or submerged locations.

603.5 Specific Requirements.

603.5.1 Atmospheric Vacuum Breaker. Water closet and urinal flushometer valves shall be protected against backflow by an approved backflow prevention assembly, device, or method. Where the valves are equipped with an atmospheric vacuum breaker, the vacuum breaker shall be installed on the discharge side of the flushometer valve with the critical level not less than 6 inches (152 mm), or the distance according to its listing, above the overflow rim of a water closet bowl or the highest part of a urinal.

603.5.2 Ballcock. Water closet and urinal tanks shall be equipped with a ballcock. The ballcock shall be installed with the critical level not less than 1 inch (25.4 mm) above the full opening of the overflow pipe. In cases where the ballcock has no hush tube, the bottom of the water supply inlet shall be installed 1 inch (25.4 mm) above the full opening of the overflow pipe.

603.5.3 Backflow Prevention. Water closet flushometer tanks shall be protected against backflow by an approved backflow prevention assembly, device, or method.

603.5.4 Heat Exchangers. Heat exchangers used for heat transfer, heat recovery, or solar heating shall protect the potable water system from being contaminated by the heat-transfer medium.

603.5.4.1 Single-Wall Heat Exchanger.

Installation of a single-wall heat exchanger shall meet the following requirements:

- (1) Connected to:
 - (a) a low-pressure hot water boiler limited to a maximum of 30 pounds-force per square inch gauge (psig) (207kPa) by an approved safety or relief valve; or
 - (b) a steam system limited to a maximum of 15 psig (103 kPa).
- (2) The heat-transfer medium is either potable water or contains fluids having a toxicity rating or Class of 1.
- (3) Bear a label with the word "Caution," followed by the following statements:
 - (a) The heat-transfer medium shall be water or other nontoxic fluid having a toxicity rating or Class of 1 as listed in Clinical Toxicology of Commercial Products, 5th edition.
 - (b) The pressure of the heat-transfer medium shall be limited to a maximum of 30 psig (207 kPa) by an approved safety or relief valve.

The word "Caution" and the statements in letters shall have an uppercase height of not less than 0.120 inch (3.048 mm). The vertical spacing between lines of type shall be not less than 0.046 inch (1.168 mm). Lowercase letters shall be compatible with the uppercase letter size specification.

603.5.4.2 Double-Wall Heat Exchanger.

Double-wall heat exchangers shall separate the potable water from the heat-transfer medium by providing a space between the two walls that are vented to the atmosphere.

603.5.5 Water Supply Inlets. Water supply inlets to tanks, vats, sumps, swimming pools, and other receptors shall be protected by one of the following means:

- (1) An approved air gap.
- (2) A listed vacuum breaker installed on the discharge side of the last valve with the critical level not less than 6 inches (152 mm) or in accordance with its listing.
- (3) A backflow preventer suitable for the contamination or pollution, installed in accordance with the requirements for that type of device or assembly as set forth in this chapter.

603.5.6 Protection from Lawn Sprinklers and Irrigation Systems.

Potable water supplies to systems having no pumps or connections for pumping equipment, and no chemical injection or provisions for chemical injection, shall be protected from backflow by one of the following devices:

- (1) Atmospheric vacuum breaker (AVB)
- (2) Pressure vacuum breaker backflow prevention assembly (PVB)
- (3) Spill-resistant pressure vacuum breaker (SVB)
- (4) Reduced-pressure principle backflow prevention assembly (RP)

603.5.6.1 Systems with Pumps.

Where sprinkler and irrigation systems have pumps, connections for pumping equipment, or auxiliary air tanks, or are otherwise capable of creating backpressure, the potable water supply shall be protected by the following type of device where the backflow device is located upstream from the source of backpressure:

- (1) Reduced-pressure principle backflow prevention assembly (RP)

603.5.6.2 Systems with Backflow Devices.

Where systems have a backflow device installed downstream from a potable water supply pump or a potable water supply pump connection, the device shall be one of the following:

- (1) Atmospheric vacuum breaker (AVB)
- (2) Pressure vacuum breaker backflow prevention assembly (PVB)
- (3) Spill-resistant pressure vacuum breaker (SVB)
- (4) Reduced-pressure principle backflow prevention assembly (RP)

603.5.6.3 Systems with Chemical Injectors.

Where systems include a chemical injector or provisions for chemical injection, the potable water supply shall be protected by the following:

- (1) Reduced-pressure principle backflow prevention assembly (RP)

603.5.7 Outlets with Hose Attachments.

Potable water outlets with hose attachments, other than water heater drains, boiler drains, and clothes washer connections, shall be protected by a nonremovable hose bibb-

type backflow preventer, a nonremovable hose bibb-type vacuum breaker, or by an atmospheric vacuum breaker installed not less than 6 inches (152 mm) above the highest point of usage located on the discharge side of the last valve. In climates where freezing temperatures occur, a listed self-draining frost-proof hose bibb with an integral backflow preventer or vacuum breaker shall be used.

603.5.8 Water-Cooled Equipment. Water-cooled compressors, degreasers, or other water-cooled equipment shall be protected by a backflow preventer installed in accordance with the requirements of this chapter. Water-cooled equipment that produces backpressure shall be equipped with the appropriate protection.

603.5.9 Aspirators. Water inlets to water-supplied aspirators shall be equipped with a vacuum breaker installed in accordance with its listing requirements and this chapter. The discharge shall drain through an air gap. Where the tailpiece of a fixture to receive the discharge of an aspirator is used, the air gap shall be located above the flood-level rim of the fixture.

603.5.10 Steam or Hot Water Boilers. Potable water connections to steam or hot water boilers shall be protected from backflow by a double check valve backflow prevention assembly or reduced pressure principle backflow prevention assembly in accordance with Table 603.2. Where chemicals are introduced into the system a reduced pressure principle backflow prevention assembly shall be provided in accordance with Table 603.2.

603.5.11 Nonpotable Water Piping. In cases where it is impractical to correct individual cross-connections on the domestic waterline, the line supplying such outlets shall be considered a nonpotable water line. No drinking or domestic water outlets shall be connected to the nonpotable waterline. Where possible, portions of the nonpotable waterline shall be exposed, and exposed portions shall be properly identified in a manner satisfactory to the Authority Having Jurisdiction. Each outlet on the nonpotable waterline that is permitted to be used for drinking or domestic purposes shall be posted: "CAUTION: NONPOTABLE WATER, DO NOT DRINK."

603.5.12 Beverage Dispensers. Potable water supply to beverage dispensers, carbonated beverage dispensers, or coffee machines shall be protected by an air gap or a vented backflow preventer in accordance with ASSE 1022. For carbonated beverage dispensers, piping material installed downstream of the backflow preventer shall not be made of copper and not be affected by carbon dioxide gas.

603.5.13 Prohibited Location. Backflow preventers shall not be located in an area containing fumes that are toxic, poisonous, or corrosive.

603.5.14 Deck-Mounted and Equipment-Mounted Vacuum Breakers. Deck-mounted or equipment-mounted vacuum breakers shall be installed

in accordance with their listing and the manufacturer's installation instructions, with the critical level not less than 1 inch (25.4 mm) above the flood-level rim.

603.5.15 Protection from Fire Systems. Except as provided under Section 603.5.15.1 and Section 603.5.15.2, potable water supplies to fire protection systems that are normally under pressure, including but not limited to standpipes and automatic sprinkler systems, except in one- or two-family or townhouse residential sprinkler systems, piped in materials approved for potable water distribution systems shall be protected from backpressure and backsiphonage by one of the following testable devices:

- (1) Double check valve backflow prevention assembly (DC)
- (2) Double check detector fire protection backflow prevention assembly
- (3) Reduced pressure principle backflow prevention assembly (RP)
- (4) Reduced pressure detector fire protection backflow prevention assembly

Potable water supplies to fire protection systems that are not normally under pressure shall be protected from backflow and shall be in accordance with the requirements of the appropriate standards referenced in Table 1401.1.

603.5.15.1 Fire Department Connection.

Where fire protection systems supplied from a potable water system include a fire department (siamese) connection that is located less than 1700 feet (518.2 m) from a nonpotable water source that is capable of being used by the fire department as a secondary water supply, the potable water supply shall be protected by one of the following:

- (1) Reduced pressure principle backflow prevention assembly (RP)
- (2) Reduced pressure detector fire protection backflow prevention assembly

Nonpotable water sources include fire department vehicles carrying water of questionable quality or water that is treated with antifreeze, corrosion inhibitors, or extinguishing agents.

603.5.15.2 Chemicals. Where antifreeze, corrosion inhibitors, or other chemicals are added to a fire protection system supplied from a potable water supply, the potable water system shall be protected by one of the following:

- (1) Reduced pressure principle backflow prevention assembly (RP)
- (2) Reduced pressure detector fire protection backflow prevention assembly

603.5.15.3 Hydraulic Design. Where a backflow device is installed in the potable water supply to a fire protection system, the hydraulic design of

the system shall account for the pressure drop through the backflow device. Where such devices are retrofitted for an existing fire protection system, the hydraulics of the sprinkler system design shall be checked to verify that there will be sufficient water pressure available for satisfactory operation of the fire sprinklers.

603.5.16 Health Care or Laboratory Areas. Vacuum breakers for washer-hose bedpans shall be located not less than 5 feet (1524 mm) above the floor. Hose connections in health care or laboratory areas shall be not less than 6 feet (1829 mm) above the floor.

603.5.17 Special Equipment. Portable cleaning equipment, dental vacuum pumps, and chemical dispensers shall be protected from backflow by an air gap, an atmospheric vacuum breaker, a spill-resistant vacuum breaker, or a reduced pressure principle backflow preventer.

603.5.18 Potable Water Outlets and Valves. Potable water outlets, freeze-proof yard hydrants, combination stop-and-waste valves, or other fixtures that incorporate a stop-and-waste feature that drains into the ground shall not be installed underground except for a freeze-proof yard hydrant that is located at least two feet above the water table and at least ten feet from any sewer or similar source of contamination.

603.5.19 Pure Water Process Systems. The water supply to a pure water process system, such as dialysis water systems, semiconductor washing systems, and similar process piping systems, shall be protected from backpressure and backsiphonage by a reduced-pressure principle backflow preventer.

603.5.19.1 Dialysis Water Systems. The individual connections of the dialysis related equipment to the dialysis pure water system shall not require additional backflow protection.

603.5.20 Plumbing Fixture Fittings. Plumbing fixture fittings with integral backflow protection shall comply with ASME A112.18.1/CSA B 125.1.

603.5.21 Swimming Pools, Spas, and Hot Tubs. Potable water supply to swimming pools, spas, and hot tubs shall be protected by an air gap or a reduced pressure principle backflow preventer in accordance with the following:

- (1) The unit is equipped with a submerged fill line.
- (2) The potable water supply is directly connected to the unit circulation system.

603.5.22 Barometric Loop. A barometric loop is an acceptable method of protection of water connections where an actual or potential backsiphonage hazard exists that is not subject to backpressure.

603.5.23 Installation of Testable Backflow Prevention Assembly. Testable backflow prevention assemblies meeting ASSE Standard 1013, 1015, 1020, 1047, 1048, or 1056 shall be installed, tested, main-

tained, and removed in accordance with sections 603.5.23.1 through 603.5.23.4.

603.5.23.1 Notification of Installation. The administrative authority shall be notified before installation of a testable backflow prevention assembly. The public water supplier shall be notified of the installed testable backflow preventer assembly within 30 days following installation on a community public water system.

603.5.23.2 Testing and Maintenance. The installation of a testable backflow prevention assembly is permitted only when a periodic testing and inspection program conducted by qualified personal is provided by an agency acceptable to the administrative authority. Inspection intervals shall not exceed one year. The administrative authority may require more frequent testing if deemed necessary to ensure protection of the potable water. A testable backflow prevention assembly shall be inspected after initial installation to ensure that it has been properly installed and that debris resulting from the piping installation has not interfered with the functioning of the assembly.

603.5.23.3 Inspection and Records. A test and inspection tag shall be affixed to the testable backflow prevention assembly. The tester shall date and sign the tag and include the tester's backflow prevention tester certification number. Written records of testing and maintenance shall be maintained and submitted to the administrative authority, and to the public water supplier, within 30 days of testing if installed on a community public water system.

603.5.23.4 Notification of Removal. The Authority Having Jurisdiction, in addition to the public water supplier, shall be notified within 30 days following removal of a testable backflow prevention assembly from a community public water supply system.

604.0 Materials.

604.1 Pipe, Tube, and Fittings. Pipe, tube, fittings, solvent cements, thread sealants, solders, and flux used in potable water systems intended to supply drinking water shall be in accordance with the requirements of NSF 61.

Materials used in the water supply system, except valves and similar devices, shall be of a like material, except where otherwise approved by the Authority Having Jurisdiction.

Materials for building water piping and building supply piping shall comply with the applicable standards referenced in Table 604.1.

604.2 Copper Tube. Copper tube for water piping shall have a weight of not less than Type L.

Exception: Type M copper tubing shall be permitted to be

**TABLE 604.1
MATERIALS FOR BUILDING SUPPLY AND WATER DISTRIBUTION PIPING AND FITTINGS**

MATERIAL	BUILDING SUPPLY PIPE AND FITTINGS	WATER DISTRIBUTION PIPE AND FITTINGS	REFERENCED STANDARD(S) PIPE	REFERENCED STANDARD(S) FITTINGS
Asbestos-Cement	X*	—	ASTM C 296	—
Brass	X	X	ASTM B 43, ASTM B 135	—
Copper	X	X	ASTM B 42, ASTM B 75, ASTM B 88, ASTM B 251, ASTM B 302, ASTM B 447	ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.26
CPVC	X	X	ASTM D 2846, ASTM F 441, ASTM F 442	ASTM D 2846, ASTM F 437, ASTM F 438, ASTM F 439, ASTM F 1970
Ductile-Iron	X	X	AWWA C151	ASME B16.4, AWWA C110, AWWA C153
Galvanized Steel	X	X	ASTM A 53	—
Malleable Iron	X	X	—	ASME B16.3
PE	X*	—	ASTM D 2239, ASTM D 2737, ASTM D 3035, AWWA C901, CSA B137.1	ASTM D 2609, ASTM D 2683, ASTM D 3261, ASTM F 1055, CSA B137.1
PE-AL-PE	X	X	ASTM F 1282, CSA B137.9	ASTM F 1282, ASTM F 1974, CSA B137.9
PE-RT	X	X	ASTM F 2769	ASTM F 1807, ASTM F 2098, ASTM F 2159; ASTM F 2735, ASTM F 2769
PEX	X	X	ASTM F 876, ASTM F 877, CSA B137.5, AWWA C904*	ASSE 1061, ASTM F 877, ASTM F 1807, ASTM F 1960, ASTM F 1961, ASTM F 2080, ASTM F 2159, ASTM F 2735, CSA B137.5
PEX-AL-PEX	X	X	ASTM F 1281, CSA B137.10, ASTM F 2262	ASTM F 1281, ASTM F 1974, ASTM F 2434, CSA B137.10
PP	X	X	ASTM F 2389, CSA B137.11	ASTM F 2389, CSA B137.11
PVC	X*	—	ASTM D 1785, ASTM D 2241, AWWA C900	ASTM D 2464, ASTM D 2466, ASTM D 2467, ASTM F 1970
Stainless Steel	X	X	ASTM A 269, ASTM A 312	—

* For building supply or cold-water applications.

used for water piping where piping is aboveground in, or on, a building or underground outside of structures.

604.3 Hard-Drawn Copper Tubing. Hard-drawn copper tubing for water supply and distribution in addition to the required incised marking, shall be marked in accordance with ASTM B 88. The colors shall be: Type K, green; Type L, blue; and Type M, red.

604.4 Flexible Copper Connectors. Listed flexible copper water connectors shall be installed in readily accessible locations, unless otherwise listed.

604.5 Cast-Iron Fittings. Cast-iron fittings up to and including 2 inches (50 mm) in size, where used in connection with potable water piping, shall be galvanized.

604.6 Malleable Iron Fittings. Malleable iron water fittings shall be galvanized.

604.7 Previously Used Piping and Tubing. Piping and tubing that has previously been used for a purpose other than for potable water systems shall not be used.

604.8 Epoxy Coating. Epoxy coating used on existing building supply or water distribution piping systems shall be in accordance with NSF 61 and AWWA C210.

604.9 Plastic Materials. Approved plastic materials shall be permitted to be used in building supply piping, provided that where metal building supply piping is used for electrical grounding purposes, replacement piping therefore shall be of like materials.

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Exception: Where a grounding system acceptable to the Authority Having Jurisdiction is installed, inspected, and approved, metallic pipe shall be permitted to be replaced with nonmetallic pipe. Plastic materials for building supply piping outside underground shall have a blue insulated copper tracer wire or other approved conductor installed adjacent to the piping. Access shall be provided to the tracer wire or the tracer wire shall terminate aboveground at each end of the nonmetallic piping. The tracer wire size shall be not less than 18 AWG and the insulation type shall be suitable for direct burial.

604.10 Solder. Solder shall comply with the requirements of Section 605.3.4.

604.11 Lead Content. Water pipe and fittings with a lead content which exceeds a weighted average of 0.25 percent in the wetted surface material, as established in the Safe Drinking Water Act, section 1417(d), shall be prohibited in piping systems used to convey potable water.

604.12 Flexible Corrugated Connectors. Flexible corrugated connectors of copper or stainless steel shall be limited to the following connector lengths:

- (1) Fixture Connectors – 30 inches (762 mm)
- (2) Washing Machine Connectors – 72 inches (1829 mm)
- (3) Dishwasher and Icemaker Connectors – 120 inches (3048 mm)

604.13 Water Heater Connectors. Flexible metallic water heater connectors or reinforced flexible water heater connectors connecting water heating to the piping system shall be in accordance with the applicable standards referenced in Table 1401.1. Copper or stainless steel flexible connectors shall not exceed 24 inches (610 mm). PEX, PEX-AL-PEX, PE-AL-PE, or PE-RT tubing shall not be installed within the first 18 inches (457 mm) of piping connected to a water heater.

605.0 Joints and Connections.

605.1 Asbestos-Cement Pipe and Joints. Joining methods for asbestos-cement pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.1.1.

605.1.1 Mechanical Joints. Mechanical joints shall be of the same composition as the pipe and sealed with an approved elastomeric gasket or joined by a listed compression type coupling. Elastomeric gaskets shall comply with ASTM D 1869. The coupling grooves, pipe ends, and elastomeric gaskets shall be cleaned. Elastomeric gaskets shall be positioned in the grooves. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the machined end of the pipe. Lubricant shall not be applied to the elastomeric gasket or groove, unless specifically recommended by the manufacturer.

605.2 Brass Pipe and Joints. Joining methods for brass pipe and fittings shall be installed in accordance with

the manufacturer's installation instructions and shall comply with Section 605.2.1 through Section 605.2.3.

605.2.1 Brazed Joints. Brazed joints between brass pipe and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Pipe shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

605.2.2 Mechanical Joints. Mechanical joints shall be of the compression, pressed, or grooved type using an approved elastomeric gasket to form a seal.

605.2.3 Threaded Joints. Threaded joints shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

605.3 Copper Pipe, Tubing, and Joints. Joining methods for copper pipe, tubing, and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.3.1 through Section 605.3.5.

605.3.1 Brazed Joints. Brazed joints between copper pipe or tubing and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Tubing shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

605.3.2 Flared Joints. Flared joints for soft copper water tubing shall be made with fittings that are in accordance with the applicable standards referenced in Table 604.1. Pipe or tubing shall be cut square using an appropriate tubing cutter. The tubing shall be reamed to full inside diameter, resized to round, and expanded with a proper flaring tool.

605.3.3 Mechanical Joints. Mechanical joints shall include, but are not limited to, compression, flanged, grooved, pressed, and push fit fittings.

605.3.3.1 Mechanically Formed Tee Fittings. Mechanically formed tee fittings shall have extracted collars that shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the pipe or tube surface to form a collar having a height not less than three times the thickness of the branch tube wall. The branch pipe or tube shall be notched to conform to the inner curve of the run pipe or tube and shall have two

dimple depth stops to ensure that penetration of the branch pipe or tube into the collar is of a depth for brazing and that the branch pipe or tube does not obstruct the flow in the main line pipe or tube. Dimple depth stops shall be in line with the run of the pipe or tube. The second dimple shall be $\frac{1}{4}$ of an inch (6.4 mm) above the first and shall serve as a visual point of inspection. Fittings and joints shall be made by brazing. Soldered joints shall not be permitted.

605.3.3.2 Pressed Fittings. Pressed fittings for copper pipe or tubing shall have an elastomeric O-ring that forms the joint. The pipe or tubing shall be fully inserted into the fitting, and the pipe or tubing marked at the shoulder of the fitting. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The fitting alignment shall be checked against the mark on the pipe or tubing to ensure the pipe or tubing is inserted into the fitting. The joint shall be pressed using the tool recommended by the manufacturer.

605.3.3.3 Push Fit Fittings. Removable and nonremovable push fit fittings for copper tubing or pipe that employ quick assembly push fit connectors shall be in accordance with ASSE 1061. Push fit fittings for copper pipe or tubing shall have an approved elastomeric O-ring that forms the joint. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The tubing shall be fully inserted into the fitting, and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is inserted into the fitting and gripping mechanism has engaged on the pipe.

605.3.4 Soldered Joints. Soldered joints between copper pipe or tubing and fittings shall be made in accordance with ASTM B 828 with the following sequence of joint preparation and operation as follows: measuring and cutting, reaming, cleaning, fluxing, assembly and support, heating, applying the solder, cooling and cleaning. Pipe or tubing shall be cut square and reamed to the full inside diameter including the removal of burrs on the outside of the pipe or tubing. Surfaces to be joined shall be cleaned bright by manual or mechanical means. Flux shall be applied to pipe or tubing and fittings and shall be in accordance with ASTM B 813, and shall become noncorrosive and nontoxic after soldering. Insert pipe or tubing into the base of the fitting and remove excess flux. Pipe or tubing and fitting shall be supported to ensure a uniform capillary space around the joint. Heat shall be applied using an air or fuel torch with the flame perpendicular to the pipe or tubing using acetylene or an LP gas. Preheating shall depend on the size of the joint. The flame shall be moved to the fitting cup and alternate between the pipe or tubing and fitting. Solder in accordance

with ASTM B 32 shall be applied to the joint surfaces until capillary action draws the molten solder into the cup. Solder and fluxes with a lead content that exceeds 0.2 percent shall be prohibited in piping systems conveying potable water. Joint surfaces shall not be disturbed until cool and any remaining flux residue shall be cleaned.

605.3.5 Threaded Joints. Threaded joints for copper pipe shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

605.4 CPVC Plastic Pipe and Joints. CPVC plastic pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.4.1 through Section 605.4.3.

605.4.1 Mechanical Joints. Removable and nonremovable push fit fittings that employ a quick assembly push fit connector shall be in accordance with ASSE 1061.

605.4.2 Solvent Cement Joints. Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements in accordance with ASTM F 493, requiring the use of a primer shall be orange in color. The primer shall be colored and be in accordance with ASTM F 656. Listed solvent cement in accordance with ASTM F 493 that does not require the use of primers, yellow or red in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D 2846, $\frac{1}{2}$ of an inch (15 mm) through 2 inches (50 mm) in diameter. Apply primer where required inside the fitting and to the depth of the fitting on pipe. Apply liberal coat of cement to the outside surface of pipe to depth of fitting and inside of fitting. Place pipe inside fitting to forcefully bottom the pipe in the socket and hold together until joint is set.

605.4.3 Threaded Joints. Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 percent. The use of molded fittings shall not result in a 50 percent reduction in the pressure rating of the pipe provided that the molded fittings shall be fabricated so that the wall thickness of the material is maintained at the threads. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be applied to male threads. Caution shall be used during assembly to prevent over tightening of the CPVC components once the thread sealant has been applied. Female CPVC threaded fittings shall be used with plastic male threads only.

605.5 Ductile Iron Pipe and Joints. Ductile iron pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.5.1 and Section 605.5.2.

605.5.1 Mechanical Joints. Mechanical joints for ductile iron pipe and fittings shall consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

605.5.2 Push-On Joints. Push-on joints for ductile iron pipe and fittings shall consist of a single elastomeric gasket that shall be assembled by positioning the elastomeric gasket in an annular recess in the pipe or fitting socket and forcing the plain end of the pipe or fitting into the socket. The plain end shall compress the elastomeric gasket to form a positive seal and shall be designed so that the elastomeric gasket shall be locked in place against displacement. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

605.6 Galvanized Steel Pipe and Joints. Galvanized steel pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.6.1 and Section 605.6.2.

605.6.1 Mechanical Joints. Mechanical joints shall be made with an approved and listed elastomeric gasket.

605.6.2 Threaded Joints. Threaded joints shall be made with pipe threads that are in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

605.7 PE Plastic Pipe/Tubing and Joints. PE plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.7.1 and Section 605.7.2.

605.7.1 Heat-Fusion Joints. Heat-fusion joints between PE pipe or tubing and fittings shall be assembled in accordance with Section 605.7.1.1 through Section 605.7.1.3 using butt, socket, and electro-fusion heat methods in accordance with ASTM D 2657.

605.7.1.1 Butt-Fusion Joints. Butt-fusion joints shall be made by heating the squared ends of two pipes, pipe and fitting, or two fittings by holding ends against a heated element. The heated element shall be removed where the proper melt is obtained and joined ends shall be placed together with applied force.

605.7.1.2 Electro-Fusion Joints. Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with a heat source. Pipe shall be clamped in place and power applied through a controlled processor. The

material surrounding the wire shall be melted along with the pipe and shall provide the pressure required for fusion.

605.7.1.3 Socket-Fusion Joints. Socket-fusion joints shall be made by simultaneously heating the outside surface of a pipe end and the inside of a fitting socket. Where the proper melt is obtained, the pipe and fitting shall be joined by inserting one into the other with applied force. The joint shall fuse together and remain undisturbed until cool.

605.7.2 Mechanical Joints. Mechanical joints between PE pipe or tubing and fittings shall include insert and mechanical compression fittings that provide a pressure seal resistance to pullout. Joints for insert fittings shall be made by cutting the pipe square, using a cutter designed for plastic piping, and removal of sharp edges. Two stainless steel clamps shall be placed over the end of the pipe. Fittings shall be checked for proper size based on the diameter of the pipe. The end of pipe shall be placed over the barbed insert fitting, making contact with the fitting shoulder. Clamps shall be positioned equal to 180 degrees (3.14 rad) apart and shall be tightened to provide a leak tight joint. Compression type couplings and fittings shall be permitted for use in joining PE piping and tubing. Stiffeners that extend beyond the clamp or nut shall be prohibited. Bends shall be not less than 30 pipe diameters, or the coil radius where bending with the coil. Bends shall not be permitted closer than 10 pipe diameters of a fitting or valve. Mechanical joints shall be designed for their intended use.

605.8 PE-AL-PE Plastic Pipe/Tubing and Joints. PE-AL-PE plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.8.1 and Section 605.8.1.1.

605.8.1 Mechanical Joints. Mechanical joints for PE-AL-PE pipe or tubing and fittings shall be either of the metal insert fittings with a split ring and compression nut or metal insert fittings with copper crimp rings. Metal insert fittings shall comply with ASTM F 1974. Crimp insert fittings shall be joined to the pipe by placing the copper crimp ring around the outer circumference of the pipe, forcing the pipe material into the space formed by the ribs on the fitting until the pipe contacts the shoulder of the fitting. The crimp ring shall then be positioned on the pipe so the edge of the crimp ring is $\frac{1}{8}$ of an inch (3.2 mm) to $\frac{1}{4}$ of an inch (6.4 mm) from the end of the pipe. The jaws of the crimping tool shall be centered over the crimp ring and tool perpendicular to the barb. The jaws shall be closed around the crimp ring and shall not be crimped more than once.

605.8.1.1 Compression Joints. Compression joints for PE-AL-PE pipe or tubing and fittings

shall be joined through the compression of a split ring, by a compression nut around the circumference of the pipe. The compression nut and split ring shall be placed around the pipe. The ribbed end of the fitting shall be inserted onto the pipe until the pipe contacts the shoulder of the fitting. Position and compress the split ring by tightening the compression nut onto the insert fitting.

605.9 PE-RT. Polyethylene of raised temperature (PE-RT) tubing shall be marked with the appropriate standard designation(s) listed in Table 604.1 for which the tubing has been approved. PE-RT tubing shall be installed in accordance with the manufacturer's installation instructions.

605.9.1 Fittings. Metal insert fittings, metal compression fittings, and plastic fittings shall be manufactured to and marked in accordance with the standards for fittings in Table 604.1.

605.10 PEX Plastic Tubing and Joints. PEX plastic tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.10.1 and Section 605.10.2.

605.10.1 Fittings. Fittings for PEX tubing shall comply with the applicable standards referenced in Table 604.1. PEX tubing in accordance with ASTM F 876 shall be marked with the applicable standard designation for the fittings specified for use with the tubing.

605.10.2 Mechanical Joints. Mechanical joints shall be installed in accordance with the manufacturer's installation instructions.

605.11 PEX-AL-PEX Plastic Tubing and Joints. PEX-AL-PEX plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.11.1 and Section 605.11.1.1.

605.11.1 Mechanical Joints. Mechanical joints between PEX-AL-PEX tubing and fittings shall include mechanical and compression type fittings and insert fittings with a crimping ring. Insert fittings utilizing a crimping ring shall be in accordance with ASTM F 1974 or ASTM F 2434. Crimp joints for crimp insert fittings shall be joined to PEX-AL-PEX pipe by the compression of a crimp ring around the outer circumference of the pipe, forcing the pipe material into annular spaces formed by ribs on the fitting.

605.11.1.1 Compression Joints. Compression joints shall include compression insert fittings and shall be joined to PEX-AL-PEX pipe through the compression of a split ring or compression nut around the outer circumference of the pipe, forcing the pipe material into the annular space formed by the ribs on the fitting.

605.12 Polypropylene (PP) Piping and Joints. PP pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.12.1 through Section 605.12.3.

605.12.1 Heat-Fusion Joints. Heat-fusion joints for polypropylene (PP) pipe and fitting joints shall be installed with socket-type heat-fused polypropylene fittings, fusion outlets, butt-fusion polypropylene fittings or pipe, or electro-fusion polypropylene fittings. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F 2389 or CSA B137.11.

605.12.2 Mechanical and Compression Sleeve Joints. Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's installation instructions.

605.12.3 Threaded Joints. PP pipe shall not be threaded. PP transition fittings for connection to other piping materials shall only be threaded by use of brass or stainless steel inserts molded in the fitting.

605.13 PVC Plastic Pipe and Joints. PVC plastic pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.13.1 through Section 605.13.3.

605.13.1 Mechanical Joints. Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint. The mechanical joint shall include a pipe spigot that has a wall thickness to withstand without deformation or collapse; the compressive force exerted where the fitting is tightened. The push-on joint shall have a minimum wall thickness of the bell at any point between the ring and the pipe barrel. The elastomeric gasket shall comply with ASTM D 3139, and be of such size and shape as to provide a compressive force against the spigot and socket after assembly to provide a positive seal.

605.13.2 Solvent Cement Joints. Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, apply primer purple in color in accordance with ASTM F 656. Primer shall be applied until the surface of the pipe and fitting is softened. Solvent cements in accordance with ASTM D 2564 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Hold joint in place and undisturbed for 1 minute after assembly.

605.13.3 Threaded Joints. Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 percent. The use of molded fittings shall not result in a 50 percent reduction in the pressure rating of the pipe provided that the molded fittings shall be fabricated so that the wall thickness of the material is maintained at the threads. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be

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applied to male threads. Caution shall be used during assembly to prevent over tightening of the PVC components once the thread sealant has been applied. Female PVC threaded fittings shall be used with plastic male threads only.

605.14 Stainless Steel Pipe and Joints. Joining methods for stainless steel pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.14.1 and Section 605.14.2.

605.14.1 Mechanical Joints. Mechanical joints shall be designed for their intended use. Such joints shall include compression, flanged, grooved, pressed, and threaded.

605.14.2 Welded Joints. Welded joints shall be either fusion or resistance welded based on the selection of the base metal. Chemical composition of the filler metal shall comply with AWS A5.9 based on the alloy content of the piping material.

605.15 Slip Joints. In water piping, slip joints shall be permitted to be used only on the exposed fixture supply.

605.16 Dielectric Unions. Dielectric unions where installed at points of connection where there is a dissimilarity of metals shall be in accordance with ASSE 1079.

605.17 Joints Between Various Materials. Joints between various materials shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.17.1 through Section 605.17.3.

605.17.1 Copper Pipe or Tubing to Threaded Pipe Joints. Joints from copper pipe or tubing to threaded pipe shall be made by the use of brass adapter, brass nipple [minimum 6 inches (152 mm)], dielectric fitting, or dielectric union in accordance with ASSE 1079. The joint between the copper pipe or tubing and the fitting shall be a soldered, brazed, flared, or pressed joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size threaded joint.

605.17.2 Plastic Pipe to Other Materials. Where connecting plastic pipe to other types of piping, approved types of adapter or transition fittings designed for the specific transition intended shall be used.

605.17.3 Stainless Steel to Other Materials. Where connecting stainless steel pipe to other types of piping, mechanical joints of the compression type, dielectric fitting, or dielectric union in accordance with ASSE 1079 and designed for the specific transition intended shall be used.

606.0 Valves.

606.1 General. Valves up to and including 2 inches (50 mm) in size shall be brass or other approved material. Sizes exceeding 2 inches (50 mm) shall be permitted to have cast-iron or brass bodies. Each gate or ball valve shall be a full-way type with working parts of non-corrosive material.

Valves carrying water used in potable water systems intended to supply drinking water shall be in accordance with the requirements of NSF 61 as referenced in Table 1401.1.

606.2 Fullway Valve. A fullway valve controlling outlets shall be installed on the discharge side of each water meter and on each unmetered water supply. Water piping supplying more than one building on one premises shall be equipped with a separate fullway valve to each building, so arranged that the water supply can be turned on or off to an individual or separate building provided; however, that supply piping to a single-family residence and building accessory thereto shall be permitted to be controlled on one valve. Such shutoff valves shall be accessible. A fullway valve shall be installed on the discharge piping from water supply tanks at or near the tank. A fullway valve shall be installed on the cold water supply pipe to each water heater at or near the water heater.

606.3 Multidwelling Units. In multidwelling units, one or more shutoff valves shall be provided in each dwelling unit so that the water supply to a plumbing fixture or group of fixtures in that dwelling unit can be shut off without stopping water supply to fixtures in other dwelling units. These valves shall be accessible in the dwelling unit that they control.

606.4 Multiple Openings. Valves used to control two or more openings shall be fullway gate valves, ball valves, or other approved valves designed and approved for the service intended.

606.5 Control Valve. A control valve shall be installed immediately ahead of each water-supplied appliance and immediately ahead of each slip joint or appliance supply.

Parallel water distribution systems shall provide a control valve either immediately ahead of each fixture being supplied or installed at the manifold, and shall be identified with the fixture being supplied.

606.6 Accessible. Required shutoff or control valves shall be accessible.

606.7 Multiple Fixtures. A single control valve shall be installed on a water supply line ahead of an automatic metering valve that supplies a battery of fixtures.

607.0 Gravity Supply Tanks.

607.1 General. Gravity tanks for potable water shall be tightly covered, and have not less than a 16 square inch (0.01 m²) overflow screened with copper screen having not less than 14 nor exceeding 18 openings per linear inch (25.4 mm).

607.2 Potable Water Tanks. Potable water tanks, interior tank coatings, or tank liners intended to supply drinking water shall be in accordance with NSF 61.

608.0 Water Pressure, Pressure Regulators, Pressure Relief Valves, and Vacuum Relief Valves.

608.1 Inadequate Water Pressure. Where the water pressure in the main or other source of supply will not pro-

vide a residual water pressure of not less than 15 pounds force per square inch (psi) (103 kPa), after allowing for friction and other pressure losses, a tank and a pump or other means that will provide said 15 psi (103 kPa) pressure shall be installed. Where fixtures, fixture fittings, or both are installed that require residual pressure exceeding 15 psi (103 kPa), that minimum residual pressure shall be provided.

608.2 Excessive Water Pressure. Where static water pressure in the water supply piping is exceeding 80 psi (552 kPa), an approved-type pressure regulator preceded by an adequate strainer shall be installed and the static pressure reduced to 80 psi (552 kPa) or less. Pressure regulator(s) equal to or exceeding 1½ inches (38 mm) shall not require a strainer. Such regulator(s) shall control the pressure to water outlets in the building unless otherwise approved by the Authority Having Jurisdiction. Each such regulator and strainer shall be accessibly located aboveground or in a vault equipped with a properly sized and sloped bore-sighted drain to daylight, shall be protected from freezing, and shall have the strainer readily accessible for cleaning without removing the regulator or strainer body or disconnecting the supply piping. Pipe size determinations shall be based on 80 percent of the reduced pressure where using Table 610.4. An approved expansion tank shall be installed in the cold water distribution piping downstream of each such regulator to prevent excessive pressure from developing due to thermal expansion and to maintain the pressure setting of the regulator. Expansion tanks used in potable water systems intended to supply drinking water shall be in accordance with NSF 61. The expansion tank shall be properly sized and installed in accordance with the manufacturer's installation instructions and listing. Systems designed by registered engineers shall be permitted to use approved pressure relief valves in lieu of expansion tanks provided such relief valves have a maximum pressure relief setting of 100 psi (689 kPa) or less.

608.3 Expansion Tanks, Combination Pressure, and Temperature Relief Valves. A water system provided with a check valve, backflow preventer, or other normally closed device that prevents dissipation of building pressure back into the water main shall be provided with an approved, listed, and adequately sized expansion tank or other approved device having a similar function to control thermal expansion. Such expansion tank or other approved device shall be installed on the building side of the check valve, backflow preventer, or other device and shall be sized and installed in accordance with the manufacturer's installation instructions.

A water system containing storage water heating equipment shall be provided with an approved, listed, adequately sized combination pressure and temperature relief valve, except for listed nonstorage instantaneous heaters having an inside diameter of not more than 3 inches (80 mm). Each such approved combination temperature and pressure relief valve shall be installed on the water-heating device in an approved location based on its listing requirements and the manufacturer's installation instructions. Each such combina-

tion temperature and pressure relief valve shall be provided with a drain in accordance with Section 608.5.

608.4 Pressure Relief Valves. Each pressure relief valve shall be an approved automatic type with drain, and each such relief valve shall be set at a pressure of not more than 150 psi (1034 kPa). No shutoff valve shall be installed between the relief valve and the system or in the drain line.

608.5 Drains. Relief valves located inside a building shall be provided with: (1) a drain that is not smaller than the relief valve outlet and piping and fittings made of galvanized steel, hard-drawn copper, CPVC, or PP; or (2) a listed relief valve drain tube with fittings. The drain and drain tube shall not reduce the internal bore of the pipe or tubing (straight lengths as opposed to coils) and shall terminate to a safe place of disposal or within 18 inches of the floor.

Relief valve drains shall not terminate in a building's crawl space. No part of a drain pipe shall be trapped or subject to freezing. The terminal end of the drain pipe shall not be threaded.

608.6 Water-Heating Devices. A water-heating device connected to a separate storage tank and having valves between said heater and tank shall be provided with an approved water pressure relief valve.

608.7 Vacuum Relief Valves. Where a hot-water storage tank or an indirect water heater is located at an elevation above the fixture outlets in the hot-water system, a vacuum relief valve shall be installed on the storage tank or heater.

609.0 Installation, Testing, Unions, and Location.

609.1 Installation. Water piping shall be adequately supported in accordance with Table 313.1. Burred ends shall be reamed to the full bore of the pipe or tube. Changes in direction shall be made by the appropriate use of fittings, except that changes in direction in copper tubing shall be permitted to be made with bends, provided that such bends are made with bending equipment that does not deform or create a loss in the cross-sectional area of the tubing. Changes in direction are allowed with flexible pipe and tubing without fittings in accordance with the manufacturer's instructions. Provisions shall be made for expansion in hot-water piping. Piping, equipment, appurtenances, and devices shall be installed in a workmanlike manner in accordance with the provisions and intent of the code. Building supply yard piping shall be not less than 12 inches (305 mm) below the average local frost depth. The cover shall be not less than 12 inches (305 mm) below finish grade.

609.2 Trenches. Water pipes shall not be run or laid in the same trench as building sewer or drainage piping constructed of clay or materials that are not approved for use within a building unless both of the following conditions are met:

- (1) The bottom of the water pipe, shall be not less than 12 inches (305 mm) above the top of the sewer or drain line.
- (2) The water pipe shall be placed on a solid shelf exca-

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vated at one side of the common trench with a clear horizontal distance of not less than 12 inches (305 mm) from the sewer or drain line.

Water pipes crossing sewer or drainage piping constructed of clay or materials that are not approved for use within a building shall be laid not less than 12 inches (305 mm) above the sewer or drain pipe.

609.3 Under Concrete Slab. Water piping installed within a building and in or under a concrete floor slab resting on the ground shall be installed in accordance with the following requirements:

- (1) Ferrous piping shall have a protective coating of an approved type, machine applied and in accordance with recognized standards. Field wrapping shall provide equivalent protection and shall be restricted to those short sections and fittings necessarily stripped for threading. Zinc coating (galvanizing) shall not be deemed adequate protection for piping or fittings. Approved nonferrous piping shall not be required to be wrapped.
- (2) Copper tubing shall be installed without joints where possible. Where joints are permitted, they shall be brazed, and fittings shall be wrought copper.

For the purpose of this section, "within a building" shall mean within the fixed limits of the building foundation.

609.4 Testing. Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source of supply. Except for plastic piping, a 50 psi (345 kPa) air pressure shall be permitted to be substituted for the water test. In either method of test, the piping shall withstand the test without leaking for a period of not less than 15 minutes.

609.5 Unions. Unions shall be installed in the water supply piping not more than 12 inches (305 mm) of regulating equipment, water heating, conditioning tanks, and similar equipment that requires service by removal or replacement in a manner that will facilitate its ready removal.

609.6 Location. Except as provided in Section 609.7, no building supply shall be located in a lot other than the lot that is the site of the building or structure served by the building supply.

609.6.1 Water Supply Near Sources of Contamination. Potable water supply pipes shall not be located in, under, or above cesspools, septic tanks, septic tank drainage fields, seepage pits, soil treatment systems, contaminated soil, sewer manholes, catch basins, storm water storage tanks, buried tanks containing chemicals or petroleum products, or any other source of contamination that in the judgment of the administrative authority might contaminate the potable water supply. A horizontal separation of ten feet shall be maintained between the outer edge of the water supply pipe and the outer edge of the contamination source.

609.7 Abutting Lot. Nothing contained in this code shall be construed to prohibit the use of an abutting lot to:

- (1) Provide access to connect a building supply to an available public water service where proper cause and legal easement not in violation of other requirements have been first established to the satisfaction of the Authority Having Jurisdiction.
- (2) Provide additional space for a building supply where proper cause, transfer of ownership, or change of boundary not in violation of other requirements have been first established to the satisfaction of the Authority Having Jurisdiction. The instrument recording such action shall constitute an agreement with the Authority Having Jurisdiction, which shall clearly state and show that the areas so joined or used shall be maintained as a unit during the time they are so used. Such an agreement shall be recorded in the office of the County Recorder as a part of the conditions of ownership of said properties, and shall be binding on heirs, successors, and assigns to such properties. A copy of the instrument recording such proceedings shall be filed with the Authority Having Jurisdiction.

609.8 Low-Pressure Cutoff Required on Booster Pumps for Water Distribution Systems. Where a booster pump (excluding a fire pump) is connected to a building supply or underground water pipe, a low-pressure cutoff switch on the inlet side of the pump shall be installed not more than 5 feet (1524 mm) of the inlet. The cutoff switch shall be set for not less than 10 psi (69 kPa). A pressure gauge shall be installed between the shutoff valve and the pump.

609.9 Disinfection of Potable Water System. New or repaired potable water systems shall be disinfected prior to use where required by the Authority Having Jurisdiction. The method to be followed shall be that prescribed by the Health Authority or, in case no method is prescribed by it, the following:

- (1) The pipe system shall be flushed with clean, potable water until potable water appears at the points of outlet.
- (2) The system or parts thereof shall be filled with a water-chlorine solution containing not less than 50 parts per million of chlorine, and the system or part thereof shall be valved-off and allowed to stand for 24 hours; or, the system or part thereof shall be filled with a water-chlorine solution containing not less than 200 parts per million of chlorine and allowed to stand for 3 hours.
- (3) Following the allowed standing time, the system shall be flushed with clean, potable water until the chlorine residual in the water coming from the system does not exceed the chlorine residual in the flushing water.
- (4) The procedure shall be repeated where it is shown by bacteriological examination made by an approved agency that contamination persists in the system.

609.10 Water Hammer. Building water supply systems where quick-acting valves are installed shall be provided

with water hammer arrester(s) to absorb high pressures resulting from the quick closing of these valves. Water hammer arresters shall be approved mechanical devices in accordance with the applicable standard(s) referenced in Table 1401.1 and shall be installed as close as possible to quick-acting valves.

609.10.1 Mechanical Devices. Where listed mechanical devices are used, the manufacturer's specifications as to location and method of installation shall be followed.

609.11 Water Meters. Water meters shall be located inside a building, installed at least 12 inches above the finished floor, and readily accessible. All water meter installations shall be rigidly supported with a permanent support in order to prevent the meter from vibrating when the water is passing through it.

Exceptions: Where installation inside a building is not possible, the water meter may be installed in an enclosed structure not subject to flooding, high groundwater, or surface drainage runoff, provided the meter is protected from freezing. Provisions shall be made to install the meters above grade when possible. When installed below grade, the top of the structure shall be located at least 12 inches above the finished grade, be secured, and be accessible. This structure shall not be connected to any storm or sanitary sewer system.

610.0 Size of Potable Water Piping.

610.1 Size. The size of each water meter and each potable water supply pipe from the meter or other source of supply to the fixture supply branches, risers, fixtures, connections, outlets, or other uses shall be based on the total demand and shall be determined according to the methods and procedures outlined in this section. Water piping systems shall be designed to ensure that the maximum velocities allowed by the code and the applicable standard are not exceeded.

610.2 Pressure Loss. Where a water filter, water softener, backflow prevention device, tankless water heater, or similar device is installed in a water supply line, the pressure loss through such devices shall be included in the pressure loss calculations of the system, and the water supply pipe and meter shall be adequately sized to provide for such a pressure loss.

No water filter, water softener, backflow prevention device, or similar device regulated by this code shall be installed in a potable water supply piping where the installation of such device produces an excessive pressure drop in such water supply piping. In the absence of specific pressure drop information, the diameter of the inlet or outlet of such device or its connecting piping shall be not less than the diameter of such water distribution piping to the fixtures served by the device.

Such devices shall be of a type approved by the Authority Having Jurisdiction and shall be tested for flow rating and pressure loss by an approved laboratory or recognized testing agency to standards consistent with the intent of this chapter.

610.3 Quantity of Water. The quantity of water required to be supplied to every plumbing fixture shall be represented by fixture units, as shown in Table 610.3. Equivalent fixture values shown in Table 610.3 include both hot and cold water demand.

610.4 Parallel Distribution Systems. Systems within the range of Table 610.4 shall be permitted to be sized from that table or by the method in accordance with Section 610.5.

Listed parallel water distribution systems shall be installed in accordance with their listing, but at no time shall a portion of the system exceed the maximum velocities allowed by the code.

610.5 Sizing per Appendix A and C. Except as provided in Section 610.4, the size of each water piping system shall be determined in accordance with the procedure set forth in Appendix A For alternate methods of sizing water supply systems, see Appendix C.

610.6 Friction and Pressure Loss. Except where the type of pipe used and the water characteristics are such that no decrease in capacity due to length of service (age of system) is expected, friction-loss data shall be obtained from the "Fairly Rough" or "Rough" charts in Appendix A of this code. Friction or pressure losses in water meter, valve, and fittings shall be obtained from the same sources. Pressure losses through water-treating equipment, backflow prevention devices, or other flow-restricting devices shall be computed in accordance with Section 610.2.

610.7 Conditions for Using Table 610.4. On a proposed water piping installation sized using Table 610.4, the following conditions shall be determined:

- (1) Total number of fixture units as determined from Table 610.3, Equivalent Fixture Units, for the fixtures to be installed.
- (2) Developed length of supply pipe from meter to most remote outlet.
- (3) Difference in elevation between the meter or other source of supply and the highest fixture or outlet.
- (4) Pressure in the street main or other source of supply at the locality where the installation is to be made.
- (5) In localities where there is a fluctuation of pressure in the main throughout the day, the water piping system shall be designed on the basis of the minimum pressure available.

610.8 Size of Meter and Building Supply Pipe Using Table 610.4. The size of the meter and the building supply pipe shall be determined as follows:

- (1) Determine the available pressure at the water meter or other source of supply.
- (2) Add or subtract depending on positive or negative elevation change, 1/2 psi (3.4 kPa) for each foot (305 mm) of difference in elevation between such source of supply and the highest water supply outlet in the building or on the premises.
- (3) Use the "pressure range" group within which this pressure will fall using Table 610.4.

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**TABLE 610.3
WATER SUPPLY FIXTURE UNITS (WSFU) AND MINIMUM FIXTURE BRANCH PIPE SIZES³**

APPLIANCES, APPURTENANCES OR FIXTURES ²	MINIMUM FIXTURE BRANCH PIPE SIZE ^{1,4} (inches)	PRIVATE	PUBLIC	ASSEMBLY ⁶
Bathtub or Combination Bath/Shower (fill)	½	4.0	4.0	—
¾ inch Bathtub Fill Valve	¾	10.0	10.0	—
Bidet	½	1.0	—	—
Clothes Washer	½	4.0	4.0	—
Dental Unit, cuspidor	½	—	1.0	—
Dishwasher, domestic	½	1.5	1.5	—
Drinking Fountain or Water Cooler	½	0.5	0.5	0.75
Hose Bibb	½	2.5	2.5	—
Hose Bibb, each additional ⁸	½	1.0	1.0	—
Lavatory (each basin), or hand sink	½	1.0	1.0	1.0
Lawn Sprinkler, each head ⁵	—	1.0	1.0	—
Mobile Home, each (minimum)	—	12.0	—	—
Sinks	—	—	—	—
Bar	½	1.0	2.0	—
Clinic Faucet	½	—	3.0	—
Clinic Flushometer Valve with or without faucet	1	—	8.0	—
Kitchen, domestic with or without dishwasher	½	1.5	1.5	—
Laundry	½	1.5	1.5	—
Service or Mop Basin	½	1.5	3.0	—
Washup, each set of faucets	½	—	2.0	—
Shower, per head	½	2.0	2.0	—
Urinal, 1.0 GPF Flushometer Valve	¾	See Footnote ⁷		—
Urinal, greater than 1.0 GPF Flushometer Valve	¾	See Footnote ⁷		—
Urinal, flush tank	½	2.0	2.0	3.0
Wash Fountain, circular spray	¾	—	4.0	—
Water Closet, 1.6 GPF Gravity Tank	½	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Tank	½	2.5	2.5	3.5
Water Closet, 1.6 GPF Flushometer Valve	1	See Footnote ⁷		—
Water Closet, greater than 1.6 GPF Gravity Tank	½	3.0	5.5	7.0
Water Closet, greater than 1.6 GPF Flushometer Valve	1	See Footnote ⁷		—

For SI units: 1 inch = 25 mm

Notes:

¹ Size of the cold branch pipe, or both the hot and cold branch pipes.

² Appliances, appurtenances, or fixtures not referenced in this table shall be permitted to be sized by reference to fixtures having a similar flow rate and frequency of use.

³ The listed fixture unit values represent their load on the cold water building supply. The separate cold water and hot water fixture unit value for fixtures having both hot and cold water connections shall be permitted to be each taken as three-quarter of the listed total value of the fixture.

⁴ The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.

⁵ For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (gpm) (L/s), and add it separately to the demand in gpm (L/s) for the distribution system or portions thereof.

⁶ Assembly (Public Use). See Minnesota Rules, chapter 1305, International Building Code.

⁷ Where sizing flushometer systems, see Section 610.10.

⁸ Reduced fixture unit loading for additional hose bibbs is to be used where sizing total building demand and for pipe sizing where more than one hose bibb is supplied by a segment of water distribution pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

**TABLE 610.4
FIXTURE UNIT TABLE FOR DETERMINING WATER PIPE AND METER SIZES**

METER AND STREET SERVICE (inches)	BUILDING SUPPLY AND BRANCHES (inches)	MAXIMUM ALLOWABLE LENGTH (feet)														
		40	60	80	100	150	200	250	300	400	500	600	700	800	900	1000
PRESSURE RANGE – 30 to 45 psi¹																
¾	½ ²	6	5	4	3	2	1	1	1	0	0	0	0	0	0	0
¾	¾	16	16	14	12	9	6	5	5	4	4	3	2	2	2	1
¾	1	29	25	23	21	17	15	13	12	10	8	6	6	6	6	6
1	1	36	31	27	25	20	17	15	13	12	10	8	6	6	6	6
¾	1¼	36	33	31	28	24	23	21	19	17	16	13	12	12	11	11
1	1¼	54	47	42	38	32	28	25	23	19	17	14	12	12	11	11
1½	1¼	78	68	57	48	38	32	28	25	21	18	15	12	12	11	11
1	1½	85	84	79	65	56	48	43	38	32	28	26	22	21	20	20
1½	1½	150	124	105	91	70	57	49	45	36	31	26	23	21	20	20
2	1½	151	129	129	110	80	64	53	46	38	32	27	23	21	20	20
1	2	85	85	85	85	85	85	82	80	66	61	57	52	49	46	43
1½	2	220	205	190	176	155	138	127	120	104	85	70	61	57	54	51
2	2	370	327	292	265	217	185	164	147	124	96	70	61	57	54	51
2	2½	445	418	390	370	330	300	280	265	240	220	198	175	158	143	133
PRESSURE RANGE – 46 to 60 psi¹																
¾	½ ²	7	7	6	5	4	3	2	2	1	1	1	0	0	0	0
¾	¾	20	20	19	17	14	11	9	8	6	5	4	4	3	3	3
¾	1	39	39	36	33	28	23	21	19	17	14	12	10	9	8	8
1	1	39	39	39	36	30	25	23	20	18	15	12	10	9	8	8
¾	1¼	39	39	39	39	39	39	34	32	27	25	22	19	19	17	16
1	1¼	78	78	76	67	52	44	39	36	30	27	24	20	19	17	16
1½	1¼	78	78	78	78	66	52	44	39	33	29	24	20	19	17	16
1	1½	85	85	85	85	85	85	80	67	55	49	41	37	34	32	30
1½	1½	151	151	151	151	128	105	90	78	62	52	42	38	35	32	30
2	1½	151	151	151	151	150	117	98	84	67	55	42	38	35	32	30
1	2	85	85	85	85	85	85	85	85	85	85	85	85	85	83	80
1½	2	370	370	340	318	272	240	220	198	170	150	135	123	110	102	94
2	2	370	370	370	370	368	318	280	250	205	165	142	123	110	102	94
2	2½	654	640	610	580	535	500	470	440	400	365	335	315	285	267	250
PRESSURE RANGE – Over 60 psi¹																
¾	½ ²	7	7	7	6	5	4	3	3	2	1	1	1	1	1	0
¾	¾	20	20	20	20	17	13	11	10	8	7	6	6	5	4	4
¾	1	39	39	39	39	35	30	27	24	21	17	14	13	12	12	11
1	1	39	39	39	39	38	32	29	26	22	18	14	13	12	12	11
¾	1¼	39	39	39	39	39	39	39	39	34	28	26	25	23	22	21
1	1¼	78	78	78	78	74	62	53	47	39	31	26	25	23	22	21
1½	1¼	78	78	78	78	78	74	65	54	43	34	26	25	23	22	21
1	1½	85	85	85	85	85	85	85	85	81	64	51	48	46	43	40
1½	1½	151	151	151	151	151	151	130	113	88	73	51	51	46	43	40
2	1½	151	151	151	151	151	151	142	122	98	82	64	51	46	43	40
1	2	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1½	2	370	370	370	370	360	335	305	282	244	212	187	172	153	141	129
2	2	370	370	370	370	370	370	370	340	288	245	204	172	153	141	129
2	2½	654	654	654	654	654	650	610	570	510	460	430	404	380	356	329

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa

Notes:

¹ Available static pressure after head loss.

² Building supply, not less than ¾ of an inch (20 mm) nominal size.

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- (4) Select the “length” column that is equal to or longer than the required length.
- (5) Follow down the column to a fixture unit value equal to or exceeding the total number of fixture units required by the installation.
- (6) Having located the proper fixture unit value for the required length, sizes of meter and building supply pipe as found in the two left-hand columns shall be applied.

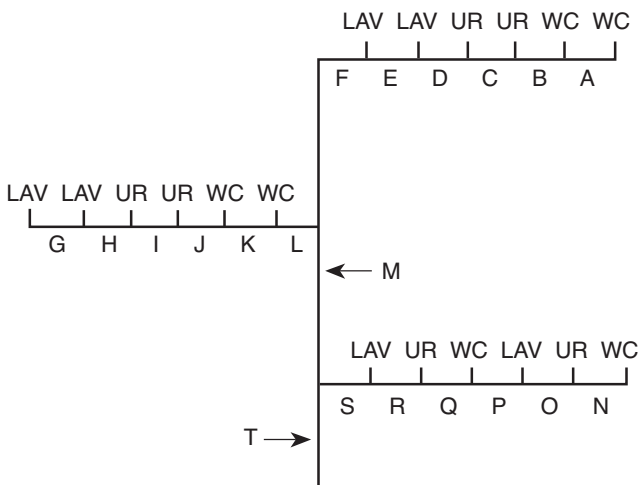
No building supply pipe shall be less than 3/4 of an inch (20 mm) in diameter.

610.9 Size of Branches. Where Table 610.4 is used, the minimum size of each branch shall be determined by the number of fixture units to be served by that branch, the total developed length of the system, and the meter and street service size in accordance with Section 610.8. No branch piping is required to be larger in size than that required by Table 610.4 for the building supply pipe.

610.10 Sizing for Flushometer Valves. Where using Table 610.4 to size water supply systems serving flushometer valves, the number of flushometer fixture units assigned to every section of pipe, whether branch or main, shall be determined by the number and category of flushometer valves served by that section of pipe, in accordance with Table 610.10. Piping supplying a flushometer valve shall be not less in size than the valve inlet.

Where using Table 610.10 to size water piping, care shall be exercised to assign flushometer fixture units based on the number and category of fixtures served.

In the example below, fixture units assigned to each section of pipe are computed. Each capital letter refers to the section of pipe above it, unless otherwise shown.



- A: 1 WC = 40 F.U.
- B: 2 WC = 70 F.U.
- C: 2 WC (70) + 1 UR (20) = 90 F.U.
- D: 2 WC (70) + 2 UR (35) = 105 F.U.
- E: 2 WC (70) + 2 UR (35) + 1 LAV (1) = 106 F.U.
- F: 2 WC (70) + 2 UR (35) + 2 LAV (2) = 107 F.U.
- G: 1 LAV = 1 F.U.
- H: 2 LAV = 2 F.U.
- I: 2 LAV (2) + 1 UR (20) = 22 F.U.
- J: 2 LAV (2) + 2 UR (35) = 37 F.U.
- K: 2 LAV (2) + 2 UR (35) + 1 WC (40) = 77 F.U.
- L: 2 LAV (2) + 2 UR (35) + 2 WC (70) = 107 F.U.
- M: 4 WC (105) + 4 UR (53) + 4 LAV (4) = 162 F.U.
- N: 1 WC = 40 F.U.
- O: 1 WC (40) + 1 UR (20) = 60 F.U.
- P: 1 WC (40) + 1 UR (20) + 1 LAV (1) = 61 F.U.
- Q: 2 WC (70) + 1 UR (20) + 1 LAV (1) = 91 F.U.
- R: 2 WC (70) + 2 UR (35) + 1 LAV (1) = 106 F.U.
- S: 2 WC (70) + 2 UR (35) + 2 LAV (2) = 107 F.U.
- T: 6 WC (125) + 6 UR (63) + 6 LAV (6) = 194 F.U.

TABLE 610.10 FLUSHOMETER FIXTURE UNITS FOR WATER SIZING USING TABLE 610.3		
FIXTURE CATEGORY: WATER CLOSET WITH FLUSHOMETER VALVES		
NUMBER OF FLUSHOMETER VALVES	INDIVIDUAL FIXTURE UNITS ASSIGNED IN DECREASING VALUE	FIXTURE UNITS ASSIGNED FOR WATER CLOSETS AND SIMILAR 10-UNIT FIXTURES IN ACCUMULATIVE VALUES
1	40	40
2	30	70
3	20	90
4	15	105
5 or more	10 each	115 plus 10 for each additional fixture in excess of 5
FIXTURE CATEGORY: URINALS WITH FLUSHOMETER VALVES		
NUMBER OF FLUSHOMETER VALVES	INDIVIDUAL FIXTURE UNITS ASSIGNED IN DECREASING VALUE	FIXTURE UNITS ASSIGNED FOR URINALS AND SIMILAR 5-UNIT FIXTURES IN ACCUMULATIVE VALUES
1	20	20
2	15	35
3	10	45
4	8	53
5 or more	5 each	58 plus 5 for each additional fixture in excess of 5

610.11 Sizing Systems for Flushometer Tanks. The size of branches and mains serving flushometer tanks shall be consistent with the sizing procedures for flush tank water closets.

610.12 Sizing for Velocity. Water piping systems shall not exceed the maximum velocities listed in this section or Appendix A.

610.12.1 Copper Tube Systems. Maximum velocities in copper and copper alloy tube and fitting systems shall not exceed 8 feet per second (ft/s) (2.4 m/s) in cold water and 5 ft/s in hot water (1.5 m/s).

610.12.2 Tubing Systems Using Copper Alloy Fittings. Maximum velocities through copper alloy fittings in tubing other than copper shall not exceed 8 ft/s (2.4 m/s) in cold water and 5 ft/s in hot water (1.5 m/s).

610.13 Exceptions. The provisions of this section relative to size of water piping shall not apply to the following:

- (1) Water supply piping systems designed in accordance with recognized engineering procedures acceptable to the Authority Having Jurisdiction.
- (2) Alteration of or minor additions to existing installations, provided the Authority Having Jurisdiction finds that there will be an adequate supply of water to operate fixtures.
- (3) Replacement of existing fixtures or appliances.
- (4) Piping that is part of fixture equipment.
- (5) Unusual conditions where, in the judgment of the Authority Having Jurisdiction, an adequate supply of water is provided to operate fixtures and equipment.
- (6) Nonpotable waterlines as defined in Section 601.2.
- (7) The size and material of irrigation water piping installed outside of a building or structure and separated from the potable water supply by means of an approved air gap or backflow prevention device is not regulated by this code. The potable water piping system supplying each such irrigation system shall be adequately sized as required elsewhere in this chapter to deliver the full connected demand of both the domestic use and the irrigation systems.

611.0 Water Conditioning Equipment.

611.1 Application. Water conditioning equipment shall comply with the requirements in this section.

611.1.1 Definition. “Water conditioning equipment” means any appliance, appurtenance, or fixture, or combination thereof, designed to treat potable water, so as to alter, modify, add, or remove any minerals, chemicals, or bacteria contained in the water. Water conditioning equipment includes but is not limited to ion exchange water softeners, backwashing water filters, oxidizing water filters, cartridge filters, chemical feed cartridges, ultraviolet lights, and equipment for reverse osmosis, ultrafiltration, nanofiltration, pH adjustment, nitrate and arsenic removal, and adsorption onto activated carbon.

611.1.2 Manufacture and Assembly. Water conditioning equipment shall: (1) be manufactured as a complete system; or (2) be assembled as a complete system by a licensed plumbing contractor or licensed water conditioning contractor, using various types of water conditioning equipment. Wetted surface materials used in water conditioning equipment shall comply with ANSI/NSF 61 standards, or the equipment shall comply with the applicable NSF standards as listed in Table 1401.1.

Exception: Water conditioning equipment that treats water for nonpotable uses that are protected by an approved backflow device, assembly, or method as required in Chapter 6 as amended.

611.1.3 Labeling. All conditioning equipment shall be labeled by;

- (1) the manufacturer of equipment manufactured as a complete system; or
- (2) the licensed plumbing contractor or licensed water conditioning contractor who assembled the complete system so as to clearly identify the type of equipment and name and address of the manufacturer, licensed plumbing contractor or licensed water conditioning contractor.

611.2 Air Gap Discharge. Any discharge from water conditioning equipment shall enter the drainage system through an air gap in accordance with Table 603.3.1 or an air gap device in accordance with Table 603.2, NSF 58, or IAPMO PS 65.

611.3 Connection Tubing. The tubing to and from water conditioning units shall be of a size and material as recommended by the manufacturer. The tubing shall comply with the requirements of NSF 14, NSF 42, NSF 44, NSF 53, NSF 55, NSF 58, NSF 62 or the appropriate material standards referenced in Table 1401.1.

611.4 Sizing of Residential Softeners. Residential-use water softeners shall be sized in accordance with Table 611.4.

TABLE 611.4 SIZING OF RESIDENTIAL WATER SOFTENERS ⁴	
REQUIRED SIZE OF SOFTENER CONNECTION (inches)	NUMBER OF BATHROOM GROUPS SERVED ¹
3/4	up to 2 ²
1	up to 4 ³

For SI units: 1 inch = 25 mm

Notes:

- ¹ Installation of a kitchen sink and dishwasher, laundry tray, and automatic clothes washer permitted without additional size increase.
- ² An additional water closet and lavatory permitted.
- ³ Over four bathroom groups, the softener size shall be engineered for the specific installation.
- ⁴ See also Appendix A, Recommended Rules for Sizing the Water Supply System, and Appendix C, Alternate Plumbing Systems*, for alternate methods of sizing water supply systems.

* Appendix C, Alternate Plumbing Systems, has not been adopted as part of this code. Alternate Systems shall be approved by the Administrative Authority.

612.0 Multipurpose Potable Water Piping Systems.

612.1 General. A multipurpose potable water piping system as defined in Minnesota Statutes, chapter 299M, shall meet the requirements of this code.

