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Plumbing works — Code of practice —

Part 3: Water supply and distribution

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Contents

Page

Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 644-3 was prepared by Technical Committee RSB/TC 17, *Urban planning.*

In the preparation of this standard, reference was made to the following standard:

IAPMO*, 2024 Uniform plumbing code*

The assistance derived from the above source is hereby acknowledged with thanks.

DRS 644 consists of the following parts, under the general title *Plumbing works — Code of practice*:

— *Part 1: General*

— *Part 2: Plumbing fixtures and fixture fittings*

— *Part 3: Water supply and distribution*

— *Part 4: Sanitary and drainage system installation*

— *Part 5: Water heaters*

— *Part 6: Fuel gas piping and firestop protection*

— *Part 7: Healthcare facilities and medical gas and medical vacuum systems*

— *Part 8: Alternate water sources for non-potable applications and non-potable rainwater catchment systems*

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Committee membership

The following organizations were represented on the Technical Committee on *Urban planning* (RSB/TC 17) in the preparation of this standard.

City of Kigali

Institute of Engineering Rwanda (IER)

Ministry of Infrastructure (MININFRA)

Rwanda Housing Authority (RHA)

Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA)

Rwanda Plumbers Organization (RPO)

Rwanda Polytechnic – Kigali College

Rwanda Polytechnic – Musanze College

Rwanda Transport Development Agency (RTDA)

Rwanda Utility Regulatory Authority (RURA)

Rwanda Water Resources Board (RWB)

University of Rwanda – College of Science and Technology (UR-CST)

Water and Sanitation Corporation (WASAC)

Water for People

Rwanda Standards Board (RSB) – Secretariat

Plumbing works — Code of practice — Part 3: Water supply and distribution

1 Scope

This Draft Rwanda Standard provides recommendations and guidelines for materials, design, and installation requirements for water supply systems. It also includes the methods and devices used for backflow prevention.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM F2620, *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings*

ASTM B32, *Standard Specification for Solder Metal*

ASTM F493, *Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings*

ASTM F2855, *Standard Specification for Chlorinated Poly(Vinyl Chloride)/Aluminum/Chlorinated Poly(Vinyl Chloride) (CPVC-AL-CPVC) Composite Pressure Tubing*

ASTM F1974, *Standard Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe*

ASTM F2434, *Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Tubing*

ASTM F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*

ASTM F2389, *Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems*

ASTM D3139, *Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems*

ASTM F656, *Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings*

ASTM B813, *Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube*

ASTM F1970, *Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems*

ASTM B828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings

ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM F1974, *Standard Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe*

ASTM D2846, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems*

ASTM F442, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR–PR)*

ASTM B42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*

ASTM B75, *Standard Specification for Seamless Copper Tube*

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM D2239, *Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter*

ASTM D2737, *Standard Specification for Polyethylene (PE) Plastic Tubing*

ASTM D3035, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter*

ASTM F1282, *Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe*

ASTM F2769, *Standard Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems*

ASTM F1281, *Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe*

ASTM D1785, *Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*

ASTM D2241, *Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)*

ASTM A269, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*

ASTM A554, *Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products*

ASTM A778, *Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products*

ASTM F3226, *Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems*

ASTM F441, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80*

ASTM F437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*

ASTM F439, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*

ASTM D2609, Standard *Specification* for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

ASTM D2683, *Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing*

ASTM D3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*

ASTM F1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing*

ASTM F1807, *Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM F2098, *Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) to Metal Insert and Plastic Insert Fittings*

ASTM F2159, *Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM F2735, *Standard Specification for Plastic Insert Fittings For SDR9 Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM F877, *Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems*

ASTM F1960, *Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM F2080, *Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe*

ASTM F3347, *Standard Specification for Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM F3348, *Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing*

ASTM D2464, *Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*

STM D2466, *Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*

ASTM D2467, *Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*

RS 466, *Epoxy enamel, two components, glossy — Specification*

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in DRS 644-1 apply.

4 Symbols and abbreviated terms

AWG American Wire Gauge

PVC polyvinyl chloride

CPVC Chlorinated Polyvinyl Chloride

CPVC/AL/CPVC Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride

PE polyethylene

PE-AL-PE polyethylene-aluminum-polyethylene

PE-RT Polyethylene of raised temperature resistance

PEX cross-linked polyethylene

PEX-AL-PEX Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene

PP Polypropylene

5 General requirements

5.1 Water Supply and Flushing.

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

NOTE This requirement is not applicable to the fixtures that do not require water for their operation and where not deemed necessary for safety and sanitation by the Competent authority.

5.1.2 In occupancies where plumbing fixtures are installed for private use, hot water shall be required for bathing, washing, laundry, cooking purposes, dishwashing or 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, public and private bidets, bathtubs, whirlpool bathtubs, and shower control valves.

5.2 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 clause 5.2.1 to 5.2.4.

5.2.1 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.

Potable Water shall be identified by a green background with white lettering.

Except as required by Section 5.2.2, 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 conform to Table 1. 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.

Table 1 — Minimum length of color field and size of letters

Outside diameter of pipe or covering inches	**Minimum length of colour 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

Nonpotable water from alternate water sources shall be identified in accordance with 5.2.2,

5.2.2 Alternate water sources

Alternate water source systems shall have a purple (Pantone colour 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 with the words “CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK” in black letters.

(2) Reclaimed (recycled) water systems shall be marked with the words: “CAUTION: NONPOTABLE RECLAIMED (RECYCLED) WATER, DO NOT DRINK” in black letters.

(3) On-site treated water systems shall be marked with the words: “CAUTION: ON-SITE TREATED NONPOTABLE WATER, DO NOT DRINK” in black letters.

(4) Rainwater catchment systems shall be marked with the words: “CAUTION: NONPOTABLE RAINWATER, DO NOT DRINK” in black letters.

5.2.3 Fixtures

Where vacuum breakers or backflow preventers are installed with fixtures conforming to relevant applicable Standards, identification of the discharge side shall be permitted to be omitted.

5.2.4 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.”

6 Unlawful connections

6.1 Prohibited installation

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

6.2 Cross-contamination

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 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 piping carrying chemicals, liquids, gases, or substances whatsoever, unless there is provided a backflow prevention device approved for the potential hazard and maintained in accordance with this standard. Each point of use shall be separately protected where potential cross-contamination of individual units exists.

6.3 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.

6.4 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 Competent Authority.

7 Cross-connection control

7.1 General

Cross-connection control shall be provided in accordance with the provisions of Standard.

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.

7.2 Approval of devices or assemblies

Before a device or an assembly is installed for the prevention of backflow, it shall have first been approved by the Competent Authority. Devices or assemblies shall be tested in accordance with recognized standards or other standards acceptable to Competent Authority. Backflow prevention devices and assemblies shall conform to Table 2, except for specific applications and provisions as stated in clause 7.5.1 to 7.5.22.

Table 2 — Backflow prevention devices, assemblies, and methods degree of hazard

Degree of hazard						
Device, assembly, or method[1]	**APPLICABLE STANDARDS**	**Pollution (low hazard)**		**Contamination (high hazard)**		**Installation [2,3]**
		Back-Siphonage	**Back-Pressure**	**Back-Siphonage**	**Back-Pressure**	
Air gap	ASME A112.1.2	X	—	X	—	See Table 3
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,

Degree of hazard						
Device, assembly, or method[1]	**APPLICABLE STANDARDS**	**Pollution (low hazard)**		**Contamination (high hazard)**		**Installation [2,3]**
		Back-Siphonage	**Back-Pressure**	**Back-Siphonage**	**Back-Pressure**	
						appliances, and appurtenances. The critical level shall not be installed below the flood level rim.
Antisiphon fill valve (ballcocks) for gravity water closet flush tanks and urinal tanks	ASSE 1002/ ASME A112.1002/ CSA B125.12	X	—	X	—	Installation of 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]
Atmospheric vacuum breaker (consists of a body, checking member and atmospheric port)	ASSE 1001 or CSA B64.1.1	X	—	X	—	Upright position. Have outlet open to atmosphere. Minimum of 6 inches or listed distance above all downstream piping and flood level rim of receptor.[4,5]
Backflow preventer for Carbonated Beverage Dispensers (two independent check valves with a vent to the atmosphere)	ASSE 1022	X	X	X	X	Installation includes carbonated beverage machines or dispensers. These devices operate under intermittent or continuous pressure conditions.
Backflow preventer with intermediate atmospheric vent	ASSE 1012	X	X	—	—	Installation of potable water connections to water boilers. No high-hazard chemicals shall be introduced into the system using such devices. Designed to operate under continuous pressure conditions. May discharge water.
Backflow preventer with intermediate atmospheric vent and pressure reducing valve	ASSE 1081	X	X	—	—	Installation of potable water connections to water boilers. No high-hazard chemicals shall be introduced into the system using such devices. Designed to operate under continuous pressure conditions. May discharge water.
Chemical dispenser with integral backflow protection	ANSI/CAN/ ASSE/IAPMO 1055	X	—	X	—	Shall be installed in accordance with manufacturer's installation

Degree of hazard						
Device, assembly, or method[1]	**APPLICABLE STANDARDS**	**Pollution (low hazard)**		**Contamination (high hazard)**		**Installation [2,3]**
		Back-Siphonage	**Back-Pressure**	**Back-Siphonage**	**Back-Pressure**	
						instructions with dedicated water supply whenever possible.
Dual check backflow preventer	ASSE 1024	X	X	—	—	Installation does not include carbonated drink dispensers.
Dual check backflow preventer wall hydrants, freeze resistant	ASSE 1053	X	—	X	—	Such devices are not for use under continuous pressure conditions.[4]
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 for 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 the 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.
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 the bottom for maintenance. May need platform/ladder for test and repair. Does not discharge water.
Freeze resistant sanitary yard hydrants	ASSE 1057	X	—	X	—	Such devices are not for use under continuous pressure conditions.[4]
Hose connection back- flow preventers	ASSE 1052	X	—	X	—	Such devices are not for use under continuous pressure conditions.[4,6]
Hose connection vacuum breakers	ASSE 1011	X	—	X	—	Such devices are not for use under continuous pressure conditions. No valve downstream.[4,6]

Degree of hazard						
Device, assembly, or method[1]	**APPLICABLE STANDARDS**	**Pollution (low hazard)**		**Contamination (high hazard)**		**Installation [2,3]**
		Back-Siphonage	**Back-Pressure**	**Back-Siphonage**	**Back-Pressure**	
Laboratory faucet back- flow preventer	ASSE 1035	X	—	X	—	Installation includes laboratory faucets. Such devices are not for use under continuous pressure conditions. No valve downstream.[4]
Pressure Vacuum Breaker Backflow Prevention Assembly (loaded air inlet valve, internally loaded check valve and means for field testing)	ASSE 1020 or CSA B64.1.2	X	—	X	—	Upright position. May have valves down-stream. Minimum of 12 inches above all downstream piping and flood-level rim of the receptor. May discharge water.
Reduced Pressure Detector Fire Protection Back-flow 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 for 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 the 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.
Reduced Pressure Principle Backflow Prevention Assembly (two independently acting loaded check valves, a differential pressure relief valve and means for 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 the bottom for maintenance. May need platform/ladder for test and repair. May discharge water.
Spill-Resistant Pressure Vacuum Breaker (single check valve with air inlet vent and	ASSE 1056	X	—	X	—	Upright position. Minimum of 12 inches or listed distance above all downstream piping and

Degree of hazard						
Device, assembly, or method[1]	**APPLICABLE STANDARDS**	**Pollution (low hazard)**		**Contamination (high hazard)**		**Installation [2,3]**
		Back-Siphonage	**Back-Pressure**	**Back-Siphonage**	**Back-Pressure**	
means of field testing)						flood-level rim of receptor.[5]
Vacuum breaker wall hydrants, hose bibbs, freeze 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]

For SI units: 1 inch = 25.4 mm

Notes:

1 See the description of devices and assemblies in this chapter.

2 Installation in pit or vault requires previous approval by Competent Authority.

3 Refer to the 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 clause 7.5.13.

6 Shall be installed in accordance with clause 7.5.7.

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.

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 Competent Authority. 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 Competent Authority.

Testing or maintenance shall be performed by a certified backflow assembly tester or repairer certified in accordance with ASSE/IAPMO/ANSI Series 5000 or any other additional certification approved by Competent Authority.

7.3 Backflow prevention devices, assemblies, and methods

Backflow prevention devices, assemblies, and methods shall conform to clause 7.2.1 to 7.2.12

7.3.1 Air gap

The minimum air gap to afford backflow protection shall be in accordance with Table 3.

Table 3 — Minimum air gaps for water distribution[4]

Fixtures	Where not affected by sidewalls[1] (inches)	Where affected by sidewalls[2] (inches)
Effective openings[3] not greater than ½ of an inch in diameter	1	1½

Effective openings[3] not greater than ¾ of an inch in diameter	1½	2¼
Effective openings[3] not greater than 1 inch in diameter	2	3
Effective openings[3] greater than 1 inch in diameter	Two times the diameter of effective opening	Three times the 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 Foot-

note 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).

7.3.2 Atmospheric Vacuum Breaker (AVB).

An atmospheric vacuum breaker consists of a body, a checking member, and an atmospheric port.

7.3.3 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.

7.3.4 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.

7.3.5 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.

7.3.6 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.

7.3.7 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.

7.3.8 Double check detector fire protection backflow prevention assembly

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

7.3.9 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).

7.3.10 Dual Check Backflow Preventer

A dual check backflow preventer consists of two independently acting check valves, force loaded to a normally closed position.

7.3.11 Laboratory Faucet Backflow Preventers

Laboratory faucet backflow preventers shall conform to ASSE 1035.

7.3.12 Backflow Preventer with Intermediate Atmospheric Vent

A backflow preventer with intermediate atmospheric vent consists of two independently acting check valves, force loaded to a normally closed position, and an intermediate chamber with a means for automatically venting to atmosphere, force loaded to a normally open position.

7.4 General requirements

Assemblies shall conform to relevant applicable Standards and be acceptable to Competent Authority, over the selection and installation of backflow prevention assemblies.

7.4.1 Backflow prevention valve

Where more than one backflow prevention valve are 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 Competent Authority.

7.4.2 Testing

The premise owner or responsible person shall have the backflow prevention assembly tested by a certified competent backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter, or more often where required by Competent Authority.

The periodic testing shall be performed in accordance with ASSE/IAPMO/ANSI Series 5000 or other relevant applicable Standards by a tester qualified in accordance with those standards. The field test kit used shall conform to ASSE 1064 or other relevant applicable Standard.

7.4.3 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 platform capable of supporting a tester or maintenance person.

7.4.4 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.

7.4.5 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.

7.4.6 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.

7.4.7 Freeze Protection.

In cold climate areas, backflow assemblies and devices shall be protected from freezing with an outdoor enclosure that conforms to ASSE 1060 or other relevant applicable Standard or by a method acceptable to Competent Authority.

7.4.8 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.

7.4.9 Prohibited Locations.

Backflow prevention devices with atmospheric vents or ports shall not be installed in pits, underground, or submerged locations. Backflow preventers shall not be located in an area containing fumes that are toxic, poisonous, or corrosive.

7.5 Specific Requirements.

Backflow prevention shall conform to the specific requirements in clause 9.1 to 9.22.

7.5.1 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.

7.5.2 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.

7.5.3 Backflow Prevention.

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

7.5.4 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. Single-wall heat exchangers used in indirect-fired water heaters shall meet the requirements of DRS 644- 5 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.

7.5.5 Water Supply Inlets.

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

a) an approved air gap;

b) 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; or

c) a backflow preventer suitable for the degree of hazard, installed in accordance with the requirements for that type of device or assembly as set forth in this chapter.

7.5.6 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:

a) atmospheric vacuum breaker (AVB);

b) pressure vacuum breaker backflow prevention assembly (PVB);

c) spill-resistant pressure vacuum breaker (SVB);

d) reduced-pressure principle backflow prevention assembly (RP);

e) a valve conforming to IAPMO PS 72 or other relevant applicable Standard.

7.5.6.1 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 Reduced-pressure principle backflow prevention assembly (RP) where the backflow device is located upstream from the source of backpressure.

7.5.6.2 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:

a) atmospheric vacuum breaker (AVB);

b) pressure vacuum breaker backflow prevention assembly (PVB);

c) spill-resistant pressure vacuum breaker (SVB);

d) reduced-pressure principle backflow prevention assembly (RP).

7.5.6.3 Systems with Chemical Injectors.

Where systems include a chemical injector or provisions for chemical injection, the potable water supply shall be protected by a reduced-pressure principle backflow prevention assembly (RP).

7.5.7 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.

7.5.8 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.

7.5.9 Aspirators.

Water inlets to water-supplied aspirators shall be equipped with a vacuum breaker installed in accordance with its listing requirements and this Standard.

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.

7.5.10 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, backflow preventer with intermediate atmospheric vent and pressure reducing valve, or reduced pressure principle backflow prevention assembly in accordance with Table 2.

Where chemicals are introduced into the system a reduced pressure principle backflow prevention assembly shall be provided in accordance with Table 2.

7.5.11 Nonportable 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 Competent Authority.

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.”

7.5.12 Beverage Dispensers.

Potable water supply to carbonated beverage dispensers shall be protected by an air gap or a vented backflow preventer that conforms to ASSE 1022 or other relevant applicable Standard. For carbonated beverage dispensers, piping material installed downstream of the backflow preventer shall not be affected by carbon dioxide gas. Non-carbonated beverage dispensers, such as ice makers and coffee machines, shall be protected by an air gap or dual check backflow preventer that conform to with ASSE 1032, ASSE 1024 or other relevant applicable Standards.

7.5.13 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.

7.5.14 Protection from Fire Systems.

Except as provided in clause 7.5.14.1 and 7.5.14.2, 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 applicable standards.

7.5.14.1 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.

7.5.14.2 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:

e) reduced pressure principle backflow prevention assembly (RP);

f) reduced pressure detector fire protection backflow prevention assembly.

7.5.14.3 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.

7.5.15 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.

7.5.16 Special Equipment.

Portable cleaning equipment and dental vacuum pumps 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.

7.5.17 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.

7.5.18 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.

The individual connections of the dialysis-related equipment to the dialysis pure water system shall not require additional backflow protection.

7.5.19 Garbage Can Washers.

Where garbage can washers are connected to a potable water supply system, the connection shall be protected against backflow in accordance with Table 2.

7.5.20 Plumbing Fixture Fittings.

Plumbing fixture fittings with integral backflow protection shall conform to ASME A112.18.1/CSA B125.1.

7.5.21 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:

g) the unit is equipped with a submerged fill line; and

h) the potable water supply is directly connected to the unit circulation system.

7.5.22 Chemical Dispensers.

The water supply to chemical dispensers shall be protected against backflow by one of the following:

i) the chemical dispenser shall conform to ANSI/CAN/ASSE/IAPMO 1055 or other relevant applicable Standards. Where an installation involves a water source coming from a faucet with an integrated vacuum breaker device, a pressure bleed device conforming to IAPMO PS 104 or other relevant applicable Standard shall be used to protect the vacuum breaker device;

j) water supply shall be protected by one of the following methods:

1) Air gap

2) Atmospheric vacuum breaker (AVB)

3) Pressure vacuum breaker backflow prevention assembly (PVB)

4) Spill-resistant pressure vacuum breaker (SVB)

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

8 Materials.

8.1 Pipe, Tube, and Fittings.

Pipe, tube, fittings, solvent cement, thread sealants, solders, and flux used in potable water systems intended to supply drinking water shall conform to NSF/ANSI/CAN 61.

Where pipe fittings and valves are made from copper alloys containing more than 15 % zinc by weight and are used in plastic piping systems, they shall be resistant to dezincification and stress corrosion cracking in compliance with NSF/ANSI 14.

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

Materials for building water piping and building supply piping shall conform to the applicable standards referenced in Table 4.

Table 4 — Materials for building supply and water distribution piping and fittings

Material	Building supply Pipe and fittings	Water distribution pipe and fittings	Pipe(s)conforming to:	fittings conforming to:
Copper and Copper Alloys	X	X	ASTM B42, ASTM B43, ASTM B75, ASTM B88, ASTM B135, ASTM B251, ASTM B302, ASTM B447	ASTM F3226, IAPMO PS 53, IAPMO PS 117
CPVC	X	X	ASTM D2846, ASTM F441, ASTM F442, CSA B137.6	ASTM D2846, ASTM F437, ASTM F438, ASTM F439, ASTM F1970, IAPMO PS 53
CPVC-AL-CPVC	X	X	ASTM F2855	ASTM D2846
Ductile-Iron	X	X	AWWA C151	IAPMO PS 53
Galvanized Steel	X	X	ASTM A53	IAPMO PS 53
Malleable Iron	X	X	—	IAPMO PS 53
PE	X[1]	—	ASTM D2239, ASTM D2737, ASTM D3035	ASTM D2609, ASTM D2683, ASTM D3261, ASTM F1055
PE-AL-PE	X	X	ASTM F1282	ASTM F1282, ASTM F1974,
PE-RT	X	X	ASTM F2769	ASTM D3261, ASTM F1055, ASTM F1807, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F2769
PEX	X	X	ASTM F876	ASTM F877, ASTM F1807, ASTM F1960, ASTM F2080, ASTM F2159, ASTM F2735, ASTM F3347, ASTM F3348
PEX-AL-PEX	X	X	ASTM F1281	ASTM F1281, ASTM F1974, ASTM F2434
PP	X	X	ASTM F2389,	ASTM F2389
PVC	X[1]	— —	ASTM D1785, ASTM D2241	ASTM D2464, ASTM D2466, ASTM D2467, ASTM F1970, IAPMO PS 53
Stainless Steel	X	X	ASTM A269, ASTM A312, ASTM A554, ASTM A778	ASTM F3226, IAPMO PS 53, IAPMO PS 117

Notes:

1 For building supply or exterior cold-water applications, not for water distribution piping.

2 For brazed fittings only.

8.2 Lead Content.

8.2.1 The maximum allowable lead content in pipes, pipe fittings, plumbing fittings, and fixtures intended to convey or dispense water for human consumption shall be not more than a weighted average of 0.25 % with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures. For solder and flux, the lead content shall be not more than 0.2 % where used in piping systems that convey or dispense water for human consumption.

NOTE this requirement is not applicable to:

Pipes, pipe fittings, plumbing fittings, fixtures, or backflow preventers used for nonpotable services such as manufacturing, industrial processing, irrigation, outdoor watering, or any other uses where the water is not used for human consumption.

Flush valves, fill valves, flushometer valves, tub fillers, shower valves, service saddles, or water distribution main gate valves that are 2 inches (50 mm) in diameter or larger.

8.2.2 Pipes, pipe fittings, valves, and faucets utilized in the water supply system for non-drinking water applications shall have a maximum of 8 % lead content.

8.3 Copper or Copper Alloy Tube.

Copper or copper alloy tube for water piping shall have a weight of not less than Type L.

NOTE Type M copper or copper alloy tubing is only permitted to be used for water piping where piping is aboveground in, or on, a building or underground outside of structures.

8.4 Hard-Drawn Copper or Copper Alloy Tubing.

Hard-drawn copper or copper alloy tubing for water supply and distribution in addition to the required incised marking shall be marked in accordance with ASTM B88. The colors shall be: Type K, green; Type L, blue; and Type M, red.

8.5 Flexible Connectors.

Flexible water connectors shall be installed in accessible locations, and where under continuous pressure shall conform to ASME A112.18.6/CSA B125.6. Flexible water connectors with an excess flow shutoff device shall conform to CSA B125.5/IAPMO Z600 or other relevant applicable Standards.

8.6 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.

8.7 Malleable Iron Fittings.

Malleable iron water fittings shall be galvanized.

8.8 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.

8.9 Epoxy coating

The epoxy coating used on existing, underground steel building supply piping shall conform to RS 466.

8.10 Plastic materials

8.10.1 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.

NOTE Where a grounding system acceptable to Competent Authority is installed, inspected, and approved, the metallic pipe are only permitted to be replaced with non-metallic pipe.

8.10.2 Plastic materials for building supply piping outside underground shall have an electrically continuous corrosion resistant 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 14 AWG (1.63 mm of diameter), and the insulation type shall be suitable for direct burial.

8.11 Solder

Solder shall conform to the requirements of clause 8.2.

8.12 Flexible Corrugated Connectors.

Flexible corrugated connectors of copper, copper alloy, or stainless steel shall be limited to the following connector lengths:

1) Fixture Connectors – 30 inches (762 mm)

2) Washing Machine Connectors – 72 inches (1 829 mm)

3) Dishwasher and Icemaker Connectors – 120 inches (3 048 mm)

8.13 Water Heater Connectors

Flexible metallic (copper and stainless steel), reinforced flexible, braided stainless steel, or polymer braided with EPDM core connectors that connect a water heater to the piping system shall conform to ASME A112.18.6/CSA B125.6. Copper, copper alloy, 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.

9 Joints and Connections.

9.1 Copper or Copper Alloy Pipe, Tubing, and Joints.

Joining methods for copper or copper alloy pipe, tubing, and fittings shall be installed in accordance with the manufacturer's installation instructions and shall conform to the requirements of clause 9.1.1 to 9.1.5.

9.1.1 Brazed Joints.

Brazed joints between copper or copper alloy 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 shall conform to AWS A5.8 and shall be applied at the point where the pipe or tubing enters the socket of the fitting.

9.1.2 Flared Joints.

Flared joints for soft copper or copper alloy water tubing shall be made with fittings that conform to the applicable standards referenced in Table 4.

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.

9.1.3 Mechanical Joints.

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

9.1.3.1 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 ¼ 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.

9.1.3.2 Press-Connect Fittings.

Press-connect fittings for copper or copper alloy 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.

9.1.3.3 Push Fit Fittings.

Removable and nonremovable push fit fittings for copper or copper alloy tubing or pipe that employ quick assembly push fit connectors shall conform to ASSE 1061 or other relevant applicable Standards.

Push fit fittings for copper or copper alloy 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.

9.1.4 Soldered Joints.

Soldered joints between copper or copper alloy pipe or tubing and fittings shall be made in accordance with ASTM B828 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 conform to ASTM B813, 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 conforming to ASTM B32 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 % 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.

9.1.5 Threaded Joints.

Threaded joints for copper or copper alloy pipe shall be made with pipe threads that conform to 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.

9.2 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 conform to the requirements of clause 9.2.1 to 9.2.3.

9.2.1 Mechanical Joints.

Mechanical joints shall include compression, flanged, grooved and push fit fittings.

Removable and nonremovable push fit fittings that employ a quick assembly push fit connector shall conform to ASSE 1061 or other relevant applicable Standard.

9.2.2 Solvent Cement Joints.

Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements shall conform to ASTM F493, requiring the use of a primer shall be orange in color.

The primer shall be colored and shall conform to ASTM F656. Listed solvent cement that conforms to ASTM F493 and that does not require the use of primers, yellow, green, or red in color, shall be permitted for pipe and fittings that conform to ASTM D2846, 1⁄2 of an inch (15 mm) through 2 inches (50 mm) in diameter or ASTM F442, 1⁄2 of an inch (15 mm) through 3 inches (80 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.

9.2.3 Threaded Joints.

Threads shall conform to ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 %. The use of molded fittings shall not result in a 50 % 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.

9.3 CPVC/AL/CPVC Plastic Pipe and Joints.

Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC) plastic pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall conform to the requirements of clause 9.3.1 or 9.3.2.

9.3.1 Solvent Cement Joints.

Solvent cement joints for CPVC/AL/CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements that conform to ASTM F493, requiring the use of a primer shall be orange in color.

The primer shall be colored and shall conform to ASTM F656. Listed solvent cement that conforms to ASTM F493 and that does not require the use of primers, yellow in color, shall be permitted to join pipe that conform to ASTM F2855 and fittings that conform to ASTM D2846, ½ 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.

9.3.2 Mechanical Joints.

Mechanical joints shall include flanged, grooved, and push fit fittings.

Removable and nonremovable push fit fittings that employ a quick assembly push fit connector shall conform to ASSE 1061 or other relevant applicable Standard.

9.4 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 conform to the requirements of clause 9.4.1 to 9.4.2.

9.4.1 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 conform to AWWA C111. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

9.4.2 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 conform to AWWA C111.

Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

9.5 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 conform to the requirements of 9.5.1 to 9.5.2.

9.5.1 Mechanical Joints.

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

9.5.2 Threaded Joints.

Threaded joints shall be made with pipe threads that conform to 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.

9.6 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 conform to the requirements of 9.6.1 to 9.6.2.

9.6.1 Heat-Fusion Joints.

Heat-fusion joints between PE pipe or tubing and fittings shall be assembled in accordance with 9.6.1.1to 9.6.1.3 using butt, socket, or electro-fusion heat methods.

9.6.1.1 Butt-Fusion Joints.

Butt-fusion joints shall be made in accordance with ASTM F2620. 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.

9.6.1.2 Electro-Fusion Joints.

Electro-fusion joints shall be heated internally by a conductor at the interface of the joint. Align and restrain fitting to pipe to prevent movement and apply electric current to the fitting. Turn off the current when the proper time has elapsed to heat the joint. The joint shall fuse together and remain undisturbed until cool.

9.6.1.3 Socket-Fusion Joints.

Socket-fusion joints shall be made in accordance with ASTM F2620. 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.

9.6.2 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.

9.7 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 conform to the requirements of 9.7.1.

9.7.1 Mechanical Joints.

9.7.1.1 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 conform to ASTM F1974.

9.7.1.2 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 1⁄8 of an inch (3.2 mm) to 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.

9.7.1.3 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 into 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.

9.8 PE-RT.

Polyethylene of raised temperature (PE-RT) tubing and fitting shall conform to the requirements of relevant applicable standards (see Table 4)

PE-RT tubing and fitting joining shall be done using mechanical joints and installed in accordance with the manufacturer' s installation instructions.

9.9 PEX Plastic Tubing and Joints.

PEX plastic tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions.

Fittings for PEX tubing shall conform to the applicable standards (see Table 4). PEX tubing that conforms to ASTM F876 shall be marked with the applicable standard designation for the fittings, specified by the tubing manufacturer for use with the tubing.

Mechanical joints shall conforms to the manufacturer's installation instructions. Removable and nonremovable push fit fittings that employ a quick assembly push fit connector shall conform to ASSE 1061 or other relevant applicable standards.

9.10 PEX-AL-PEX Plastic Tubing and Joints.

9.10.1 PEX-AL-PEX plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and joints shall conform to 9.10.2 to 9.10.4.

9.10.2 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 conform to ASTM F1974 or ASTM F2434.

9.10.3 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.

9.10.4 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.

9.11 Polypropylene (PP) Piping and Joints.

PP pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and joints shall conform to the requirements of 9.11.1 to 9.11.3.

9.11.1 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 F2389 or other CSA B137.11 .

9.11.2 Mechanical and Compression Sleeve Joints.

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

9.11.3 Threaded Joints.

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

9.12 PVC Plastic Pipe and Joints.

PVC plastic pipe and fitting joining shall be done in accordance with the manufacturer's installation instructions and joints shall conform to the requirements of 9.12.1 to 9.12.3 and PVC piping shall not be exposed to direct sunlight.

where PVC piping is directly exposed to sunlight exposed part shall not exceed 24 inches (610 mm) in length and be wrapped with not less than 0.04 of an inch (1.02 mm) thick UV resistant tape or otherwise protected from UV degradation

9.12.1 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 conform to ASTM D3139, 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.

9.12.2 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 that conforms to ASTM F656.

Primer shall be applied to the surface of the pipe and fitting is softened. Solvent cement that conforms to ASTM D2564 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.

9.12.3 Threaded Joints.

Threads shall conform to ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50%. The use of molded fittings shall not result in a 50 % 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 PVC components once the thread sealant has been applied. Female PVC threaded fittings shall be used with plastic male threads only.

9.13 Stainless Steel Pipe and Joints.

Joining stainless steel pipe and fittings shall be done in accordance with the manufacturer's installation instructions and joints shall conform to the requirements of 9.13.1 and 9.13.2.

9.13.1 Mechanical Joints.

Mechanical joints shall be designed for their intended use. Such joints shall include compression, flanged, grooved, press-connect, and threaded.

9.13.2 Welded Joints.

Welded joints shall be either fusion or resistance welded based on the selection of the base metal. The chemical composition of the filler metal shall conform to AWS A5.9 based on the alloy content of the piping material.

9.14 Slip Joints.

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

9.15 Dielectric Unions.

Dielectric unions where installed at points of connection where there is a dissimilarity of metals shall be in accordance with ASSE 1079, IAPMO PS 66 or relevant applicable Standards.

9.16 Joints Between Various Materials.

Joints between various materials shall be installed in accordance with the manufacturer's installation instructions and shall conform to the requirements in clause 9.16.1to 9.16.3

9.16.1 Copper or Copper Alloy Pipe or Tubing to Threaded Pipe Joints.

Joints from copper or copper alloy pipe or tubing to threaded pipe shall be made using copper alloy adapter, copper alloy nipple [minimum 6 inches (152 mm)], dielectric fitting, or dielectric union in accordance with ASSE 1079, IAPMO PS 66 or other relevant applicable Standards.

The joint between the copper or copper alloy pipe or tubing and the fitting shall be a soldered, brazed, flared, or press-connect joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size threaded joint.

9.16.2 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.

9.16.3 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, IAPMO PS 66 or other relevant applicable Standards and designed for the specific transition intended shall be used.

10 Valves.

10.1 General.

Valves up to and including 2 inches (50 mm) in size shall be copper alloy or other approved material. Sizes exceeding 2 inches (50 mm) shall be permitted to have bodies of cast iron, copper alloy, or other approved materials. Each gate or ball valve shall be a fullway or full-port type with working parts of the non-corrosive material.

Where valves are made from copper alloys containing more than 15 % zinc by weight and are used in plastic piping systems, they shall be resistant to dezincification and stress corrosion cracking in compliance with NSF/ANSI 14.

Valves carrying water used in potable water systems shall conform to the requirements of IAPMO/ANSI Z1157, ASTM F1979, ASTM F2389, or other relevant applicable Standards . Valves intended to supply drinking water shall also conform to the requirements of NSF/ANSI/CAN 61.

10.2 Full way valve.

A fullway valve controlling outlets shall be installed on the discharge side of each water meter and each unmetered water supply.

Water piping supplying more than one building on one premise shall be equipped with a separate full way valve to each building, so arranged that the water supply can be turned on or off to an individual or separate building provided.

Supply piping to a single-family residence and building accessory thereto shall be permitted to be controlled by 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.

10.3 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.

10.4 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.

10.5 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. Where parallel water distribution system manifolds are located in attics, crawl spaces, or other locations not readily accessible, a separate shutoff valve shall be required immediately ahead of each individual fixture or appliance served.

10.5.1 Manifolds.

Field installed manifolds for water distribution shall conform with the applicable requirements for valves, pipes, and fittings as referenced in this code. Manufactured water distribution manifolds shall be in accordance with IAPMO IGC 109 or other relevant applicable Standard.

10.6 Accessible.

Required shutoff or control valves shall be accessible.

10.7 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.

10.8 Check Valve Required.

All systems that circulate water by means of a pump or other mechanical device or method shall have a check valve(s) or equal device(s) installed so as to ensure the direction of flow.

10.9 Leak Detection Devices.

Where leak detection devices for water supply and distribution are installed, they shall conform to ANSI/CAN/IAPMO Z1349 or other relevant applicable Standards.

11 Potable Water Supply Tanks.

11.1 General.

Potable water supply tanks shall be installed in accordance with the manufacturer's installation instructions and supported in accordance with the Rwanda building code.

11.2 Private Well Water Tanks.

Pressurized potable water tanks for private well water systems shall conform to ASSE 1099/WSC-PST 2000 or other relevant applicable Standards.

11.3 Potable Water Tanks.

Potable water supply tanks, interior tank coatings, or tank liners intended to supply drinking water shall conform to NSF/ANSI/CAN 61.

11.4 Venting.

Tanks used for potable water shall be tightly covered and vented in accordance with the manufacturer's installation instructions. Such vent shall be screened with a corrosion-resistant material of not less than number 24 mesh.

11.5 Overflow.

Tanks shall have not less than a 16 square inch (0.01 m2) overflow that is screened with a corrosion-resistant material of not less than number 24 mesh.

11.6 Valves.

Pressurized tanks shall be provided with a listed pressure-relief valve installed in accordance with the manufacturer's installation instructions. The relief valve shall be discharged in accordance with clause 15.5.

Where a potable water supply tank is located above the fixtures, appliances, or system components it serves, it shall be equipped with a vacuum relief valve that conforms to ANSI Z21.22/CSA 4.4 .

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

12.1 Inadequate Water Pressure.

Where the water pressure in the main or other source of supply will not provide 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 a residual pressure exceeding 15 psi (103 kPa), that minimum residual pressure shall be provided.

12.2 Excessive Water Pressure.

Where static water pressure in the water supply piping exceeds 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 regulators for potable water distribution systems shall conform to ASSE 1003 or other relevant applicable Standards.

Pressure regulator(s) equal to or exceeding 1½ inches (40 mm) shall not require a strainer. Such regulator(s) shall control the pressure to water outlets in the building unless otherwise approved by Competent Authority.

Each such regulator and strainer shall be accessibly located aboveground or in a vault equipped with a properly sized and sloped boresighted 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 % of the reduced pressure (see table in 14.4).

An approved expansion tank shall be installed in the cold water distribution piping downstream of each such regulator to prevent pressure exceeding 80 psi (552 kPa) from developing due to thermal expansion. Expansion tanks used in potable water systems intended to supply drinking water shall conform to NSF/ANSI/CAN 61.

The expansion tank shall be properly sized, securely fastened to the structure, and installed in accordance with the manufacturer's installation instructions and listing. Systems designed by a licensed plumbing contractor or registered design professionals 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.

12.3 Expansion tanks and combination temperature and pressure-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, independent of the type of water heater used, shall be provided with an approved, listed, and adequately sized expansion tank or other approved device having a similar function to control thermal expansion.

Pre-pressurized water expansion tanks shall conform to IAPMO/ANSI Z1088 or other relevant applicable Standard. 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, securely fastened to the structure, 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 temperature and pressure-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 combination temperature and pressure-relief valve shall be provided with a drain in accordance with clause 12.5.

NOTE An expansion tank is not required for an instantaneous non-storage water heater.

12.4 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.

12.5 Discharge Piping.

The discharge piping serving a temperature relief valve, pressure relief valve, or combination of both shall have no valves, obstructions, or means of isolation and be provided with the following:

a) not less than the size of the valve outlet and shall discharge full size to the flood level of the area receiving the discharge and pointing down;

b) materials shall be rated at not less than the operating temperature of the system and approved for such use or shall conform to ASME A112.4.1;

c) discharge pipe shall discharge independently by gravity through an air gap into the drainage system or outside of the building with the end of the pipe not exceeding 2 feet (610 mm) and not less than 6 inches (152 mm) above the ground and pointing downwards;

d) discharge in such a manner that does not cause personal injury or structural damage;

e) no part of such discharge pipe shall be trapped or subject to freezing;

f) the terminal end of the pipe shall not be threaded;

g) discharge from a relief valve into a water heater pan shall be prohibited; and

h) the discharge termination point shall be readily observable.

12.6 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.

12.7 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 that conforms to ANSI Z21.22/CSA 4.4 shall be installed on the storage tank or heater.

13 Installation, Testing, Unions, and Location.

13.1 Installation.

Water piping shall be adequately supported in accordance with WDRS xxx-2: 2025. 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 or copper alloy 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.

13.1.1 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 excavated 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 drainpipe.

13.1.2 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 or copper alloy 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 standard, "within a building" shall mean within the fixed limits of the building foundation.

13.2 Testing.

Upon completion of a section or of the entire hot and cold water supply system, the system shall be tested with water or air.

The potable water test pressure shall be greater than or equal to the working pressure under which the system is to be used. The air pressure shall be a minimum of 50 psi (345 kPa).

Plastic pipe shall not be tested with air. The piping system shall withstand the test pressure without showing evidence of leakage for a period of not less than 15 minutes.

NOTE where permitted by the manufacturer's instructions PEX, PP or PE-RT tube can be tested with air

13.3 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.

13.4 Location.

Except as provided in clause 13.5, no building supply shall be located in a lot other than the lot that is the site of the building or structure served by such building supply.

13.5 Abutting Lot.

Nothing contained in this Standard 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 Competent Authority.

2) Provide additional space for a building supply where the proper cause, transfer of ownership, or change of boundary not in violation of other requirements have been first established to the satisfaction of Competent Authority. The instrument recording such action shall constitute an agreement with Competent Authority, 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 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 Competent Authority.

13.6 Pumps.

Pumps shall be installed in accordance with the manufacturer's installation instructions.

13.6.1 Access.

Pumps shall be accessible for repairs.

13.6.2 Potable Water Pumps.

Pumps intended to supply drinking water shall be in accordance with NSF/ANSI/CAN 61 .

13.6.3 Hot-Water Recirculating Pumps.

For healthcare facilities, long term care facilities, hotels, or motels, devices that automatically turn off the recirculation pump(s) shall not be required.

13.7 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 cut off 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.

13.8 Disinfection of Potable Water System.

New or repaired potable water systems shall be disinfected prior to use where required by Competent Authority. 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 the 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 a bacteriological examination made by an approved agency that contamination persists in the system.

13.9 Water Hammer.

13.9.1 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.

13.9.2 Water hammer arresters shall be approved mechanical devices that conform to ASSE 1010 or other relevant applicable Standards and shall be installed as close as possible to quick-acting valves.

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

13.10 Pipe Insulation.

Insulation of domestic hot water piping shall be in accordance with the requirements of clause 13.10.1 and 13.10.2.

13.10.1 Insulation Requirements.

Domestic hot water piping shall be insulated.

13.10.2 Pipe Insulation Wall Thickness.

Hot water pipe insulation shall have a minimum wall thickness of not less than the diameter of the pipe for a pipe up to 2 inches (50 mm) in diameter. Insulation wall thickness shall be not less than 2 inches (51 mm) for a pipe of 2 inches (50 mm) or more in diameter.

NOTE insulation is not required for piping that penetrates framing members for the distance of the framing penetration and hot water piping between the fixture control valve or supply stops and the fixture or appliance.

14 Size of Potable Water Piping.

14.1 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 clause. Water piping systems shall be designed to ensure that the maximum velocities allowed by the code and the applicable standard are not exceeded.

14.2 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 Competent Authority 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.

14.3 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 5. Equivalent fixture values shown in Table 5 include both hot and cold water demand.

Table 5 — Water supply fixture units (WSFU) and minimum fixture branch pipe sizes[3]

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	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	—
Clinical Faucet	½	—	3.0	—
Clinical 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
Nonwater Urinal with Drain Cleansing Action	½	1.0	1.0	1.0
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 Annex A WDRS xxx-2)].

[7] Where sizing flushometer systems, see 14.10.

[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.

14.4 Sizing Water Supply and Distribution Systems.

14.4.1 Systems within the range of Table 6 shall be permitted to be sized from that table or by the method in accordance with clause 14.5.

Table 6 — 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 psi[1]																
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 psi[1]																
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 psi[1]																
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.

14.1.2 On a proposed water piping installation sized using Table 6, the following conditions shall be determined:

a) total number of fixture units as determined from Table 5, Equivalent Fixture Units, for the fixtures to be installed;

b) developed length of supply pipe from meter to the most remote outlet;

c) difference in elevation between the meter or other source of supply and the highest fixture or outlet;

d) pressure in the street main or another source of supply at the locality where the installation is to be made; and

e) 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.

14.1.3 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.

14.5 Alternative ways of Sizing water piping systems.

Except as provided in clause 15.4, the size of each water piping system shall be determined in accordance with the procedure set forth in annex A, and for alternate methods of sizing water supply systems, refers to Table 7

Table 7—Water supply fixture units (WSFU) for bathroom groups[1,2]

	Private use bathroom group		Serving 3 or more private use bathroom groups	
	Cold	Hot[3]	Cold	Hot
Bathroom Groups Having up to 1.6 GPF Gravity-Tank and Pressure Tank Water Closets				
Half-Bath or Powder Room	3.5	0.8	2.5	0.5
1 Bathroom Group	5.0	2.5	3.5	1.8
1½ Bathrooms	6.0	2.5	3.0	3.0
2 Bathrooms	7.0	3.5	3.4	3.4
2½ Bathrooms	8.0	3.6	3.8	3.8
3 Bathrooms	9.0	4.5	4.1	4.1
Each Additional ½ Bath	0.5	0.1	0.4	0.4
Each Additional Bathroom Group	1.0	0.5	0.8	0.8
Other Groups of Fixtures				
Bathroom Group (1.6 GPF Flushometer Value)	6.0	2.5	4.0	1.7
Kitchen Group (Sink and Dishwasher)	2.0	2.0	1.5	1.5
Laundry Group (Sink and Clothes Washer)	5.0	5.0	3.0	3.0

Notes:

1 A bathroom group, for this table, consists of one water closet, up to two lavatories, and either one bathtub or one shower.

2 A half-bath or powder room, for this table, consists of one water closet and one lavatory.

3 Multi -unit dwellings with individual water heaters use the same WSFU as for individual dwellings.

14.6 Friction and Pressure Loss.

Except where the type of pipe used and the water characteristics are such that no decrease in capacity due to the length of service (age of system) is expected, friction-loss data shall be obtained from the “Fairly Rough” or “Rough” charts in annex A of this code. Friction or pressure losses in a 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 14.2.

14.7 Size of Meter and Building Supply Pipe Using Table 6.

The size of the meter and the building supply pipe shall be determined as follows:

a) determine the available pressure at the water meter or other source of supply;

b) 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;

c) use the “pressure range” group within which this pressure will fall using Table 6;

d) select the “length” column that is equal to or longer than the required length;

e) Follow down the column to a fixture unit value equal to or exceeding the total number of fixture units required by the installation; and

f) 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.

14.8 Size of Branches.

Where Table 6 is used, the minimum size of each branch shall be determined by the total fixture units served by that branch and then following the steps in clause 14.8. No branch piping shall exceed the total demand in fixture units for the system computed from Table 5.

14.9 Sizing for Flushometer Valves.

Where using Table 6 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 8. Piping supplying a flushometer valve shall be not less in size than the valve inlet.

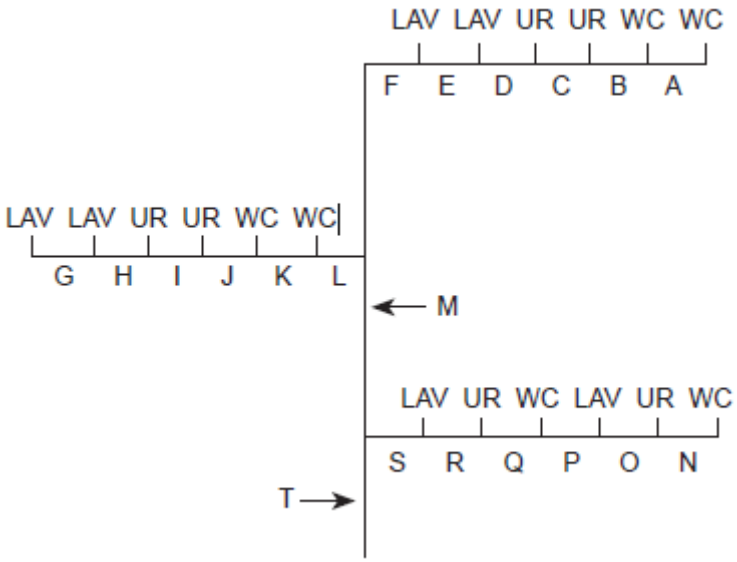
Table 8 — Flushometer fixture units for water Sizing using table 5

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

Where using Table 8 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.

EXAMPLE 14.9

SIZING METHOD FOR PUBLIC USE FIXTURES

USING TABLE 8

14.10 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.

14.11 Sizing for Velocity.

Water piping systems shall not exceed the maximum velocities listed in this section or annex A.

14.11.1 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 (1.5 m/s) in hot water.

14.11.2 Tubing Systems Using Copper Fittings.

Maximum velocities through copper fittings in tubing other than copper shall not exceed 8 ft/s (2.4 m/s) in cold water and 5 ft/s (1.5 m/s) in hot water.

14.12 Exceptions

The provisions of this Standards relative to the size of water piping shall not apply to the following:

a) Water supply piping systems designed in accordance with recognized engineering procedures acceptable to Competent Authority.

b) Alteration of or minor additions to existing installations provided Competent Authority finds that there will be an adequate supply of water to operate fixtures.

c) Replacement of existing fixtures or appliances.

d) Piping that is part of fixture equipment.

e) Unusual conditions where, in the judgment of Competent Authority, an adequate supply of water is provided to operate fixtures and equipment.

f) 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 are 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.

15 Drinking Water Treatment Units.

15.1 Application.

Drinking water treatment units shall conform to the applicable referenced standards in Table XXXX.

15.2 Alkaline Water Treatment.

Alkaline water treatment devices shall conform to IAPMO IGC 322 or other applicable Standard.

15.3 Scale Reduction Devices.

Scale reduction devices shall conform to IAPMO/ANSI Z601 or other relevant applicable Standard.

15.4 Air Gap Discharge.

Discharge from drinking water treatment units shall enter the drainage system through an air gap in accordance with Table 3 or an air gap device that conforms to Table 2, IAPOMM PS 65 or other applicable Standards.

15.5 Connection Tubing.

The tubing to and from drinking water treatment units shall be of a size and material as recommended by the manufacturer.

15.6 Sizing of Residential Softeners.

Residential-use water softeners shall be sized in accordance with Table 9.

Table 9 — sizing of residential water softeners

Required size of softener connection (inches)	Number of bathroom groups served[1]
¾	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 sink, 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 Annex A, Recommended Rules for Sizing the Water Supply System, and Annex C, Alternate Plumbing Systems, for alternate methods of sizing water supply systems.

16 Residential Fire Sprinkler Systems.

16.1 Where required.

Where residential sprinkler systems are required in one and two-family dwellings or townhouses, the systems shall be installed by personnel, installer, or both, certified in accordance with the ASSE/IAPMO/Series 7000 or other applicable Standards. Partial residential sprinkler systems shall be permitted to be installed in buildings not required to be equipped with a residential sprinkler system.

16.2 Types of Systems.

This section shall apply to stand-alone and multipurpose wet-pipe sprinkler systems that do not include the use of antifreeze. A multipurpose fire sprinkler system shall provide potable water to both fire sprinklers and plumbing fixtures. A stand-alone sprinkler system shall be separate and independent from the potable water distribution system. A backflow preventer shall not be required to separate a stand-alone sprinkler system from the water distribution system where the sprinkler system material is in accordance with the requirements of clause 8.

16.3 Sprinklers.

Sprinklers shall be installed in accordance with the requirements of clause 16.3.1 to 16.3.7.

16.3.1 Required Sprinkler Locations.

Sprinklers shall be installed to protect all floor areas of a dwelling unit in one and two-family dwellings or townhouses.

Sprinklers are not required for:

g) attics, crawl spaces, and normally unoccupied concealed spaces that do not contain fuel-fired appliances do not require sprinklers;

h) Clothes closets, linen closets, and pantries that do not exceed 24 square feet (2.2 m2) in area, with the smallest dimension not exceeding 3 feet (914 mm) and having wall and ceiling surfaces of gypsum board;

i) Bathrooms and toilet rooms that do not exceed 55 square feet (5.1 m2) in area;

j) Garages; carports; exterior porches; unheated entry areas, such as mud rooms, that are adjacent to an exterior door; and similar areas;

k) Covered unheated projections of the building at entrances/exits provided it is not the only means of egress from the dwelling unit; and

l) Ceiling pockets that meet the following requirements:

1) The total volume of an unprotected ceiling pocket does not exceed 100 cubic feet (2.83 m3).

2) The entire floor under the unprotected ceiling pocket is protected by the sprinklers at the lower ceiling elevation.

3) Each unprotected ceiling pocket is separated from an adjacent unprotected ceiling pocket by not less than a 10 feet (3048 mm) horizontal distance.

4) The interior finish of the unprotected ceiling pocket is noncombustible material.

5) Skylights not exceeding 32 square feet (2.97 m2).

16.3.2 Sprinkler Installation.

Sprinklers shall be listed residential sprinklers and shall be installed in accordance with the sprinkler manufacturer's installation instructions.

16.3.3 Temperature Rating and Separation from Heat Sources.

Sprinklers shall have a temperature rating of not less than 135°F (57°C) and not more than 170°F (77°C). Sprinklers shall be separated from heat sources in accordance with the sprinkler manufacturer's installation instructions. Sprinklers located close to a heat source in accordance with clause 16.3.3.1 shall be intermediate temperature sprinklers.

16.3.3.1 Intermediate Temperature Sprinklers.

Sprinklers shall have an intermediate temperature rating of not less than 175°F (79°C) and not more than 225°F (107°C) where installed in the following locations:

a) directly under skylights, where the sprinkler is exposed to direct sunlight;

b) in attics and concealed spaces located directly beneath a roof; and

c) Within the distance to a heat source in accordance with Table 10.

Table 10 — locations where intermediate temperature sprinklers are required

Heat source	Distance from heat Source[1]	
	Minimum distance[2] (inches)	Maximum distance (inches)
Fireplace, Side of Open or Recessed Fireplace	12	36
Fireplace, Front of Recessed Fireplace	36	60
Coal and Wood Burning Stove	12	42
Kitchen Range Top	9	18
Oven	9	18
Vent Connector or Chimney Connector	9	18
Heating Duct, Not Insulated	9	18
Hot Water Pipe, Not Insulated	6	12
Side of Ceiling or Wall Warm Air Register	12	24
Front of Wall Mounted Warm Air Register	18	36
Water Heater, Furnace, or Boiler	3	6
Luminaire up to 250 Watts	3	6
Luminaire 250 Watts up to 499 Watts	6	12

For SI units: 1 inch = 25.4 mm

Notes:

[1] Distances shall be measured in a straight line from the nearest edge of the heat source to the nearest edge of the sprinkler.

[2] Sprinklers shall not be located at distances less than the minimum table distance unless the sprinkler listing allows a lesser distance

16.3.4 Freezing Areas.

The piping system shall be protected in accordance with the requirements of WDRS xxx-1. Where sprinklers are required in areas that are subject to freezing, dry-sidewall or dry-pendent sprinklers extending from a non-freezing area into a freezing area shall be installed.

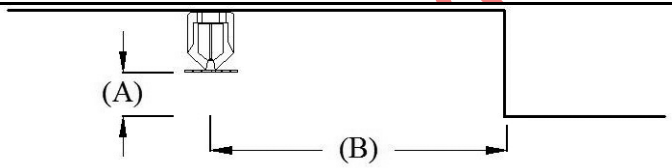
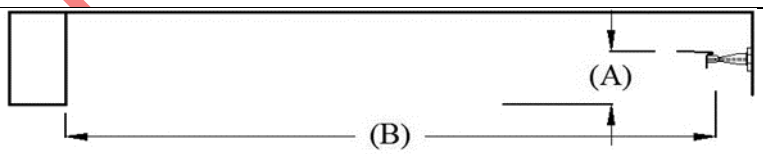
16.3.5 Coverage Area Limit.

The area of coverage of a single sprinkler shall be based on the sprinkler listing and the sprinkler manufacturer's installation instructions. The area of coverage of a single sprinkler shall not exceed 400 square feet (37.16 m2).

16.3.6 Obstructions to Sprinkler Coverage.

The water discharge from a sprinkler shall not be blocked by obstructions unless additional sprinklers are installed to protect the obstructed area. Additional sprinklers shall not be required where sprinkler separation from obstructions is in accordance with the requirements of Table 11, or the minimum distances specified in the sprinkler manufacturer's installation instructions.

Table 11 — minimum separation from obstruction

Pendent sprinklers	
Distance from deflector to plane at bottom of obstruction (a) (inches)	**Minimum distance to obstruction (b) (feet)**
1	1½
3	3
5	4
7	4½
9	6
11	6½
14	7
Sidewall sprinkler forward obstruction	
Distance from deflector to plane at bottom of obstruction (a) (inches)	**Minimum distance to obstruction (b) (feet)**
1	8
2	10
3	11
4	12
6	13
7	14
9	15
11	16
14	17
For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm	

16.3.6.1 Additional Requirements for Pendent Sprinklers.

Pendent sprinklers located within 3 feet (914 mm) of the center of a ceiling fan, surface-mounted ceiling luminaire, or similar object shall be considered to be obstructed, and additional sprinklers shall be provided.

16.3.6.2 Additional Requirements for Sidewall Sprinklers.

Sidewall sprinklers located within 5 feet (1524 mm) of the center of a ceiling fan, surface-mounted ceiling luminaire, or similar object shall be considered to be obstructed, and additional sprinklers shall be provided.

16.3.7 Sprinkler Modifications Prohibited.

Sprinklers shall not be painted, caulked, or modified. A sprinkler that has been painted, caulked, modified, or damaged shall be replaced with a new sprinkler.

16.4 Sprinkler Piping System.

Sprinkler piping systems shall be installed in accordance with clause 16.4.1 to 16.4.5.

16.4.1 General.

Sprinkler piping shall be installed in accordance with the requirements for water distribution piping. Sprinkler piping shall conform to the material requirements for cold water distribution piping. For multipurpose piping systems, the sprinkler piping shall connect to and be a part of the cold water distribution piping system.

16.4.2 Nonmetallic Pipe and Tubing.

Nonmetallic pipe and tubing, such as CPVC, PEX-AL-PEX, PE-RT, and PEX, shall be certified for residential sprinkler installations and shall have a pressure rating of not less than 130 psi (896 kPa) at 120°F (49°C).

16.4.2.1 Nonmetallic Pipe Protection.

Nonmetallic pipe and tubing systems shall be protected from exposure to the occupied space by a layer of not less than 3⁄8 of an inch (9.5 mm) thick gypsum wallboard, 1⁄2 of an inch (12.7 mm) thick plywood, or other material having a 15-minute fire rating.

Pipe protection from exposure is not required:

a) in areas that are not required to be protected with sprinklers in accordance with 16.3.1.

b) Pipe protection shall not be required where exposed piping is permitted by the pipe third-party listing.

16.4.2.2 Sprinkler Installation on Systems Assembled with Solvent Cement.

The solvent cementing of fittings shall be completed, and threaded adapters for sprinklers shall be verified as being clear of excess cement before the installation of sprinklers on systems assembled with solvent cement.

16.4.3 Shutoff Valves Prohibited.

Shutoff valves shall not be installed in a location where the valve would isolate piping serving one or more sprinklers. Shutoff valves shall only be permitted for the entire water distribution system.

16.4.4 Single Dwelling Limit.

The sprinkler piping beyond the service valve located at the beginning of the water distribution system shall serve only one dwelling unit.

16.4.5 Drain.

A ½ inch (15 mm) drain for the sprinkler system shall be provided on the system side of the water distribution shutoff valve.

16.5 Sprinkler Piping Design.

Sprinkler piping systems shall be sized in accordance with clause 16.5.1 to 16.5.3.

16.5.1 Determining System Design Flow.

The sizing of the sprinkler piping system shall be based on the flow rate and pressure of each sprinkler in accordance with 16.5.1.1 and the number of sprinklers in accordance with 16.5.1.2.

16.5.1.1 Determining required flow rate for each sprinkler

The minimum flow rate and pressure for each residential sprinkler shall be in accordance with the manufacturer's published data for the specific sprinkler model based on the following:

(1) The area of coverage.

(2) The ceiling configuration.

(3) The temperature rating.

(4) Additional conditions specified by the sprinkler manufacturer.

16.5.1.2 System flow rate

The flow rate used for sizing the sprinkler piping system shall be based on the following:

a) the flow rate for a room having only one sprinkler shall be the flow rate required for the sprinkler in accordance with 16.5.1.1;

b) The flow rate for a room having two or more sprinklers shall be determined by identifying the sprinkler in the room with the highest required flow rate in accordance with 16.5.1.1 and multiplying that flow rate by 2;

c) Where the sprinkler manufacturer specifies different criteria for ceiling configurations that are not smooth, flat, and horizontal the required flow rate for that room shall be in accordance with the sprinkler manufacturer's instructions;

d) The flow rate used for sizing the sprinkler system shall be the flow required by the room with the largest flow rate in accordance with clause16.5.1.2(a), 16.5.1.2(b) and 16.5.1.2(c); and

e) For the purpose of this section, it shall be permissible to reduce the flow rate for a room by subdividing the space into two or more rooms, where each room is evaluated separately on the required design flow rate. Each room shall be bounded by walls and a ceiling. Openings in walls shall have a lintel not less than 8 inches (203 mm) in depth, and each lintel shall form a solid barrier between the ceiling and the top of the opening.

16.5.2 Sprinkler pipe water supply

The water supply for a multipurpose or stand-alone sprinkler system shall be provided by the public water main, private water main, private well system, or storage tank. The water supply required shall be determined in accordance with 16.5.1.2 at a pressure not less than that used in accordance with 16.5.3.

16.5.2.1 Water Pressure from Individual Sources.

Where a dwelling unit water supply is from a tank system, a private well system, or a combination of these, the available water pressure shall be based on the minimum pressure control setting of the pump.

16.5.2.2 Required capacity

The water supply shall have the capacity to provide the required flow rate to the sprinklers for a period of time as follows:

a) Seven minutes for one story dwelling units less than 2000 square feet (185.8 m2) in area.

b) Ten minutes for multi-level dwelling units and one-story dwelling units not less than 2000 square feet (185.8 m2) in the area.

Where a well system, a water supply tank system, or a combination thereof is used a combination of well capacity and tank storage shall be permitted to meet the capacity requirement.

16.5.3 Sprinkler pipe sizing

The sprinkler piping shall be sized for the flow rate in accordance with 16.5.1. The flow rate required to supply the plumbing fixtures shall not be required to be added to the sprinkler design flow for multipurpose or stand alone piping systems.

The sizing of the water supply to the plumbing fixtures shall be determined in accordance with this chapter. For multipurpose piping systems, the largest pipe size required based on either the sprinkler piping calculations or the water distribution piping calculations shall be installed.

16.5.3.1 Sprinkler pipe sizing method

The sprinkler pipe shall be sized using the prescriptive method in 16.5.3.2 or by hydraulic calculation in accordance with applicable Standards.NFPA 13D. The sprinkler pipe size from the water supply source to a sprinkler shall be not less than ¾ of an inch (20 mm) in diameter. Threaded adapter fittings at the point where sprinklers are attached to the piping shall be not less than ½ of an inch (15 mm) in diameter.

16.5.3.2 Prescriptive pipe sizing method

The sprinkler pipe shall be sized by determining the available pressure to offset friction loss in piping and based on the piping material, diameter and length using the equation in 16.5.3.2.1 and the procedure in 16.5.3.2.2.

16.5.3.2.1 Available pressure equation

The available system pressure (P_t) for sizing the sprinkler piping shall be determined in using the following equation:

$$Pt = Psup - PLws - PLm - PLd - PLe - Psp \quad \text{(Equation 16.5.3.2.1)}$$

Where:

Pt = Pressure used for sizing the system in (see table in 16.5.3.2.2)

Psup= Pressure available from the water supply source

PLws= Pressure loss in the water service pipe

PLm= Pressure loss through the water meter

PLd = Pressure loss from devices other than the water meter

PLe = Pressure loss associated with changes in elevation

Psp = Maximum pressure required by a sprinkler

16.5.3.2.2 Calculation procedure

The following procedure shall be used to determine the minimum size of the residential sprinkler piping:

Step 1 - Determine P_{sup}

Obtain the supply pressure available from the water main from the water purveyor, or for an individual source; the available supply pressure shall be in accordance with 16.5.2.1. The pressure shall be the flowing pressure available at the flow rate used when applying Table 12.

Table 12 — Water service pressure loss (PLWS)[1, 2, 3]

Low rate gpm	¾ inch water service pressure loss psi				1 inch water service pressure loss psi				1¼ inch water service pressure loss psi			
	40 feet or less	41 feet To 75 feet	76 feet To 100 feet	101 feet To 150 feet	40 feet or less	41 feet To 75 feet	76 feet To 100 feet	101 feet To 150 feet	40 feet or less	41 feet To 75 feet	76 feet To 100 feet	101 feet To 150 feet
8	5.1	8.7	11.8	17.4	1.5	2.5	3.4	5.1	0.6	1.0	1.3	1.9
10	7.7	13.1	17.8	26.3	2.3	3.8	5.2	7.7	0.8	1.4	2.0	2.9
12	10.8	18.4	24.9	NP	3.2	5.4	7.3	10.7	1.2	2.0	2.7	4.0
14	14.4	24.5	NP	NP	4.2	7.1	9.6	14.3	1.6	2.7	3.6	5.4
16	18.4	NP	NP	NP	5.4	9.1	12.4	18.3	2.0	3.4	4.7	6.9
18	22.9	NP	NP	NP	6.7	11.4	15.4	22.7	2.5	4.3	5.8	8.6
20	27.8	NP	NP	NP	8.1	13.8	18.7	27.6	3.1	5.2	7.0	10.4
22	NP	NP	NP	NP	9.7	16.5	22.3	NP	3.7	6.2	8.4	12.4
24	NP	NP	NP	NP	11.4	19.3	26.2	NP	4.3	7.3	9.9	14.6
26	NP	NP	NP	NP	13.2	22.4	NP	NP	5.0	8.5	11.4	16.9
28	NP	NP	NP	NP	15.1	25.7	NP	NP	5.7	9.7	13.1	19.4
30	NP	NP	NP	NP	17.2	NP	NP	NP	6.5	11.0	14.9	22.0
32	NP	NP	NP	NP	19.4	NP	NP	NP	7.3	12.4	16.8	24.8
34	NP	NP	NP	NP	21.7	NP	NP	NP	8.2	13.9	18.8	NP
36	NP	NP	NP	NP	24.1	NP	NP	NP	9.1	15.4	20.9	NP

For SI units: 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 inch = 25 mm, 1 foot = 304.8 mm

Notes:

1 Values are applicable for underground piping materials and are based on polyethylene pipe having an SDR of 11 and a Hazen Williams C Factor of 150.

2 Values include the following length allowances for fittings: 25 % length increase for actual lengths up to 100 feet (30 480 mm) and 15 % length increase for actual lengths over 100 feet (30 480 mm).

3 NP – Means not permitted.

Step 2 – Determine PL_{ws}

Use Table 12 to determine the pressure loss in the water service pipe based on the size of the water service. Where the water service supplies more than one dwelling unit, 5 gpm (0.3 L/s) shall be added to the sprinkler flow rate.

Step 3 – Determine P_{Lm}

Use Table 13 to determine the pressure loss from the water meter based on the water meter size.

Table 13 — minimum water meter pressure loss (P_{Lm})[1, 2]

Flow rate gpm	5/8 inch meter pressure loss psi	¾ inch meter pressure loss psi	1 inch meter pressure loss psi
8	2	1	1
10	3	1	1
12	4	1	1
14	5	2	1
16	7	3	1
18	9	4	1
20	11	4	2
22	NP	5	2
24	NP	5	2
26	NP	6	2
28	NP	6	2
30	NP	7	2
32	NP	7	3
34	NP	8	3
36	NP	8	3

For SI units: 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 inch = 25 mm

Notes:

[1] Table 13 establishes conservative values for water meter pressure loss for installations where the water meter loss is unknown. Where the actual water meter pressure loss is known, PLm shall be the pressure loss as specified by the meter manufacturer.

[2] NP – Means not permitted.

Step 4 – Determine P_{Ld}

Determine the pressure loss from devices, other than the water meter, installed in the piping system supplying sprinklers such as pressure-reducing valves, backflow preventers, water softeners, or water filters. Device pressure losses shall be based on the device manufacturer's specifications. The flow rate used to determine pressure loss shall be the sprinkler flow rate in accordance with 16.5.1.2. As an alternative to deducting pressure loss for a device, an automatic bypass valve shall be installed to divert flow around the device when a sprinkler activates.

Step 5 – Determine PL_e

Use Table 14 to determine the pressure loss associated with changes in elevation. The elevation used in applying the table shall be the difference between the elevation where the water source pressure was measured and the elevation of the highest sprinkler.

Table 14 — elevation loss (PL_e)

Elevation (feet)	Pressure loss (psi)
5	2.2
10	4.4

15	6.5
20	8.7
25	10.9
30	13.0
35	15.2
40	17.4
For SI units: 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa	

Step 6 – Determine PS_p

Determine the maximum pressure required by an individual sprinkler based on the flow rate from 16.5.1.1. The minimum pressure required is specified in the sprinkler manufacturer's published data for the specific sprinkler model based on the selected flow rate.

Step 7 – Calculate P_t

Using equation 16.5.3.2.1, calculate the available system pressure for sizing the sprinkler piping.

Step 8 – Determine the maximum allowable pipe length

Use Annex B (Table B.1 to Table B.6) to select a material and size for the residential sprinkler piping. The piping material and size shall be acceptable where the developed length of pipe between the inside water service valve and the most remote sprinkler does not exceed the maximum allowable length specified by the applicable table. Interpolation of Pt between the tabular values shall be permitted.

The maximum allowable length of piping in accordance with Annex B incorporates an adjustment for pipe fittings, and no additional consideration of friction losses associated with pipe fittings shall be required.

16.6 Instructions and signs

An owner's manual for the fire sprinkler system shall be provided to the owner. A sign or valve tag shall be installed at the main shutoff valve to the water distribution system stating the following: "**Warning, the water system for this home supplies fire sprinklers that require certain flow and pressure to fight a fire. Devices that restrict the flow decrease the pressure, or automatically shut-off the water to the fire sprinkler system, such as water softeners, filtration systems, and automatic shutoff valves shall not be added to this system without a review of the fire sprinkler system by a fire protection specialist. Do not remove this sign**."

16.7 Inspection and testing

The inspection and testing of sprinkler systems shall be in accordance with 16.7.1 and 16.7.2.

16.7.1 Pre-concealment inspection

The following shall be verified prior to the concealment of any sprinkler system piping:

a) Sprinklers are installed in all areas in accordance with 16.3.1.

b) Where sprinkler water spray patterns are obstructed by construction features, luminaires or ceiling fans, additional sprinklers are installed in accordance with 16.3.6.

c) Sprinklers are the correct temperature rating and are installed at or beyond the required separation distances from heat sources in accordance with 16.3.3.

d) the minimum pipe size in accordance with the requirements of Annex B or, where the piping system was hydraulically calculated in accordance with 17.5.3.1, the size used in the hydraulic calculation.

e) the pipe length does not exceed the length permitted by Annex B or, where the piping system was hydraulically calculated in accordance with 17.5.3.1, pipe lengths and fittings shall not exceed those used in the hydraulic calculation.

f) Nonmetallic piping that conveys water to sprinklers is certified as having a pressure rating of not less than 130 psi (896 kPa) at 120 °F (49 °C).

g) Piping is properly supported.

h) The piping system is tested in accordance 13.4.

16.7.2 Final inspection

Upon completion of the residential sprinkler system, the system shall be inspected. The following shall be verified during the final inspection:

a) Sprinklers are not painted, damaged, or otherwise hindered from the operation.

b) Where a pump is required to provide water to the system, the pump starts automatically upon system water demand.

c) Pressure reducing valves, water softeners, water filters, or other impairments to water flow that were not part of the original design has not been installed.

d) The sign or valve tag in accordance with 16.6 is installed, and the owner’s manual for the system is present.

Annex A
(normative)

Recommended rules for sizing the water supply system

A.1 General

This annex provides a general procedure for sizing a water supply system. Because of the variable conditions encountered, it is impractical to lay down definite detailed rules of procedure for determining the sizes of water supply pipes in annex, which shall necessarily be limited in length.

A.1 Preliminary information

Daily service pressure

Obtain the necessary information regarding the minimum daily service pressure in the area where the building is to be located.

Water meter

Where the building supply is to be metered, obtain information regarding friction loss relative to the rate of flow of meters in the range of sizes likely to be used. Friction-loss data is capable of being obtained from most manufacturers of water meters. Friction losses for disk- type meters shall be permitted to be obtained from Chart shown in Figure A.1.

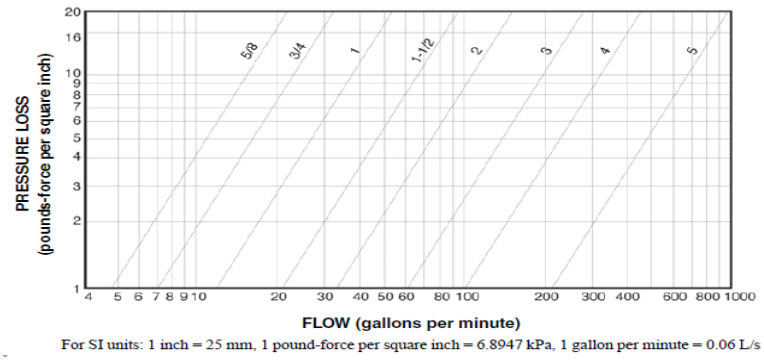


Figure A.1 Chart for friction losses for disk-type water meters

Local information

Obtain available local information regarding the use of different kinds of pipe with respect both to durability and to decrease in capacity with the length of service in the particular water supply.

Demand load

Supply demand

Estimate the supply demand for the building main, the principal branches and risers of the system by totaling the fixture units on each, Table A.1, and then by reading the corresponding ordinate from Chart shown in Figure A.2 or Chart Shown in Figure A.3, whichever is applicable.

Table A.1—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[7]	½	1.0	1.0	–
Lavatory	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	–
Clinical Faucet	½	–	3.0	–
Clinical 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	3.0	4.0	5.0
Urinal, greater than 1.0 GPF Flushometer Valve	¾	4.0	5.0	6.0
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	5.0	5.0	8.0
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	7.0	8.0	10.0

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 included 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 total load on the cold water building supply. The separate cold water and hot water fixture unit value for fixtures having both cold and hot water connections shall be permitted to be three-quarters 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 sep-arately to the demand in gpm (L/s) for the distribution system or portions thereof.

[6] Assembly [Public Use (see Annex A DRS 644-2)].

[7] 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 by 2.5 fixture units

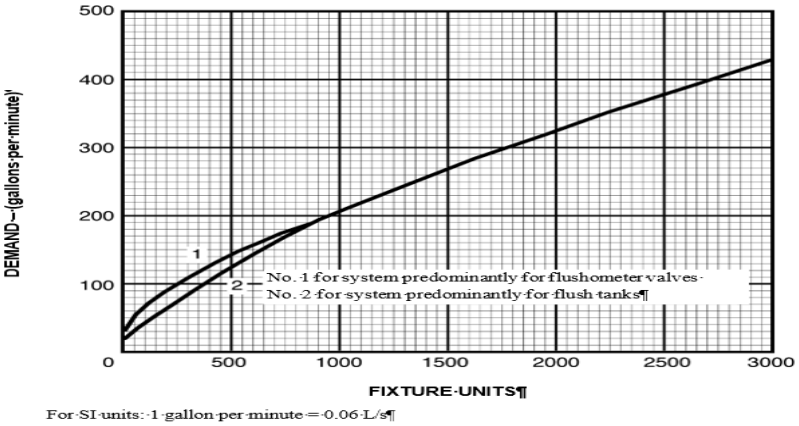


Figure A.2 chart showing estimate curve for demand load

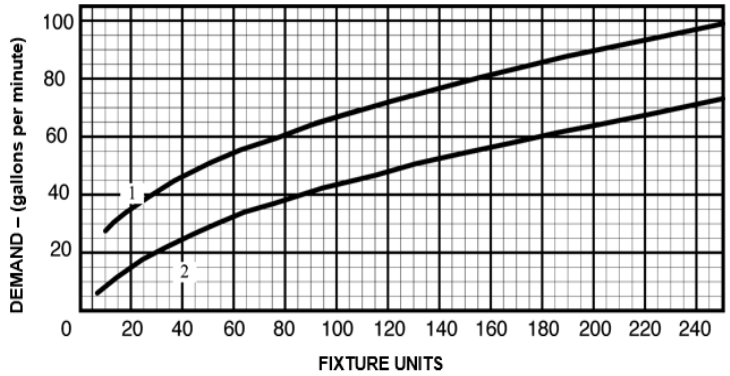


Figure A.3 Chat showing estimate curve for enlarged scale demand load

Continuous Supply Demand.

Estimate continuous supply demands in gallons per minute (gpm) (L/s) for lawn sprinklers, air conditioners, etc., and add the sum to the total demand for fixtures. The result is the estimated supply demand of the building supply.

Permissible Friction Loss.

Residual Pressure.

Decide what is the desirable minimum residual pressure that shall be maintained at the highest fixture in the supply system. The available residual pressure shall be not less than 15 pounds-force per square inch (psi) (103 kPa).

Where fixtures, fixture fittings, or both are installed that require a residual pressure exceeding 15 psi (103 kPa), that minimum residual pressure shall be provided.

Elevation.

Determine the elevation of the highest fixture or group of fixtures above the water (street) main. Multiply this difference in elevation by 0.43. The result is the loss of static pressure in psi (kPa).

Available Pressure.

Subtract the sum of loss in static pressure and the residual pressure to be maintained at the highest fixture from the average minimum daily service pressure. The result will be the pressure available for friction loss in the supply pipes, where no water meter is used.

Where a meter is to be installed, the friction loss in the meter for the estimated maximum demand should also be subtracted from the service pressure to determine the pressure loss available for friction loss in the supply pipes.

Developed Length.

Determine the developed length of pipe from the water (street) main to the highest fixture. Where close estimates are desired, compute with the aid of Table A.2, Table A 3 or Table A.4 whichever is applicable, the equivalent length of pipe for fittings in the line from the water (street) main to the highest fixture and add the sum to the developed length.

Table A.2 — Allowance in equivalent length of pipe for friction loss in valves and threaded fittings* equivalent length of pipe for various fittings

Diameter of fitting (inches)	90° standard elbow (feet)	45° standard elbow (feet)	90° standard tee (feet)	Coupling or straight run of tee(feet)	Gate valve (feet)	Globe valve (feet)	Angle valve (feet)
⅜	1.0	0.6	1.5	0.3	0.2	8	4
½	2.0	1.2	3.0	0.6	0.4	15	8
¾	2.5	1.5	4.0	0.8	0.5	20	12
1	3.0	1.8	5.0	0.9	0.6	25	15
1¼	4.0	2.4	6.0	1.2	0.8	35	18
1½	5.0	3.0	7.0	1.5	1.0	45	22
2	7.0	4.0	10.0	2.0	1.3	55	28
2½	8.0	5.0	12.0	2.5	1.6	65	34
3	10.0	6.0	15.0	3.0	2.0	80	40
4	14.0	8.0	21.0	4.0	2.7	125	55
5	17.0	10.0	25.0	5.0	3.3	140	70
6	20.0	12.0	30.0	6.0	4.0	165	80

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 degree = 0.017 rad

* Allowances are based on nonrecessed threaded fittings. Use one-half the allowances for recessed threaded fittings or streamlined solder fittings.

Table A.3 — Equivalent length of copper tube size CPVC pipe for various fittings

Diameter of fitting (inches)	90° Elbow (feet)	45° Elbow (feet)	Coupling or straight run of tee (feet)	90° Standard tee (feet)
½	1.6	0.8	1.0	3.1
¾	2.1	1.1	1.4	4.1
1	2.6	1.4	1.7	5.3
1¼	3.5	1.8	2.3	6.9
1½	4.0	2.1	2.7	8.1
2	5.2	2.8	3.5	10.3

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

Table **A.4— Equivalent length of schedule 40 and 80 cpvc pipe for various fittings**

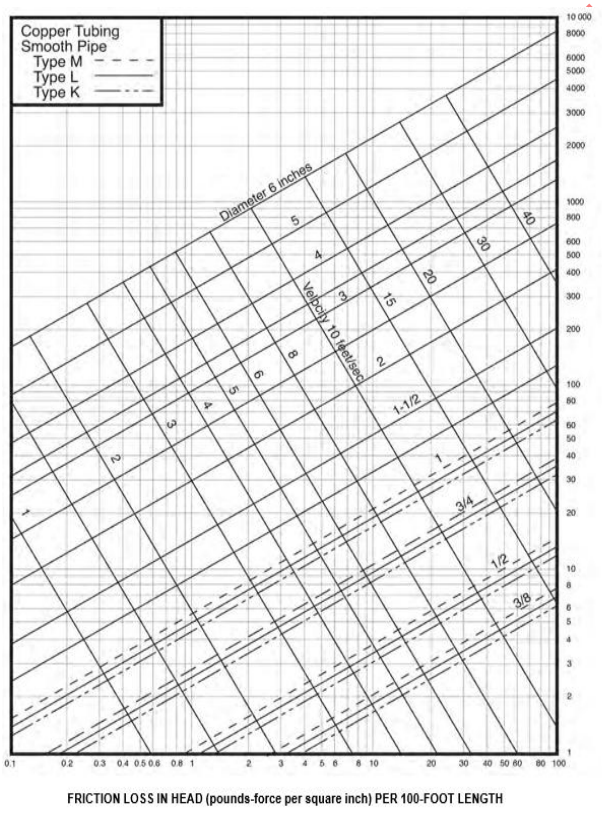
Diameter of fitting (inches)	90° Elbow (feet)	45° Elbow (feet)	Coupling or straight run of tee (feet)	90° Standard tee (feet)
½	1.5	0.8	1.0	4.0
¾	2.0	1.1	1.4	5.0
1	2.5	1.4	1.7	6.0
1¼	3.8	1.8	2.3	7.0
1½	4.0	2.1	2.7	8.0
2	5.7	2.6	4.3	12.0
For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm				

The pressure available for friction loss in psi (kPa), divided by the developed lengths of pipe from the water (street) main to the highest fixture, times 100, will be the average permissible friction loss per 100 feet (30 480 mm) length of pipe.

Size of Building Supply.

Diameter.

Knowing the permissible friction loss per 100 feet (30 480 mm) of pipe and the total demand, the diameter of the building supply pipe shall be permitted to be obtained from Chart shown in figure A.4 (a) to (g) whichever is applicable. The diameter of pipe on or next above the coordinate point corresponding to the estimated total demand and the permissible friction loss will be the size needed up to the first branch from the building supply pipe.



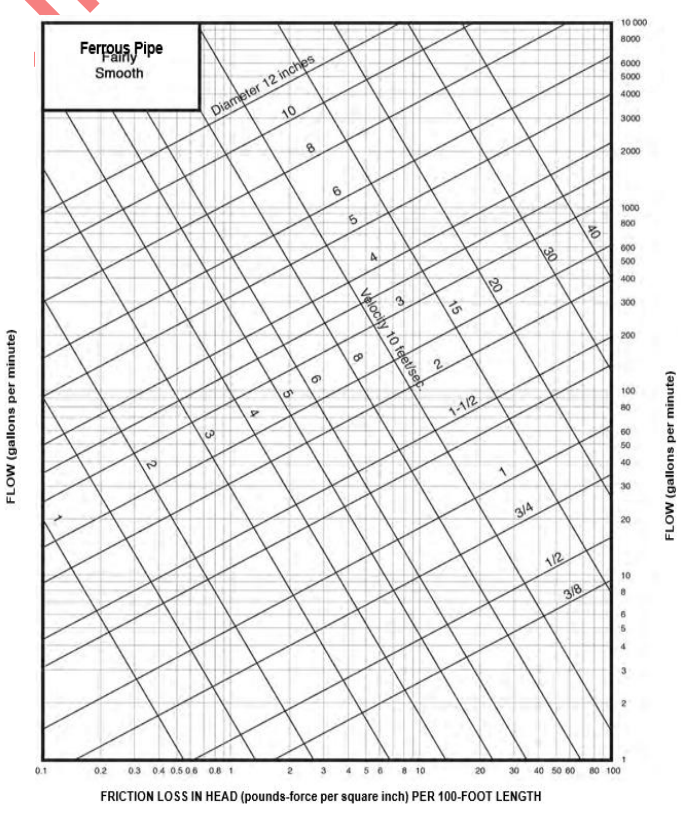


Figure A.4(a)

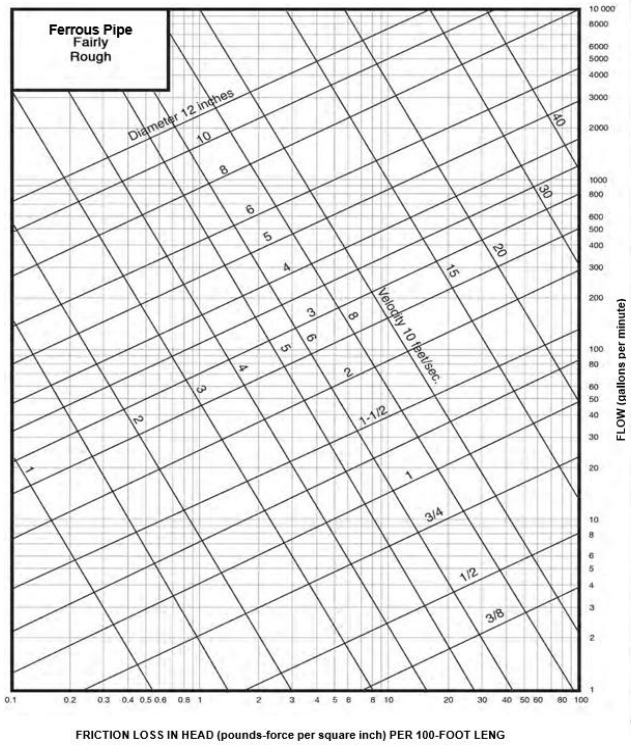


Figure A.4(b)

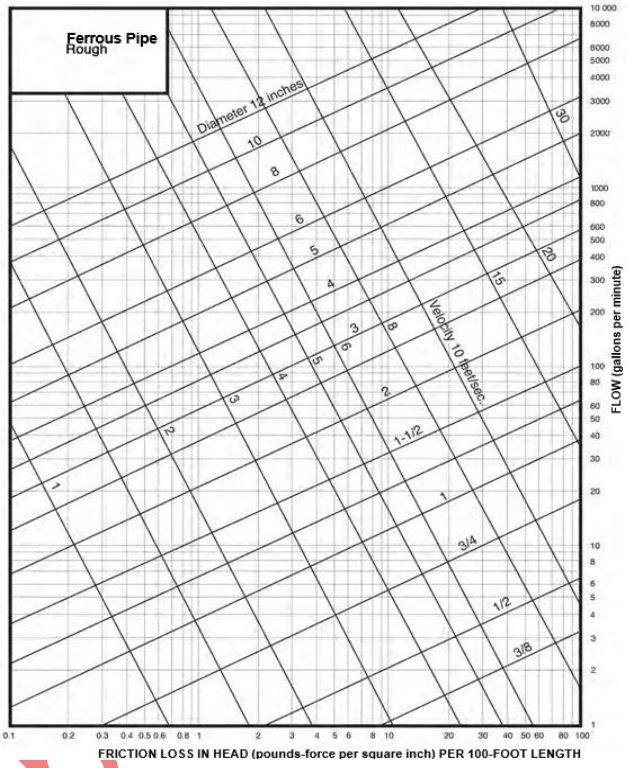


Figure A.4(c)

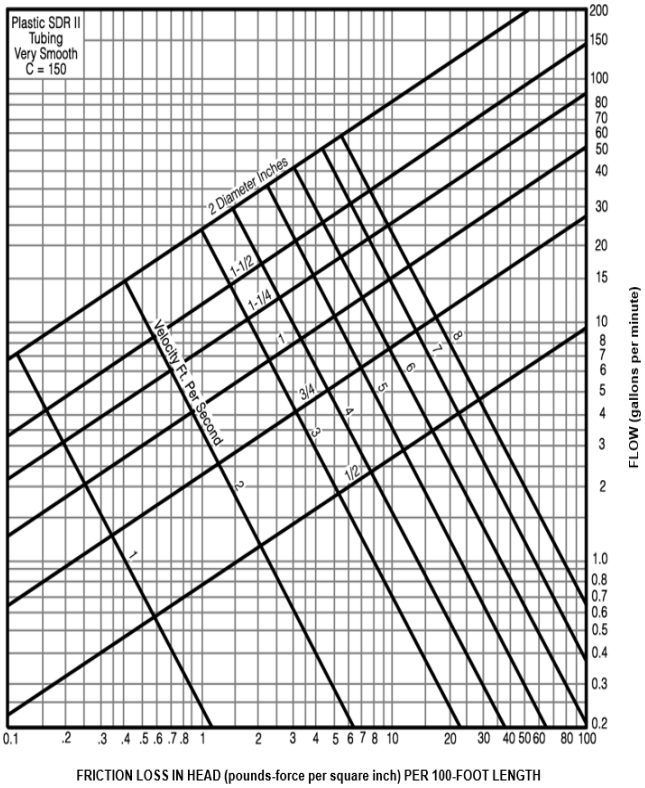


Figure A.4(d)

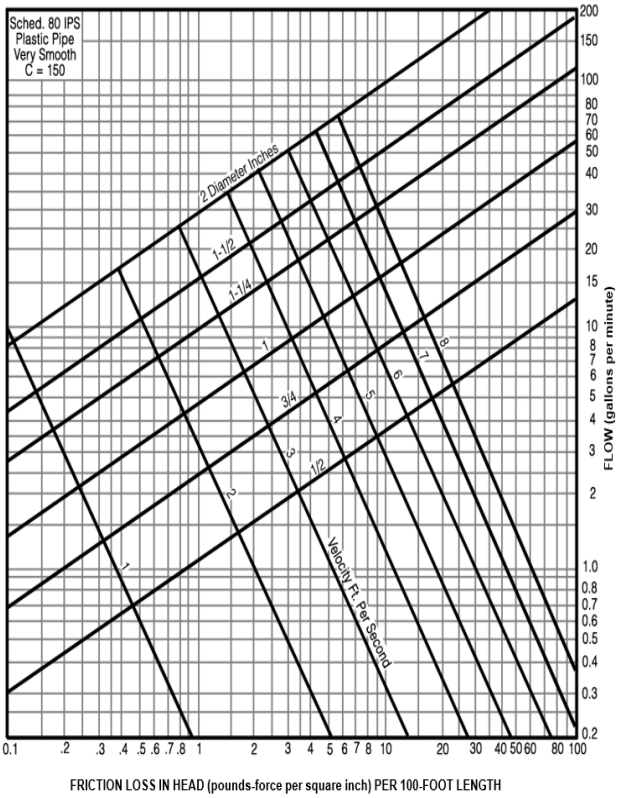


Figure A.4(e) **Figure A.4(f)**

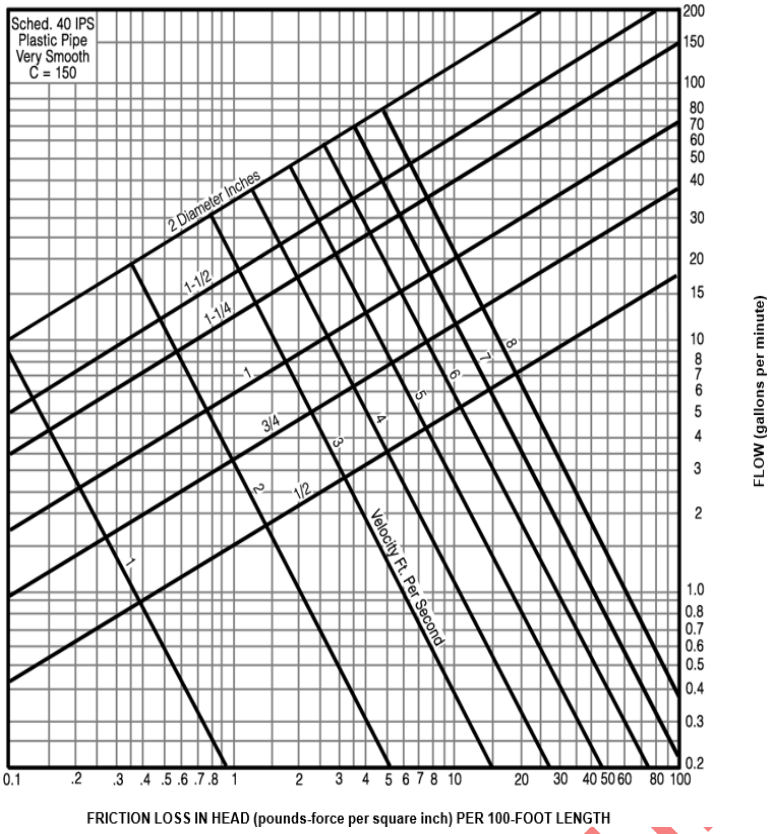


Figure A.4(g)

Figure A.4 chart used in sizing estimate permitted supply pipe diameter knowing permitted friction loss and the total demand.

A.1.1 Copper and Copper Alloy Piping

Where copper tubing or copper alloy pipe is to be used for the supply piping and where the character of the water is such that slight changes in the hydraulic characteristics are expected, Figure A.4 shall be permitted to be used.

A.1.1.1 Hard Water

Chart shown in Figure A.4(b) shall be used for ferrous pipe with the most favorable water supply in regards to corrosion and caking. Where the water is hard or corrosive, Chart Shown in Figure A.4(c) or Figure A.4(d) will be applicable. For extremely hard water, it will be advisable to make additional allowances for the reduction of the capacity of hot-water lines in service.

Size of Principal Branches and Risers.

Size.

The required size of branches and risers shall be permitted to be obtained in the same manner as the building supply, by obtaining the demand load on each branch or riser and using the permissible friction loss computed in A.4.

Branches.

Where fixture branches to the building supply are sized for the same permissible friction loss per 100 feet (30 480 mm) of pipe as the branches and risers to the highest level in the building and lead to the inadequate water supply to the upper floor of a building, one of the following shall be done:

a) Selecting the sizes of pipe for the different branches so that the total friction loss in each lower branch is approximately equal to the total loss in the riser, including both friction loss and loss in static pressure;

b) throttling each such branch using a valve until the preceding balance is obtained;

c) increasing the size of the building supply and risers above the minimum required to meet the maximum permissible friction loss.

Water Closets.

The size of branches and mains serving flushometer tanks shall be consistent with sizing procedures for flush tank water closets.

General.

Velocities.

Velocities shall not exceed 10 feet per second (ft/s) (3 m/s), except as otherwise approved by the Authority Having Jurisdiction.

Pressure-Reducing Valves.

Where a pressure- reducing valve is used in the building supply, the developed length of supply piping and the permissible friction loss shall be computed from the building side of the valve.

Fittings.

The allowances in Table A.2 for fittings are based on non-recessed threaded fittings. For recessed threaded fittings and streamlined soldered fittings, one-half of the allowances given in the table will be ample.

Sizing.

Example.

Assume an office building of four stories and basement; pressure on the building side of the pressure- reducing valve of 55 psi (379 kPa) (after an allowance for reduced pressure falloff at peak demand); an elevation of highest fixture above the pressure-reducing valve of 45 feet (13 716 mm); a developed length of pipe from the

pressure- reducing valve to the most distant fixture of 200 feet (60 960 mm); and fixtures to be installed with flush valves for water closets and stall urinals as follows:

Where the pipe material and water supply are such that chart shown in Figure A.4 (b) applies, the required diameter of the building supply is 3½ inches (90 mm), and the required diameter of the branch to the hot-water heater is 1½ inches (40 mm).

The sizes of the various branches and risers shall be permitted to be determined in the same manner as the size of the building supply or the branch to the hot-water system, by estimating the demand for the riser or branch from Chart shown in Figure A.2 or Figure A.3 and applying the total demand estimate from the branch, riser, or section thereof to the appropriate flowchart.

Table A.5 — Example

Fixture units and estimated demands							
Building supply demand					Branch to hot water system		
Kind of fixtures	Number of fixtures	Fixture unit demand	Total units	Building supply demand (Gallons per minute)	Number of fixtures	Fixture unit demand calculation	Demand (gallons per minute)
Water Closets	130	8.0	1 040	–	–	–	–
Urinals	30	4.0	120	–	–	–	–
Showerheads	12	2.0	24	–	12	12 x 2 x ¾ = 18	–
Lavatories	100	1.0	100	–	100	100 x 1 x ¾ = 75	–
Service Sinks	27	3.0	81	–	27	27 x 3 x ¾ = 61	–
Total	–	–	1 365	252	–	154	55

For SI units: 1 gallon per minute = 0.06 L/s, 1 pound-force per square foot = 6.8947 kPa

Allowing for 15 psi (103 kPa) at the highest fixture under the maximum demand of 252 gallons per minute (15.90 L/s), the pressure available for friction loss is found by the following:

55 – [15 + (45 x 0.43)] = 20.65 psi (142.38 kPa)

The allowable friction loss per 100 feet (30 480 mm) of the pipe is, therefore:

100 x 20.65 ÷ 200 = 10.32 psi (71.15 kPa)

Annex B
(normative)

Maximum allowable length for pipe for various piping material and size

Maximum allowable length for pipes knowing flow rate, available pressure, material and size shall be in accordance with Table B.1 to Table B.5.

Table B.1 — Allowable pipe length for 3⁄4-inch type M copper water tubing*

Sprinkler flow rate (gpm)	Water distribution size (inch)	Available pressure - P*t* (psi)									
		15	20	25	30	35	40	45	50	55	60
		Allowable length of pipe from service valve to farthest sprinkler (feet)									
8	¾	217	289	361	434	506	578	650	723	795	867
9	¾	174	232	291	349	407	465	523	581	639	697
10	¾	143	191	239	287	335	383	430	478	526	574
11	¾	120	160	200	241	281	321	361	401	441	481
12	¾	102	137	171	205	239	273	307	341	375	410
13	¾	88	118	147	177	206	235	265	294	324	353
14	¾	77	103	128	154	180	205	231	257	282	308
15	¾	68	90	113	136	158	181	203	226	248	271
16	¾	60	80	100	120	140	160	180	200	220	241
17	¾	54	72	90	108	125	143	161	179	197	215
18	¾	48	64	81	97	113	129	145	161	177	193
19	¾	44	58	73	88	102	117	131	146	160	175
20	¾	40	53	66	80	93	106	119	133	146	159
21	¾	36	48	61	73	85	97	109	121	133	145
22	¾	33	44	56	67	78	89	100	111	122	133
23	¾	31	41	51	61	72	82	92	102	113	123
24	¾	28	38	47	57	66	76	85	95	104	114
25	¾	26	35	44	53	61	70	79	88	97	105
26	¾	24	33	41	49	57	65	73	82	90	98
27	¾	23	30	38	46	53	61	69	76	84	91
28	¾	21	28	36	43	50	57	64	71	78	85
29	¾	20	27	33	40	47	53	60	67	73	80
30	¾	19	25	31	38	44	50	56	63	69	75
31	¾	18	24	29	35	41	47	53	59	65	71
32	¾	17	22	28	33	39	44	50	56	61	67
33	¾	16	21	26	32	37	42	47	53	58	63
34	¾	NP	20	25	30	35	40	45	50	55	60
35	¾	NP	19	24	28	33	38	42	47	52	57
36	¾	NP	18	22	27	31	36	40	45	49	54
37	¾	NP	17	21	26	30	34	38	43	47	51
38	¾	NP	16	20	24	28	32	36	40	45	49
39	¾	NP	15	19	23	27	31	35	39	42	46
40	¾	NP	NP	18	22	26	29	33	37	40	44

For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm

* NP – Means not permitted.

Table B.2 — Allowable pipe length for 1 inch type M copper water tubing

Sprinkler flow rate (gpm)	Water distribution size	Available pressure - P*t* (psi)									
		15	20	25	30	35	40	45	50	55	60
		Allowable length of pipe from service valve to farthest sprinkler (feet)									

	(inch)										
8	1	806	1075	1343	1612	1881	2149	2418	2687	2955	3224
9	1	648	864	1080	1296	1512	1728	1945	2161	2377	2593
10	1	533	711	889	1067	1245	1422	1600	1778	1956	2134
11	1	447	596	745	894	1043	1192	1341	1491	1640	1789
12	1	381	508	634	761	888	1015	1142	1269	1396	1523
13	1	328	438	547	657	766	875	985	1094	1204	1313
14	1	286	382	477	572	668	763	859	954	1049	1145
15	1	252	336	420	504	588	672	756	840	924	1008
16	1	224	298	373	447	522	596	671	745	820	894
17	1	200	266	333	400	466	533	600	666	733	799
18	1	180	240	300	360	420	479	539	599	659	719
19	1	163	217	271	325	380	434	488	542	597	651
20	1	148	197	247	296	345	395	444	493	543	592
21	1	135	180	225	270	315	360	406	451	496	541
22	1	124	165	207	248	289	331	372	413	455	496
23	1	114	152	190	228	267	305	343	381	419	457
24	1	106	141	176	211	246	282	317	352	387	422
25	1	98	131	163	196	228	261	294	326	359	392
26	1	91	121	152	182	212	243	273	304	334	364
27	1	85	113	142	170	198	226	255	283	311	340
28	1	79	106	132	159	185	212	238	265	291	318
29	1	74	99	124	149	174	198	223	248	273	298
30	1	70	93	116	140	163	186	210	233	256	280
31	1	66	88	110	132	153	175	197	219	241	263
32	1	62	83	103	124	145	165	186	207	227	248
33	1	59	78	98	117	137	156	176	195	215	234
34	1	55	74	92	111	129	148	166	185	203	222
35	1	53	70	88	105	123	140	158	175	193	210
36	1	50	66	83	100	116	133	150	166	183	199
37	1	47	63	79	95	111	126	142	158	174	190
38	1	45	60	75	90	105	120	135	150	165	181
39	1	43	57	72	86	100	115	129	143	158	172
40	1	41	55	68	82	96	109	123	137	150	164
For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm											

Table B.3 — Allowable pipe length for ¾ inch IPS CPVC pipe

Sprinkler flow rate (gpm)	Water distribution size (inch)	Available pressure - P*t* (psi)									
		15	20	25	30	35	40	45	50	55	60
		Allowable length of pipe from service valve to farthest sprinkler (feet)									
8	¾	348	465	581	697	813	929	1045	1161	1278	1394
9	¾	280	374	467	560	654	747	841	934	1027	1121
10	¾	231	307	384	461	538	615	692	769	845	922
11	¾	193	258	322	387	451	515	580	644	709	773
12	¾	165	219	274	329	384	439	494	549	603	658
13	¾	142	189	237	284	331	378	426	473	520	568
14	¾	124	165	206	247	289	330	371	412	454	495
15	¾	109	145	182	218	254	290	327	363	399	436
16	¾	97	129	161	193	226	258	290	322	354	387
17	¾	86	115	144	173	202	230	259	288	317	346
18	¾	78	104	130	155	181	207	233	259	285	311
19	¾	70	94	117	141	164	188	211	234	258	281
20	¾	64	85	107	128	149	171	192	213	235	256
21	¾	58	78	97	117	136	156	175	195	214	234
22	¾	54	71	89	107	125	143	161	179	197	214
23	¾	49	66	82	99	115	132	148	165	181	198
24	¾	46	61	76	91	107	122	137	152	167	183

25	¾	42	56	71	85	99	113	127	141	155	169
26	¾	39	52	66	79	92	105	118	131	144	157
27	¾	37	49	61	73	86	98	110	122	135	147
28	¾	34	46	57	69	80	92	103	114	126	137
29	¾	32	43	54	64	75	86	96	107	118	129
30	¾	30	40	50	60	70	81	91	101	111	121
31	¾	28	38	47	57	66	76	85	95	104	114
32	¾	27	36	45	54	63	71	80	89	98	107
33	¾	25	34	42	51	59	68	76	84	93	101
34	¾	24	32	40	48	56	64	72	80	88	96
35	¾	23	30	38	45	53	61	68	76	83	91
36	¾	22	29	36	43	50	57	65	72	79	86
37	¾	20	27	34	41	48	55	61	68	75	82
38	¾	20	26	33	39	46	52	59	65	72	78
39	¾	19	25	31	37	43	50	56	62	68	74
40	¾	18	24	30	35	41	47	53	59	65	71
For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm											

Table B.4 — Allowable pipe length for 1 inch IPS CPVC pipe

Sprinkler flow rate (gpm)	Water distribution size (inch)	Available pressure - Pt (psi)									
		15	20	25	30	35	40	45	50	55	60
		Allowable length of pipe from service valve to farthest sprinkler (feet)									
8	1	1049	1398	1748	2098	2447	2797	3146	3496	3845	4195
9	1	843	1125	1406	1687	1968	2249	2530	2811	3093	3374
10	1	694	925	1157	1388	1619	1851	2082	2314	2545	2776
11	1	582	776	970	1164	1358	1552	1746	1940	2133	2327
12	1	495	660	826	991	1156	1321	1486	1651	1816	1981
13	1	427	570	712	854	997	1139	1281	1424	1566	1709
14	1	372	497	621	745	869	993	1117	1241	1366	1490
15	1	328	437	546	656	765	874	983	1093	1202	1311
16	1	291	388	485	582	679	776	873	970	1067	1164
17	1	260	347	433	520	607	693	780	867	954	1040
18	1	234	312	390	468	546	624	702	780	858	936
19	1	212	282	353	423	494	565	635	706	776	847
20	1	193	257	321	385	449	513	578	642	706	770
21	1	176	235	293	352	410	469	528	586	645	704
22	1	161	215	269	323	377	430	484	538	592	646
23	1	149	198	248	297	347	396	446	496	545	595
24	1	137	183	229	275	321	366	412	458	504	550
25	1	127	170	212	255	297	340	382	425	467	510
26	1	118	158	197	237	276	316	355	395	434	474
27	1	111	147	184	221	258	295	332	368	405	442
28	1	103	138	172	207	241	275	310	344	379	413
29	1	97	129	161	194	226	258	290	323	355	387
30	1	91	121	152	182	212	242	273	303	333	364
31	1	86	114	143	171	200	228	257	285	314	342
32	1	81	108	134	161	188	215	242	269	296	323
33	1	76	102	127	152	178	203	229	254	280	305
34	1	72	96	120	144	168	192	216	240	265	289
35	1	68	91	114	137	160	182	205	228	251	273
36	1	65	87	108	130	151	173	195	216	238	260
37	1	62	82	103	123	144	165	185	206	226	247
38	1	59	78	98	117	137	157	176	196	215	235
39	1	56	75	93	112	131	149	168	187	205	224
40	1	53	71	89	107	125	142	160	178	196	214
For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm											

Table B.5 — Allowable pipe length for ¾ inch PEX tubing*

SPRINKLER FLOW RATE (gpm)	WATER DISTRIBUTION SIZE (inch)	Available pressure - P_f (psi)									
		15	20	25	30	35	40	45	50	55	60
		ALLOWABLE LENGTH OF PIPE FROM SERVICE VALVE TO FARTHEST SPRINKLER (feet)									
8	¾	93	123	154	185	216	247	278	309	339	370
9	¾	74	99	124	149	174	199	223	248	273	298
10	¾	61	82	102	123	143	163	184	204	225	245
11	¾	51	68	86	103	120	137	154	171	188	205
12	¾	44	58	73	87	102	117	131	146	160	175
13	¾	38	50	63	75	88	101	113	126	138	151
14	¾	33	44	55	66	77	88	99	110	121	132
15	¾	29	39	48	58	68	77	87	96	106	116
16	¾	26	34	43	51	60	68	77	86	94	103
17	¾	23	31	38	46	54	61	69	77	84	92
18	¾	21	28	34	41	48	55	62	69	76	83
19	¾	19	25	31	37	44	50	56	62	69	75
20	¾	17	23	28	34	40	45	51	57	62	68
21	¾	16	21	26	31	36	41	47	52	57	62
22	¾	NP	19	24	28	33	38	43	47	52	57
23	¾	NP	17	22	26	31	35	39	44	48	52
24	¾	NP	16	20	24	28	32	36	40	44	49
25	¾	NP	NP	19	22	26	30	34	37	41	45
26	¾	NP	NP	17	21	24	28	31	35	38	42
27	¾	NP	NP	16	20	23	26	29	33	36	39
28	¾	NP	NP	15	18	21	24	27	30	33	36
29	¾	NP	NP	NP	17	20	23	26	28	31	34
30	¾	NP	NP	NP	16	19	21	24	27	29	32
31	¾	NP	NP	NP	15	18	20	23	25	28	30
32	¾	NP	NP	NP	NP	17	19	21	24	26	28
33	¾	NP	NP	NP	NP	16	18	20	22	25	27
34	¾	NP	NP	NP	NP	NP	17	19	21	23	25
35	¾	NP	NP	NP	NP	NP	16	18	20	22	24
36	¾	NP	NP	NP	NP	NP	15	17	19	21	23
37	¾	NP	NP	NP	NP	NP	NP	16	18	20	22
38	¾	NP	NP	NP	NP	NP	NP	16	17	19	21
39	¾	NP	NP	NP	NP	NP	NP	NP	16	18	20
40	¾	NP	NP	NP	NP	NP	NP	NP	16	17	19

For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm

* NP – Means not permitted.

Table B.6 — Allowable pipe length for 1 inch PEX tubing

Sprinkler flow rate (gpm)	Water distribution size (inch)	Available pressure - P_f (psi)									
		15	20	25	30	35	40	45	50	55	60
		Allowable length of pipe from service valve to farthest sprinkler (feet)									
8	1	314	418	523	628	732	837	941	1046	1151	1255
9	1	252	336	421	505	589	673	757	841	925	1009
10	1	208	277	346	415	485	554	623	692	761	831
11	1	174	232	290	348	406	464	522	580	638	696
12	1	148	198	247	296	346	395	445	494	543	593
13	1	128	170	213	256	298	341	383	426	469	511
14	1	111	149	186	223	260	297	334	371	409	446
15	1	98	131	163	196	229	262	294	327	360	392
16	1	87	116	145	174	203	232	261	290	319	348

17	1	78	104	130	156	182	208	233	259	285	311
18	1	70	93	117	140	163	187	210	233	257	280
19	1	63	84	106	127	148	169	190	211	232	253
20	1	58	77	96	115	134	154	173	192	211	230
21	1	53	70	88	105	123	140	158	175	193	211
22	1	48	64	80	97	113	129	145	161	177	193
23	1	44	59	74	89	104	119	133	148	163	178
24	1	41	55	69	82	96	110	123	137	151	164
25	1	38	51	64	76	89	102	114	127	140	152
26	1	35	47	59	71	83	95	106	118	130	142
27	1	33	44	55	66	77	88	99	110	121	132
28	1	31	41	52	62	72	82	93	103	113	124
29	1	29	39	48	58	68	77	87	97	106	116
30	1	27	36	45	54	63	73	82	91	100	109
31	1	26	34	43	51	60	68	77	85	94	102
32	1	24	32	40	48	56	64	72	80	89	97
33	1	23	30	38	46	53	61	68	76	84	91
34	1	22	29	36	43	50	58	65	72	79	86
35	1	20	27	34	41	48	55	61	68	75	82
36	1	19	26	32	39	45	52	58	65	71	78
37	1	18	25	31	37	43	49	55	62	68	74
38	1	18	23	29	35	41	47	53	59	64	70
39	1	17	22	28	33	39	45	50	56	61	67
40	1	16	21	27	32	37	43	48	53	59	64
For SI units: 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s, 1 inch = 25 mm, 1 foot = 304.8 mm											

Annex C
(normative)

Peak water demand calculator

C.1 General

This annex provides a method for estimating the demand load for the building water supply and principal branches for single- and multi-family dwellings with water-conserving plumbing fixtures, fixture fittings, and appliances.

C.2 Demand load

C.2.1 Water-conserving fixtures.

Plumbing fixtures, fixture fittings, and appliances shall not exceed the design flow rate in Table C.1.

Table C.1 — Design flow rate for water-conserving plumbing fixtures and appliances in residential occupancies

FIXTURE AND APPLIANCE	MAXIMUM DESIGN FLOW RATE (gallons per minute)
Bar Sink	1.5
Bathtub	5.5
Bidet	2.0
Clothes Washer*	3.5
Combination Bath/Shower	5.5
Dishwasher*	1.3
Kitchen Faucet	2.2
Laundry Faucet (with aerator)	2.0
Lavatory Faucet	1.5
Shower, per head	2.0
Water Closet, 1.28 GPF Gravity Tank	3.0
For SI units: 1 gallon per minute = 0.06 L/s * Clothes washers and dishwashers shall have an energy star label.	

C.3 Water demand calculator

The estimated design flow rate for the building supply and principal branches and risers shall be determined by the IAPMO Water Demand Calculator available for download at http://www.iapmo.org/WEStand/Pages/WaterDemandCalculator.aspx

C.3.1 Meter and building supply

To determine the design flow rate for the water meter and building supply, enter the total number of indoor plumbing fixtures and appliances for the building in Column [B] of the Water Demand Calculator and run Calculator. See Table C.3 for an example.

C.3.2 Fixture branches and fixture supplies

To determine the design flow rate for fixture branches and risers, enter the total number of plumbing fixtures and appliances for the fixture branch or riser in Column [B] of the Water Demand Calculator and run Calculator. The flow rate for one fixture branch and one fixture supply shall be the design flow rate of the fixture according to Table C.1.

C.3.3 Continuous supply demand

Continuous supply demands in gallons per minute (gpm) for lawn sprinklers, air conditioners, hose bibbs, etc., shall be added to the total estimated demand for the building supply as determined by Section C.3.1. Where there is more than one hose bibb installed on the plumbing system, the demand for only one hose bibb shall be added to the total estimated demand for the building supply. Where a hose bibb is installed on a fixture branch, the demand of the hose bibb shall be added to the design flow rate for the fixture branch as determined by C.3.2.

C.3.4 Other fixtures

Fixtures not included in Table C.1 shall be added in Rows 12 through 14 in the Water Demand Calculator as Other Fixture. The probability of use and flow rate for Other Fixtures shall be added by selecting the comparable probability of use and flow rate from Columns [C] and [E].

C.3.5 Size of water piping per Annex A

Except as provided in Section C.2 for estimating the demand load for single- and multi-family dwellings, the size of each water piping system shall be determined in accordance with the procedure set forth in Annex A. After determining the permissible friction loss per 100 feet (30 480 mm) of pipe in accordance with Section A.1 and the demand flow in accordance with the Water Demand Calculator, the diameter of the building supply pipe, branches and risers shall be obtained from Figure A.4(a) through Figure A.4(g), whichever is applicable, in accordance with Section A.1.

C.3.6 Minimum fixture branch size.

The minimum fixture branch size shall be 1/2 inch (15 mm) in diameter.

Table C.2 — Water demand calculator example

[A] FIXTURE		[B] ENTER NUMBER OF FIXTURES	[C] PROBABILITY OF USE (%)	[D] ENTER FIXTURE FLOW RATE (GPM)	[E] MAXIMUM RECOMMENDED FIXTURE FLOW RATE (GPM)
1	Bar Sink	0	2.0	1.5	1.5
2	Bathtub	0	1.0	5.5	5.5
3	Bidet	0	1.0	2.0	2.0

4	Clothes Washer	1	5.5	3.5	3.5
5	Combination Bath/Shower	1	5.5	5.5	5.5
6	Dishwasher	1	0.5	1.3	1.3
7	Kitchen Faucet	1	2.0	2.2	2.2
8	Laundry Faucet	0	2.0	2.0	2.0
9	Lavatory Faucet	1	2.0	1.5	1.5
10	Shower, per head	0	4.5	2.0	2.0
11	Water Closet, 1.28 GPF Gravity Tank	1	1.0	3.0	3.0
12	Other Fixture 1	0	0.0	0.0	6.0
13	Other Fixture 2	0	0.0	0.0	6.0
14	Other Fixture 3	0	0.0	0.0	6.0
Total Number of Fixtures		6		RESET	RUN WATER DEMAND CALCULATOR
99th Percentile Demand Flow =		8.5 GPM			
For SI units: 1 gallon per minute = 0.66 L/s, 1 gallon = 3.785 L					

C.3.7 Examples illustrating use of water demand calculator

Example 1: Indoor Water Use Only – Use the information given below to find the pipe size for the building supply to a res- idential building with six indoor fixtures as shown in Figure 1 [Pipe Section 4].

Given Information:

Type of construction:	Residential, one-bathroom	Friction loss per 100 ft (30 480 mm):	15 psi (103 kPa)
Type of pipe material:	L-copper	Maximum velocity:	10 ft/s (3.05 m/s)
Fixture number/type:	1 combination bath/shower 1 dishwasher	1 kitchen faucet 1 WC	1 lavatory faucet 1 clothes washer

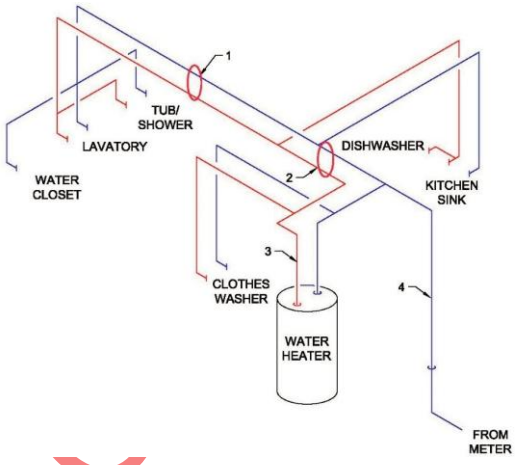


Figure C.1 — Residential building with six indoor fixtures

Solution: Step 1 of 2 – Find demand load for the building supply.

The Water Demand Calculator [WDC] in Figure 2 is used to determine the demand load expected from indoor water use. The WDC has white-shaded cells and light gray-shaded cells. The values in the light gray cells are derived from a national survey of indoor water use at homes with efficient fixtures and cannot be changed.

The white-shaded cells accept input from the designer. For instance, fixture counts from the given information are entered in Column [B]; the corresponding recommended fixture flow rates are already provided in Column [D]. The flow rates in Column [D] may be reduced only if the manufacturer specifies a lower flow rate for the fixture. Column [E] establishes the upper limits for the flow rates entered into Column [D]. Clicking the Run Water Demand Calculator button gives 8.5 gpm (0.54 L/s) as the estimated indoor water demand for the whole building. This result appears in the dark gray box of the WDC in Figure 2.

Table C.3 — Water demand calculator for indoor use at home with six efficient fixtures (example 1)

[A] FIXTURE		[B] ENTER NUMBER OF FIXTURES	[C] PROBABILITY OF USE (%)	[D] ENTER FIXTURE FLOW RATE (GPM)	[E] MAXIMUM RECOMMENDED FIX- TURE FLOW RATE (GPM)
1	Bar Sink	0	2.0	1.5	1.5
2	Bathtub	0	1.0	5.5	5.5
3	Bidet	0	1.0	2.0	2.0
4	Clothes Washer	1	5.5	3.5	3.5
5	Combination Bath/Shower	1	5.5	5.5	5.5
6	Dishwasher	1	0.5	1.3	1.3
7	Kitchen Faucet	1	2.0	2.2	2.2
8	Laundry Faucet	0	2.0	2.0	2.0
9	Lavatory Faucet	1	2.0	1.5	1.5
10	Shower, per head	0	4.5	2.0	2.0
11	Water Closet, 1.28 GPF Gravity Tank	1	1.0	3.0	3.0
12	Other Fixture 1	0	0.0	0.0	6.0
13	Other Fixture 2	0	0.0	0.0	6.0
14	Other Fixture 3	0	0.0	0.0	6.0
Total Number of Fixtures		6		RESET	RUN WATER DEMAND CALCULATOR
99th Percentile Demand Flow =		8.5 GPM			
For SI units: 1 gallon per minute = 0.66 L/s, 1 gallon = 3.785 L					

Solution: Step 2 of 2 – Determine the pipe size of the building supply.

Figure A.4(a) for copper piping systems (from Annex A, shown in Figure C.2) is used to determine the pipe size, based on given friction loss, given maximum allowable pipe velocity, given pipe material and the demand load computed in Step 1. In Figure 3, the intersection of the given friction loss (15 psi) (103 kPa) and the maximum allowable pipe velocity (10 ft/s) (3.05 m/s) is labeled point A. The vertical line that descends from point A to the base of the chart intersects four nominal sizes for L-copper pipe. These intersection points are labeled B, C, D, E and correspond to pipe sizes of 1 inch (25 mm), 3/4 inch (20 mm), 1/2 inch (15 mm) and 3/8 inch (10 mm), respectively. A horizontal line from points B, C, D, E to the right-hand side of the chart gives maximum flow rates of 24 gpm (1.5 L/s), 12 gpm (0.757 L/s), 4.5 gpm (0.28 L/s), and 2.3 gpm (0.145 L/s), respectively. These results are summarized in Table C.4 which shows that a 3/4 inch (20 mm) type L copper line is the minimum size that can convey the peak water demand of 8.5 gpm (0.54 L/s).

Table C.4 — Pipe size options for building supply

Point in figure 3	Pipe diameter (inch)	Maximum flow (gpm)	Ok for building supply*
E	⅜	2.3	No
D	½	4.5	No
C	¾	12	Yes
B	1	24	Yes
For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s * For Building in Examples 1, 2, 3, and 4.			

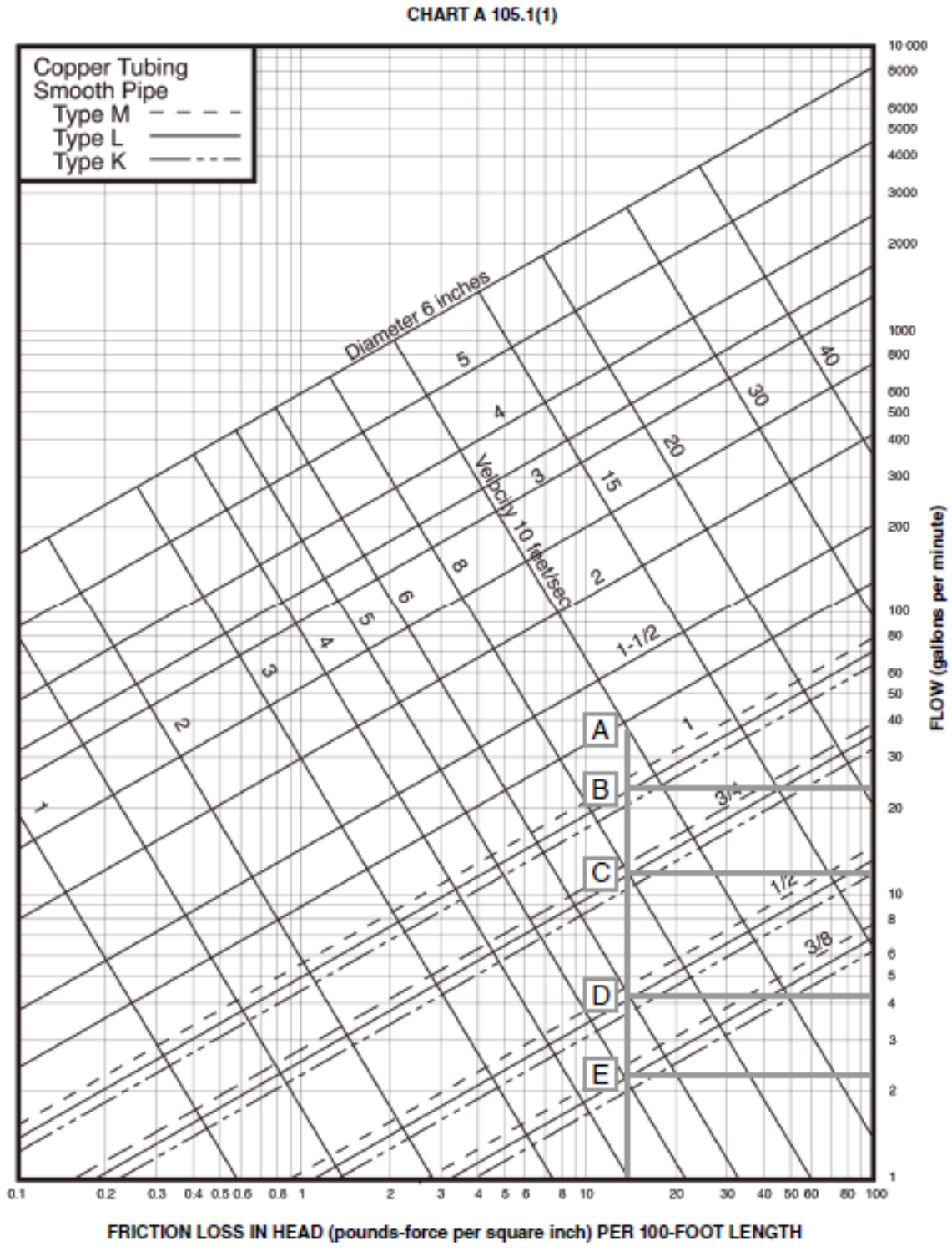


Figure C.2 — Chart A 105.1(1) for finding pipe size

For SI units 1 foot = 304.8 mm, 1 gallon per minutes = 0.06 L/s, 1 pound force per square inch = 6.8947 kPa

Example 2: Indoor and Outdoor Water Use – Find the pipe size for the building supply [Figure 1, Pipe Section 4] if the building in Example 1 adds two outdoor fixtures (hose bibb, each with a fixture flow of 2.0 gpm) (0.13 L/s).

Solution: Step 1 of 2 – Find demand load for the building supply.

The WDC has been developed exclusively for peak indoor water use which can be viewed as a high-frequency short duration process. Because fixtures for outdoor water use may operate continuously for very long periods, they are not included in the WDC. To account for water use from one or more outdoor fixtures, add the demand of the single outdoor fixture with the highest flowrate to the calculated demand for indoor water use. With two hose bibbs, the demand of only one hose bibb is included. Hence, in this example, the total demand for the whole house is 8.5 gpm (0.54 L/s) + 2.0 gpm (0.13 L/s) = 10.5 gpm (0.662 L/s).

Solution: Step 2 of 2 – Determine the pipe size of the building supply.

Table C.4 shows that at 10.5 gpm (0.662 L/s) the building supply shall be 3/4 inch (20 mm) in diameter.

Example 3: Indoor, Outdoor and Other Fixture Water Use – Find the pipe size for the water supply [Figure 1, Pipe Section 4] if the building in Example 2 adds a kitchen pot filler and a dog bath each with a faucet flow rate of 5.5 gpm (0.35 L/s).

Solution: Step 1 of 2 – Find demand load for the building supply.

The kitchen pot filler and dog bath are not listed in Column [A] of the WDC. To accommodate cases such as this, the WDC provides up to three additional rows for "Other Fixtures". Enter the kitchen pot filler and dog bath in Column [A] of the WDC and enter the fixture count for each in Column [B]. Find an indoor fixture that has a similar probability of use in Column [C] and add that to the column. Finally, enter the flow rate of the kitchen pot filler and dog bath in Column [D]. The estimated indoor water demand for the whole building is 11 gpm, as shown in the WDC in Figure 4. As illustrated in Example 2, the hose bibb will increase the total demand for the whole house to 13 gpm (0.820 L/s).

Note that a reset button is provided to clear any numbers in Column [B] from a previous calculation.

Solution: Step 2 of 2 – Determine the pipe size of the building supply.

Table C.4 shows that at 13 gpm (0.820 L/s) the building supply shall be 1inch (25 mm) in diameter.

Example 4: Sizing Branches and Risers – For individual hot and cold branches, repeat Steps 1 and 2. For example, for the hot water branch at the water heater [Figure 1, Pipe Section 3], enter all the fixtures and appliances that use hot water into the Water Demand Calculator (toilets will be excluded) as seen in Figure 5. Use the calculated demand load to find the pipe size in Step 2. Table C.4 shows that at 7.7 (0.49 L/s) gpm, the hot water branch shall be 3/4 inch (20 mm) in diameter.

For each additional hot and cold branch [Figure 1, Pipe Sections 1 and 2], enter the number of fixtures and appliances served by that branch into the WDC and use that demand in Step 2 to determine the branch size. If the branch serves a hose bibb, add the demand of the hose bibb to the calculated demand flow for the branch. As discussed in Example 2, the hose bibb is not to be entered into WDC, since the Calculator is for indoor uses only.

When there is only one fixture or appliance served by a fixture branch, the demand flow shall not exceed the fixture flow rate in Column [E] of the Water Demand Calculator. The fixture flow rate would be used in Step 2 to determine the size of the fixture branch and supply.

Table C.5 — Water demand calculator to accommodate other fixtures (example 3)

[A] FIXTURE		[B] ENTER NUMBER OF FIXTURES	[C] PROBABILITY OF USE (%)	[D] ENTER FIXTURE FLOW RATE (GPM)	[E] MAXIMUM RECOMMENDED FIX- TURE FLOW RATE (GPM)
1	Bar Sink	0	2.0	1.5	1.5
2	Bathtub	0	1.0	5.5	5.5
3	Bidet	0	1.0	2.0	2.0
4	Clothes Washer	1	5.5	3.5	3.5
5	Combination Bath/Shower	1	5.5	5.5	5.5
6	Dishwasher	1	0.5	1.3	1.3
7	Kitchen Faucet	1	2.0	2.2	2.2
8	Laundry Faucet	0	2.0	2.0	2.0
9	Lavatory Faucet	1	2.0	1.5	1.5
10	Shower, per head	0	4.5	2.0	2.0
11	Water Closet, 1.28 GPF Gravity Tank	1	1.0	3.0	3.0
12	Pot Filler	1	2.0	5.5	6.0
13	Dog Bath	1	1.0	5.5	6.0
14	Other Fixture 3	0	0.0	0.0	6.0
Total Number of Fixtures		8			RUN WATER DEMAND CALCULATOR
99th Percentile Demand Flow =		11.0 GPM		RESET	

For SI units: 1 gallon per minute = 0.66 L/s, 1 gallon = 3.785 L

Table C.6 — Water demand calculator for the hot water branch (example 4)

[A] FIXTURE		[B] ENTER NUMBER OF FIXTURES	[C] PROBABILITY OF USE (%)	[D] ENTER FIXTURE FLOW RATE (GPM)	[E] MAXIMUM RECOMMENDED FIX- TURE FLOW RATE (GPM)
1	Bar Sink	0	2.0	1.5	1.5
2	Bathtub	0	1.0	5.5	5.5
3	Bidet	0	1.0	2.0	2.0
4	Clothes Washer	1	5.5	3.5	3.5
5	Combination Bath/Shower	1	5.5	5.5	5.5
6	Dishwasher	1	0.5	1.3	1.3
7	Kitchen Faucet	1	2.0	2.2	2.2
8	Laundry Faucet	0	2.0	2.0	2.0
9	Lavatory Faucet	1	2.0	1.5	1.5
10	Shower, per head	0	4.5	2.0	2.0
11	Water Closet, 1.28 GPF Gravity Tank	0	1.0	3.0	3.0
12	Other Fixture 1	0	0.0	0.0	6.0
13	Other Fixture 2	0	0.0	0.0	6.0
14	Other Fixture 3	0	0.0	0.0	6.0

Total Number of Fixtures	5		RESET	RUN WATER DEMAND CALCULATOR
99th Percentile Demand Flow =	7.7 GPM			

For SI units: 1 gallon per minute = 0.66 L/s, 1 gallon = 3.785 L

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