Chapter 6: Water Resource Conservation, Quality and Efficiency

General Comments

Potable water is viewed by the U.S. government as a precious commodity. The U.S. Environmental Protection Agency's (EPA) Office of Drinking Water specifies the quality requirements for water to be classified as potable. Water quality requirements regarding allowable levels of contaminants are becoming increasingly restrictive. This chapter is intended to cover methods for reducing the amount of potable water used in buildings.

As potable water becomes less readily available, water utilities in some jurisdictions are providing reclaimed water service for their customers.

Reclaimed water is tertiary-treated waste water that has been sufficiently disinfected to be safe for exposure to humans, but it is not of drinking water quality. In the majority of areas where reclaimed water is in use, local regulations only allow the water to be used for outside irrigation demands.

The shortage and rising cost of potable water have inspired designers, water utilities and water conservation activists to investigate other sources of water for use inside and outside buildings. Gray water (that is, water discharged from bathtubs, showers, handwash sinks, clothes washers and laundry trays) is, once properly treated, a viable water source for flushing water closets and urinals and for a water supply to below-grade irrigation systems.

Purpose

Chapter 6 regulates the use of potable water to achieve the lowest possible water demand from potable water sources. This chapter also regulates the design of the hot water distribution system so that significant volumes of water are not wasted in order to get hot water to the user.

SECTION 601 (IgCC 701) GENERAL

601.1 (IgCC 701.1) Scope. The provisions of this chapter shall establish the means of conserving water, protecting water quality and providing for safe water consumption.

❖ This chapter focuses on conservation of potable water by reducing flow rates provided by fixtures and by use of nonpotable water where possible. The use of nonpotable water inside and on the grounds of buildings raises concerns about the safety of water that humans might come in contact with. The regulations in this chapter cover identification of piping systems that convey nonpotable water.

601.2 (IgCC 701.2) Water usage metering required. Water consumed from any source associated with the building or building site shall be metered. Each potable and reclaimed source of water, and each onsite nonpotable water source, shall be metered separately. Meters shall be installed in accordance with the requirements of the *International Plumbing Code*. For the purposes of Section 601.2.1 (IgCC 701.2.1), each meter identified in Table 601.2.1 (IgCC Table 701.2.1) shall be capable of communicating water consumption data remotely and at a minimum, be capable of providing daily data with electronic data storage and reporting capability that can produce reports that show daily, monthly, and annual water consumption.

Exception: Fire sprinkler systems installed in accordance with Section (IFC 903.3) shall not be required to be metered.

❖ Every water source must have a meter installed to provide water usage information. This information is valuable in determining how much water is being drawn from the water source so that abnormal conditions can be identified and corrected to prevent water waste. For example, if the water distribution piping developed a leak or a fixture such as a water closet was leaking, the system could require the addition of makeup water that must be paid for. No matter what type of water is being used, conservation is necessary. The meters required at each source are not required to have any special capabilities like the meters required for the applications indicated in Table 601.2.1.

This section requires that meters be installed in accordance with the *International Plumbing Code*® (IPC®). The IPC does not currently have any specific requirements concerning meter installation; however, all requirements for labeling (such as for nonpotable water piping), piping materials and piping connections apply.

In addition to the meter required at the source of water, Table 601.2.1 indicates specific applications where other meters are required to be installed. The meters for these applications must have special capabilities for data storage and data reporting as indicated in the section.

The exception recognizes that water, potable or nonpotable, used for a fire sprinkler system doesn't need to be metered. A fire event where sprinklers would discharge is extremely rare and safety overrides the need for measuring the amount of water used in such event. Including a meter in the fire sprinkler water system adds friction loss that would have to be considered in the design of the entire sprinkler system.

601.2.1 (IgCC 701.2.1) Individual metering required. All potable and nonpotable water supplied to the applications listed in Table 601.2.1 (IgCC Table 701.2.1) shall be individually metered in accordance with the requirements indicated in Table 601.2.1 (IgCC Table 701.2.1). Similar appliances and equipment shall be permitted to be grouped and supplied from piping connected to a single meter.

Exception: In Group I-2 occupancies and ambulatory care facilities, water used for patient treatment or to support patient care shall not be required to be individually metered.

❖ Table 601.2.1 indicates specific water use applications where meters are required to be installed. Note that Section 601.1 has requirements for meters used for these applications. This section allows for a single meter to serve numerous similar appliances and equipment. For example, a group of evaporative coolers for a building could be served by a single meter.

Table 601.2.1 indicates applications where the water supply to the application must be metered. Note that not every application requires metering. Some applications have a threshold value in the second column that indicates what size of equipment or level of water use requires metering.

The exception is an allowance for not metering water used for patient care or for supporting patient care in ambulatory care facilities and in Group I-2 occupancies. The *International Building Code*® (IBC®) indicates that Group I-2 occupancies include foster care facilities, detoxification facilities, hospitals, nursing homes and psychiatric hospitals. This list is not a complete list of I-2 facilities. The architect/design professional must be consulted to determine if the facility is a Group I-2 occupancy. Water systems are directly tied to the environment of care. The complexity of healthcare systems is such that individual metering of the indicated systems is impractical. Systems, such as water features and therapy pools that are used for patient treatment, make up only a small fraction of the overall water consumption for the facilities. Knowing the water consumption by installing meters provides minimal benefit for controlling water usage.

TABLE 601.2.1 (IgCC TABLE 701.2.1)
METERING REQUIREMENTS

APPLICATION	REQUIREMENTS
Irrigation	Irrigation systems that are automatically controlled shall be metered.
Tenant spaces	Tenant spaces that are estimated to consume over 1000 gallons of water per day shall be metered individually.
Onsite water collection systems	The makeup water lines supplying onsite water collection systems shall be metered.
Ornamental water features	Ornamental water features with a permanently installed water supply shall be required to utilize a meter on makeup water supply lines.
Pools and in-ground spas	Indoor and outdoor pools and in-ground spas shall be required to utilize a meter on makeup water supply lines.
Open and closed circuit cooling towers	Cooling towers with a flow through a tower greater than 500 gallons per minute shall be required to utilize a meter on makeup water and blow-down water supply lines.
Steam boilers	The makeup water supply line to steam boilers anticipated to draw more than 100,000 gallons annually or having a rating of 500,000 Btu/h or greater shall be metered.
Industrial processes	Industrial processes consuming more than 1,000 gallons per day on average shall be metered individually.
Evaporative coolers	Evaporative coolers supplying in excess of 0.6 gallons per minute, on average, makeup water shall be metered.
Fluid coolers and chillers	Water-cooled fluid coolers and chillers that do not utilize closed-loop recirculation shall be metered.
Makeup water for closed loop systems such as chilled water and hydronic systems	Makeup water supplying systems of 50 tons of cooling capacity or 500,000 Btu/h of heating capacity shall be metered.
Roof spray systems	Roof spray systems for irrigating vegetated roofs or thermal conditioning shall be metered.

For SI: 1 gallon = 3.8 L, 1 gallon per minute = 3.8 Lpm, 1 ton = 12,000 Btu, 1 British thermal unit per hour = 0.00029 kWh.

SECTION 602 (IgCC 702)
FIXTURES, FITTINGS, EQUIPMENT AND APPLIANCES

602.1 (IgCC 702.1) Fitting and fixture consumption. Fixtures shall comply with Table 602.1 (IgCC Table 702.1) and the following:

1. For dwelling unit and guestroom shower compartments with a floor area of not greater than 2600 in^2 (1.7 m^2), the combined flow rate from shower water outlets that are capable of operating simultaneously including rain systems, waterfalls, body sprays and jets shall not exceed 2.0 gallons per minute (gpm) (7.6 L/min). Where the floor area of such shower compartments is greater than 2600 in^2 (1.7 m^2), the combined flow rate from simultaneously operating shower water outlets shall not exceed 2.0 gpm (7.6 L/min) for each additional 2600 in^2 (1.7 m^2) of floor area or portion thereof.
2. In gang shower rooms, the combined flow rate from shower water outlets that are capable of operating simultaneously, including rain systems, waterfalls, body sprays and jets, shall not exceed 2.0 gpm (7.6 L/min) for every 1600 in^2 (1.01 m^2) or portion thereof of room floor area.
3. In shower compartments required to comply with the requirements of Chapter (IBC Chapter 11), the combined flow rate from shower water outlets that are capable of operating simultaneously, including rain systems, waterfalls, body sprays and jets, shall not exceed 4.0 gpm (15.1 L/min) for every 2600 in^2 (1.7 m^2) or portion thereof of room floor area.

❖ Table 602.1 lists the maximum allowable flow rates and flush volumes for various plumbing fixtures. Some of the flow rates/flush volumes in this table are less than the maximum allowed by the IPC, refer to IPC Table 604.4. More information about flow rates/flush volumes can be found in the commentary to Table 602.1.

This section also addresses the maximum number of showerheads in shower compartments. Luxury shower compartments often have numerous showerheads (such as hand showers, rainfall panels and body jets) that can operate simultaneously. Such showers operated with multiple outlets flowing can use a considerable volume of water in a short period of time. Item 1 limits the flow rate by the size of the shower compartment. Item 2 covers gang showers in a similar manner. Item 3 offers a slightly greater flow rate for shower compartments that are required to be accessible in accordance with Chapter 11 of the IBC.

TABLE 602.1 (IgCC TABLE 702.1)
MAXIMUM FIXTURE AND FITTING FLOW RATES FOR REDUCED WATER CONSUMPTION[f, g]

FIXTURE OR FIXTURE FITTING TYPE	MAXIMUM FLOW RATE
Showerhead[a]	2.0 gpm at 80 psi and WaterSense labeled
Lavatory faucet and bar sink—private	1.5 gpm at 60 psi
Lavatory faucet—public (metered)	0.25 gpc[b]
Lavatory faucet—public (nonmetered)	0.5 gpm at 60 psi
Kitchen faucet—private	1.8 gpm at 60 psi
Kitchen and bar sink faucets in other than dwelling units and guestrooms	2.2 gpm at 60 psi
Urinal	0.5 gpf and WaterSense labeled or nonwater urinal
Water closet—public and remote[c]	1.6 gpf
Water closet—public and nonremote	1.28 gpf average[d, e]
Water closet—tank type, private	1.28 gpf and WaterSense labeled[d]
Water closet—flushometer type, private	1.28 gpf[e]
Prerinse spray valves	1.3 gpm and WaterSense labeled
Drinking fountains (manual)	0.7 gpm
Drinking fountains (metered)	0.25 gpc[b]

For SI: 1 foot = 304.8 mm, 1 gallon per cycle (gpc) = 3.8 Lpc, 1 gallon per flush (gpf) = 3.8 Lpf, 1 gallon per minute (gpm) = 3.8 Lpm, 1 pound per square inch = 6.895 kPa.

a. Includes hand showers, body sprays, rainfall panels and jets. Showerheads shall be supplied by automatic compensating valves that comply with ASSE 1016/ASME A112.1016/CSA B125.16 and that are specifically designed to function at the flow rate of the showerheads being used.
b. Gallons per cycle of water volume discharged from each activation of a metered faucet.
c. A remote water closet is a water closet located not less than 30 feet upstream of other drain line connections or fixtures and is located where less than 1.5 drainage fixture units are upstream of the drain line connection.
d. The effective flush volume for a dual-flush water closet is defined as the composite, average flush volume of two reduced flushes and one full flush.
e. In public settings, the maximum water use of a dual flush water closet is based solely on its full flush operation; not an average of full and reduced volume flushes.
f. Water dispensers associated with drinking fountains shall not have limitations for flow rate.
g. Where a faucet has a pot filler mode, the flow shall not exceed 22 gpm at 60 psi. Such faucets shall automatically return to the flow rate indicated in the table when the pot filler mode activation mechanism is released or when the faucet flow is turned off.

❖ Showerheads include hand showers, body sprays, rainfall panels and jets. The maximum allowable flow rate indicated is ensured by the requirement that the showerhead be WaterSense® labeled. The WaterSense program was developed by the EPA to support the protection of natural resources. Products that are required to be WaterSense labeled must meet stringent criteria for water efficiency, with such efficiency certified by a third-party agency. In other words, showerhead product manufacturers cannot simply state the maximum flow rate of 2.0 gpm is not exceeded; the

product must also be tested to prove that fact. The requirement for WaterSense labeling of prerinse spray valves ensures that designs comply with the flow rate maximum for those products.

Note a requires that showerheads must be supplied by automatic compensating mixing valves that comply with ASSE 1016/ASME A112.1016/CSA B125.16. An automatic compensating mixing valve is a valve that maintains the user-set shower water temperature within a narrow range independent of pressure changes that could occur in the supply piping to the mixing valve. This requirement is the same as what has been required by the IPC for many editions. However, the last part of the note deserves special attention in that the mixing valve must be designed to operate at the flow rate of the showerhead that is connected to the outlet of the mixing valve.

The table uses the terms "private" and "public," which are not defined in Chapter 2. These terms are defined in the IPC. "Private" applies to plumbing fixtures in residences, apartments, sleeping rooms of hotel/motels and where plumbing fixtures are intended for utilization by a family or an individual that "lives" in the dwelling unit. Although the IPC provides a definition for "Public" fixtures, it generally suffices to consider applications that are not private as public.

A "metered" fixture or fixture fitting is one where the total volume of discharge is limited for each operational cycle. A "nonmetered" fixture or fixture fitting is where the flow rate continues for as long as the user needs the flow.

The maximum flow rate for the urinal entry in the table is for a water-supplied urinal flushometer valve. The flushometer valve, and not the urinal itself, must be WaterSense labeled to ensure that the design does not use an amount greater than the maximum amount of water per flush.

The table entry for "Water closet—public and remote" addresses a potential problem resulting from the reduction of the amount of water being discharged to the plumbing drainage piping. The problem has been labeled "dry drains." In drainage flows where there are solids to be transported by water in the drainage system, the reduction of flushing water has raised concerns in the plumbing design community about whether there is enough water in the waste flow to carry the solids along horizontal piping completely through to their intended destination. Many other factors are contributors to the dry drain problem, such as drain piping slope, the size of the drain and the lack of discharges from other water-supplied fixtures that are upstream of the solids-discharging fixture. Note c explains what constitutes a remote water closet and requires that the flush volume for such water closets be not greater than a maximum of 1.6 gallons per flush (gpf) as opposed to the lower maximum of 1.28 gpf. The code is not requiring that 1.6 gpf water closets be installed for the "remote" applications but only allows that maximum quantity be used if the designer or installer believes the extra flush volume is necessary in that application. Water closets having 1.28 gpf could be used in such applications.

The IPC defines a water dispenser as a plumbing fixture that is for the purpose of dispensing potable water into a cup, glass or bottle. Note f concerns water dispensers that are "associated" with drinking fountains. The "association" means that the drinking fountain supplies water to the water dispenser. Because a container is being filled, there is no need to limit the volume of water dispensed.

Note g concerns kitchen faucets used in private applications, that is, in kitchens of dwelling units. An overwhelming number of uses for kitchen faucets are for practices other than filling pots. Hands and vegetables are washed, utensils are rinsed and some water is needed to operate food waste disposers. For these uses, a reduction of flow from 2.2 gallons per minute (gpm) to 1.8 gpm is rarely an issue. However, when a pot needs to be filled, the flow reduction is noticeable. Therefore, a temporary override to provide greater water flow (2.2 gpm) is needed for this purpose.

602.2 (IgCC 702.2) Combination tub and shower valves. Tub spout leakage from combination tub and shower valves that occurs when the outlet flow is diverted to the shower shall not exceed 0.1 gpm, measured in accordance with the requirements of ASME A112.18.1/CSA B125.1.

❖ This section limits the amount of leakage from tub spouts that are in the diverting mode to cause water flow to the showerhead. Water that isn't flowing to the showerhead is simply wasted without benefit to the shower user.

602.3 (IgCC 702.3) Food establishment prerinse spray valves. Food establishment prerinse spray valves shall have a maximum flow rate in accordance with Table 602.1 (IgCC Table 702.1) and shall shut off automatically when released.

❖ A prerinse spray valve is used to wash leftover food off of trays, plates and pans. During peak dining periods, such prerinse valves are in use almost constantly and thus the flow rate of water needs to be limited in accordance with Table 602.1. Furthermore, prerinse valves must shut off automatically when released by the user so that water is not wasted when the prerinse is not being used to spray items. A common design feature for older prerinse valves was to include a ring or a latch on the handle so that the user would not have to constantly squeeze the handle during use. Such "hold open" features waste considerable volumes of water.

602.4 (IgCC 702.4) Drinking fountain controls. Drinking fountains equipped with manually controlled valves shall shut off automatically upon release of the valve. Metered drinking fountains shall comply with the flow volume specified in Table 602.1 (IgCC Table 702.1).

❖ The section requires that drinking fountains be either manually or automatically controlled so that water waste is kept to a minimum. It is no longer acceptable

to provide drinking fountains that constantly flow water such as was a common practice many years ago in order to always be a source of cool drinking water.

602.5 (IgCC 702.5) Appliances. Sections 602.5.1 (IgCC 702.5.1) through 602.5.4 (IgCC 702.5.4) shall regulate appliances that are not related to space conditioning.

❖ This section covers appliances that are not space conditioning appliances. Space conditioning appliances are furnaces and air conditioning units. The referenced sections cover clothes washers, icemakers, steam cookers and dishwashers.

602.5.1 (IgCC 702.5.1) Clothes washers. Clothes washers of the type in the ENERGY STAR program as defined in "ENERGY STAR® Program Requirements, Product Specification for Clothes Washers, Eligibility Criteria," shall have a water factor (WF) not exceeding 6.0 and a *modified energy factor* (MEF) of not less than 2.0.

❖ This section regulates how much water and energy clothes washers can use. The definitions of "Water factor" and "Modified energy factor" in Chapter 2 contain equations that are used to compute the factors for a particular machine. ENERGY STAR is a joint program of the EPA and the U. S. Department of Energy (DOE), which was developed to protect the environment through energy efficient products and practices.

602.5.2 (IgCC 702.5.2) Ice makers. Ice makers shall not be water cooled. Ice makers producing cubed-type ice shall be ENERGY STAR qualified as commercial ice machines. Ice makers of a type not currently ENERGY STAR qualified, such as flake, nugget or continuous-type ice makers, shall not exceed the total water use of 25 gallons per 100 pounds (94 L per 45 kg) of ice produced.

❖ This section prohibits water-cooled ice makers, as most of these types of machines use a "once through" water cooling system. The water takes away the heat from the ice-making plates and is discharged down the drain. Such systems use less electricity than air-cooled systems and have the additional advantage of carrying the absorbed heat away from the room containing the ice-making machine. The overall cost to operate such machines is higher than an air-cooled machine because of the significant quantities of potable water that are wasted and paid for in high water utility bills and the resulting sewage disposal costs.

Machines that produce cubed-type ice are required to be ENERGY STAR qualified as commercial ice machines. ENERGY STAR qualified means that the machine has been tested to verify that the energy and water consumptions per hundred pounds of ice produced do not exceed ENERGY STAR limitations. At the time the code was developed, the ENERGY STAR program for ice makers had not finalized limitations for other types of ice makers, such as the flake, nugget and continuous types. The code regulates water use for those types of machines.

602.5.3 (IgCC 702.5.3) Steam cookers. Steam cookers shall consume not more than the amounts indicated in Table 503.1 (IgCC Table 609.2.3).

❖ Steam cookers are water use-intensive appliances. Many steamer designs have a separate boiler or steam generator that produces steam for the cooking compartment. Steam from the boiler is circulated around the pans of food. Excess steam is condensed by a stream of cool water that is directed to the building drainage system. Another type of steamer is the connectionless type that does not drain condensed steam and cooling water to the drainage system. In this type of steam cooker, steam is generated in a reservoir at the bottom of the cooking compartment. Water is added manually, as needed. Any remaining water after daily operations is manually drained and disposed of to the drainage system.

This section directs the code user to Table 503.1 for water use limitations for steam cookers. The table limits water use to 5 gallons per hour per pan for cookers with a drain connection and to 2 gallons per hour per pan for cookers without a drain connection.

602.5.4 (IgCC 702.5.4) Dishwashers. Dishwashers shall be ENERGY STAR qualified where an ENERGY STAR category exists for the specific dishwasher type. Where an ENERGY STAR category does not exist, the dishwasher shall be in accordance with Table 602.5.4 (IgCC 702.5.4).

❖ Most types of dishwashing machines are covered by the ENERGY STAR qualification program. ENERGY STAR qualified means that the machine has been tested to verify that the energy and water consumptions do not exceed ENERGY STAR limitations. The code regulates the water use for those types of machines that the ENERGY STAR program does not cover in Table 602.5.4.

TABLE 602.5.4 (IgCC TABLE 702.5.4)
MAXIMUM WATER CONSUMPTION
FOR COMMERCIAL DISHWASHERS

DISHWASHER TYPE	MAXIMUM WATER CONSUMPTION
Rackless conveyor	2.2 gallons per minute
Utensil washer	2.2 gallons per rack

For SI: 1 gallon = 3.785 L, 1 gallon per minute = 3.785 Lpm.

602.6 (IgCC 702.6) Municipal reclaimed water. Where required by Table 302.1 (IgCC Table 302.1) and where municipal reclaimed water is accessible and allowed for such use by the laws, rules and ordinances applicable in the jurisdiction, it shall be supplied to water closets, water-supplied urinals, water-supplied trap primers and applicable industrial uses. A municipal reclaimed water supply shall be deemed accessible where the supply is not greater that 150 percent of the distance that the potable water supply is from the lot boundary or the supply is within 100 feet (30.5 m) of a potable water supply that serves the lot.

❖ If the jurisdiction indicates in Table 302.1 that municipal reclaimed water is to be utilized, if municipal reclaimed water is accessible, and if the laws, rules

and ordinances of the jurisdiction allow use of municipal reclaimed water within buildings, this section requires that municipal reclaimed water be supplied to water closets, water-supplied urinals, water-supplied trap primers and applicable industrial uses (such as for cooling water). The source of municipal reclaimed water must be within a specified proximity of the building lot boundary before it can be considered accessible. This proximity is based on the distance that the potable water source is to the building lot line. The municipal reclaimed water source must be within 150 percent of the distance that the potable water source is to the building lot boundary or within 100 feet (30.5 m) of the potable water source that serves the building lot. The following examples clarify the code's requirement.

Example 1: The municipal reclaimed water source is 75 feet (22.9 m) east of the potable water source (a pipeline) that serves the building lot. The potable water source (a pipeline) is 300 feet (91.4 m) east of the building lot boundary. Because the municipal reclaimed water source is within 100 feet (30.5 m) of the potable water source that serves the building lot, a municipal reclaimed water line must be installed to the building.

Example 2: The potable water source is 50 feet west of the western boundary of a building lot. The municipal reclaimed waterline is 70 feet (21.3 m) east of the eastern boundary of a building lot. Because the municipal reclaimed water source is within 150 percent of 50 feet (15.2 m) [which is 75 feet (22.9 m)], a municipal reclaimed waterline must be installed to the building.

602.7 (IgCC 702.7) Hot and tempered water distribution. Water supply piping shall be in accordance with Section 602.7.1 (IgCC 702.7.1) or Section 602.7.2 (IgCC 702.7.2). The flow rate through $^{1}/_{4}$-inch (6.4 mm) tubing shall not exceed 0.5 gpm (1.9 Lpm). The flow rate through $^{5}/_{16}$-inch (7.9 mm) tubing shall not exceed 1 gpm (3.8 Lpm). The flow rate through $^{3}/_{8}$-inch (9.5 mm) tubing shall not exceed 1.5 gpm (5.7 Lpm).

❖ A significant amount of water is wasted in almost every type of building where cold and then warmer water must flow for a period of time before hot or tempered water finally arrives at a water outlet, such as a faucet. In simple terms, this problem of water waste can be alleviated by either placing the hot water source very close to the fixture or minimizing the total volume of water contained in the piping between the hot water source and the outlet.

This section directs the reader to use either the method in Section 602.7.1 (the “volume” method) or Section 602.7.2 (the “length” method) for designing the hot or tempered water systems. Both methods are based on limiting the volume of water between the hot water source and the fixture. As using the “volume” method can be tedious, the “length” method is simpler to achieve the desired outcome. The commentaries for those sections discuss which fixtures are required to have the hot or tempered water supply piping designed in methods indicated.

602.7.1 (IgCC 702.7.1) Maximum allowable pipe length method. The maximum allowable pipe length from the source of hot or tempered water to the termination of the fixture supply pipe shall be in accordance with the maximum pipe length columns in Tables 602.7.2(2) [IgCC Table 702.7.2(2)] through 602.7.2(10) [IgCC Table 702.7.2(10)], as appropriate for the type of pipe to be installed. Where the type of pipe to be installed is unknown or the type of pipe is not covered by Tables 602.7.2(2) [IgCC Table 702.7.2(2)] through 602.7.2(10) [IgCC Table 702.7.2(10)], Table 602.7.2(1) [IgCC Table 702.7.2(1)] shall be used for design purposes. Where the length contains more than one size of pipe, the largest size shall be used for determining the maximum allowable length of the pipe in the tables.

❖ This section indicates that the termination point for calculating the length of hot and tempered water piping is the end of the fixture supply pipe. The IPC defines “fixture supply” as the piping leading to a plumbing fixture. According to the IPC, this pipe ends at the point where, a reduced diameter “connector” is used to connect from the end of the fixture supply pipe to the faucet on the fixture. For example, in most cases, a fixture stop valve is installed on the end of a fixture supply pipe, on the back wall (or cabinet bottom) beneath a lavatory or kitchen sink. The IPC limits the length of these small diameter connectors to 30 inches. Could a fixture supply pipe exit the wall and, without terminating at a stop valve, continue onward to connect directly to the faucet (such as a central manifold plumbing system would allow)? Yes. Would this mean that the end of the fixture supply pipe is at the faucet? The code does not offer an answer for this arrangement or other arrangements where fixture supply piping connects directly to a faucet, such as a combination tub-shower valve.

This section is not specific as to which fixtures having hot or tempered water connected to them are required to have supply piping systems designed in the prescribed manner. The only conclusion is that this section applies to all fixtures. Does this section apply to plumbing appliances that use hot water such as dishwashers? The proposal (GEW159-14) indicated that the intent was to coordinate with the requirements approved for the 2015 *International Energy Conservation Code*® (IECC®). The coordinating IECC sections do include plumbing appliances; however, this code is not as specific.

This section directs the code user to Tables 602.7.2(1) through 602.7.2(10) and the Maximum Pipe or Tube Length columns (table columns 3, 4 and 5). Table column 3 is for hot or tempered water distribution systems that do not have a hot or tempered water circulation loop or hot or tempered water piping that has heat tracing installed for the purposes of keeping the water in the piping at the same temperature as was delivered by the hot or tempered water source. In other words, the heat tracing is not for the sole purpose of preventing freezing of the pipe contents. For example,

if the piping from the hot (or tempered) water source is $^3/_4$-inch nominal size, the maximum length of piping is 21 feet (6.4 m). If the piping between the hot or tempered water source consists of some length of $^3/_4$-inch piping and some piping that is smaller in diameter, then the maximum length limitation is as if the entire length of piping was $^3/_4$ inch.

602.7.2 (IgCC 702.7.2) Maximum allowable pipe volume method. The water volume in the piping shall be calculated in accordance with Section 602.7.2.1 (IgCC 702.7.2.1). The maximum volume of hot or tempered water in the piping to public lavatory faucets, metering or nonmetering, shall be 2 ounces (0.06 L). For fixtures other than public lavatory faucets, the maximum volume shall be 64 ounces (1.89 L) for hot or tempered water from a water heater or boiler; and 24 ounces (0.7 L) for hot or tempered water from a circulation loop pipe or an electrically heat-traced pipe. The water volume in the piping shall be calculated in accordance with Section 602.7.2.1 (IgCC 702.7.2.1).

❖ This section covers the "volume" method for sizing piping and components in the hot or tempered water system to fixtures. For public lavatories, the maximum volume in this piping is only 2 ounces. The IPC limits the flow rate for public lavatories to 0.5 gallons per minute (gpm). A small volume between the hot water source and the end of the fixture supply pipe is necessary to actually deliver water of a tempered temperature in the relatively short time that most people are willing to wait at the fixture.

For fixtures other than public lavatory faucets, the allowable volume is greater, depending on the source of the hot or tempered water. Where a water heater (or boiler) is the source, the maximum volume is 64 ounces to allow for reasonable flexibility in locating water heaters near the fixtures. There could be other closer fixtures drawing water from the water heater such that the hot water is moved closer to the farthest fixture, resulting in less waste of water to have hot water arrive at the fixture. Where the water source is water piping with a constant supply of water at the required temperature for delivery (from a circulation loop pipe or an electrically heat-traced pipe), the maximum volume is less because this source (the piping) can be routed relatively close to the fixtures. And generally, the fixture supply pipes are individually "taken off" from these sources such that no other fixtures are drawing off hot water from those pipes to move hot water closer to the farthest fixture.

Volumes between the hot water source and the end of the fixture supply pipe are determined in accordance with Section 602.7.2.1, which requires that the second column of Tables 602.7.2(2) through 602.7.2(10) or Table 602.7.2(1) be used to determine pipe volumes (see the commentary to Section 602.7.2.1 for additional information on volume determination).

If the type of piping to be installed is known at the time of piping system design, Tables 602.7.2(2) through 602.7.2(10) can be used to more accurately determine the allowable lengths of that type of piping; however, sometimes the type of piping that will be used is not yet determined at the time of piping design. Table 602.7.2(1) can be used to cover all types of piping that might be used. When the type of piping that will be used is known, there is no need to redesign the system using Tables 602.7.2(2) through 602.7.2(10). The original use of Table 602.7.2(1) for the design covers all types.

Note that the tables do not consider pressure losses (friction losses) for a piping system designed using these volume limits. The piping system designer will need to verify that the selected piping sizes and lengths will result in ample flow pressure for proper operation of the fixtures. Section 604.3 and Table 604.3 of the IPC indicate the required flow and pressure for various fixtures. Notes in the tables indicate a maximum flow rate for certain small sizes of tubing. Friction loss (pressure loss) for small sizes of tubing can be significant even at relatively low flow rates. These table notes are general limitations to prevent designers from thinking that these smaller tube sizes could be used for all applications to provide for greater flexibility in designs.

602.7.2.1 (IgCC 702.7.2.1) Water volume determination. The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the source of hot water and the termination of the fixture supply pipe. The volume shall be determined from the liquid ounces per foot column of Tables 602.7.2(2) [IgCC Table 702.7.2(2)] through 602.7.2(10) [IgCC Table 702.7.2(10)] as appropriate for the type of pipe. Where the type of pipe is unknown or the type of pipe is not covered by Tables 602.7.2(2) [IgCC Table 702.7.2(2)] through 602.7.2(10) [IgCC Table 702.7.2(10)], Table 602.7.2(1) [IgCC Table 702.7.2(1)] shall be used to determine the volume. The volume contained within fixture shutoff valves, flexible water supply connectors to a fixture fitting, or within a fixture fitting shall not be included in the water volume determination. Where hot or tempered water is supplied by a circulation loop pipe or an electrically heat-traced pipe, the volume shall include the portion of the fitting on the source pipe that supplies water to the fixture.

❖ This section specifies what volumes are to be included in the calculation of internal volume required by Section 602.7.2. The volume calculation must include pipe, fittings, valves, meters and manifolds in the flow path from the source of hot water supply to the end of the fixture supply pipe. Note that the end of the fixture supply pipe is where the fixture shutoff valve connects to the pipe. The volume of the fixture shutoff valve, the volume of the flexible supply tubing from the shutoff valve to the fixture fitting, and the volume of the fixture fitting are not to be included in the volume calculation. The volume in pipe must be determined from column two of Tables 602.7.2(2) through 602.7.2(10). The volumes of components other than pipe can be obtained from the manufacturers of those components.

TABLE 602.7.2(1) [IgCC TABLE 702.7.2(1)]
VOLUME AND MAXIMUM LENGTH OF PIPE OR TUBE OF A TYPE UNKNOWN OR NOT COVERED[b]

NOMINAL PIPE OR TUBE SIZE (inch)	LIQUID OUNCES PER FOOT OF LENGTH	MAXIMUM PIPE OR TUBE LENGTH		
		System without a circulation loop or heat-traced line (feet)	System with a circulation loop or heat-traced line (feet)	Lavatory faucets – public (metering and nonmetering) (feet)
1/4[a]	0.33	50	16	6
5/16[a]	0.5	50	16	4
3/8[a]	0.75	50	16	3
1/2	1.5	43	16	2
5/8	2	32	12	1
3/4	3	21	8	0.5
7/8	4	16	6	0.5
1	5	13	5	0.5
1 1/4	8	8	3	0.5
1 1/2	11	6	2	0.5
2 or larger	18	4	1	0.5

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m, 1 ounce = 29.6 ml.
a. The flow rate for 1/4-inch size pipe or tube is limited to 0.5 gallons per minute; for 5/16-inch size, it is limited to 1 gpm; for 3/8-inch size, it is limited to 1.5 gpm.
b. Not covered means pipe or tube types not covered by Tables 602.7.2(2) [IgCC Table 702.7.2(2)] through 602.7.2(10) [IgCC Table 702.7.2(10)].

TABLE 602.7.2(2) [IgCC TABLE 702.7.2(2)]
VOLUME AND MAXIMUM LENGTH OF TYPE K COPPER TUBING

NOMINAL PIPE OR TUBE SIZE (inch)	LIQUID OUNCES PER FOOT OF LENGTH	MAXIMUM TUBE LENGTH		
		System without a circulation loop or heat-traced line (feet)	System with a heat-traced line (feet)	Lavatory faucets – public (metering and nonmetering) (feet)
3/8[a]	0.84	44.6	14.3	2.7
1/2	1.45	44.5	16.6	2.1
3/4	2.90	21.7	8.3	0.5
1	5.17	12.6	4.8	0.5
1 1/4	8.09	7.9	3.0	0.5
1 1/2	11.45	5.8	1.9	0.5
2 or larger	20.04	3.6	0.9	0.4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m, 1 ounce = 29.6 ml.
a. The flow rate for 3/8-inch size is limited to 1.5 gallons per minute.

TABLE 602.7.2(3) [IgCC TABLE 702.7.2(3)]
VOLUME AND MAXIMUM LENGTH OF TYPE L COPPER TUBING

NOMINAL PIPE OR TUBE SIZE (inch)	LIQUID OUNCES PER FOOT OF LENGTH	MAXIMUM TUBE LENGTH		
		System without a circulation loop or heat-traced line (feet)	System with a circulation loop or heat-traced line (feet)	Lavatory faucets – public (metering and nonmetering) (feet)
3/8[a]	0.97	38.7	12.4	2.3
1/2	1.55	41.6	15.5	1.9
3/4	3.22	19.6	7.5	0.5
1	5.49	11.8	4.6	0.5
1 1/4	8.38	7.6	2.9	0.5
1 1/2	11.83	5.6	1.9	0.5
2 or larger	20.58	3.5	0.9	0.4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m, 1 ounce = 29.6 ml.
a. The flow rate for 3/8-inch size is limited to 1.5 gpm.