Improving Bathing Safety

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An 81-year-old man is fatally scalded in a bathtub, accidentally turning on the hot water as he slips and falls.

A four-year old girl receives a $15 million settlement after she is seriously scalded while playing in a sink and turning on the hot water. Defendants in the case include the manufacturers of the water heater and heater thermostat in the girl's apartment, the building's owners, the property management company, the local gas company, and the plumbing company.

These and thousands of other tragic accidents have contributed to the bathroom's dubious distinction as the most dangerous room in the house. The Consumer Products Safety Commission first addressed this concern in the late 1970s, urging higher safety standards for plumbing products and related bathroom accessories. As the opening stories illustrate, children and the elderly are at the highest risk for injuries in the bathroom. However, plumbing engineers should be aware of existing product standards that can help keep all users safe from the two major bathroom hazards: Tap water scalding and "slip and fall" injuries.

Scalding dangers

Tap water scalding has recently received considerable attention through the public education efforts. According to National Safe Kids, children can suffer tap water scald injuries when they are left unattended in the bathroom, or when they are placed in water that is too hot. Since children have thinner skin than adults, they can suffer a full thickness or third-degree burn in just three seconds.

Elderly adults and disabled users also face increased risk from scalding, since reduced skin sensation and slower reflexes can mean longer exposure to scalding water. Users of all ages face danger from slipping and falling while trying to get away from sudden changes in water temperature, often caused by a phenomenon known as "thermal shock."

We have all experienced at least mild thermal shock. Thermal shock occurs when someone inadvertently flushes a toilet or starts the washing machine while a family member is showering. The cold or hot water supply experiences sudden demand, causing the water pressure to drop. If the cold water pressure drops, and the shower valve does not compensate for the fluctuation, the hot water output continues unabated.

Less common, but also possible, is a sudden change in the supply temperature, which can occur in cases of hot or cold water supply failure. In either case, serious consequences can develop when the resulting change of water temperature is sufficient to scald bathers, or shock them into a sudden motion leading to a slip and fall accident.

Ironically, measures to save water,

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Mr. DeMarco currently serves as Vice Chairman of ASME/ANSI A112 Committee, Panel 19 (Plumbing Fixtures) and Working Groups 1 (Cast Iron) and 4 (Enameled Steel). He is also active in various ASTM and ASSE standards writing committees.

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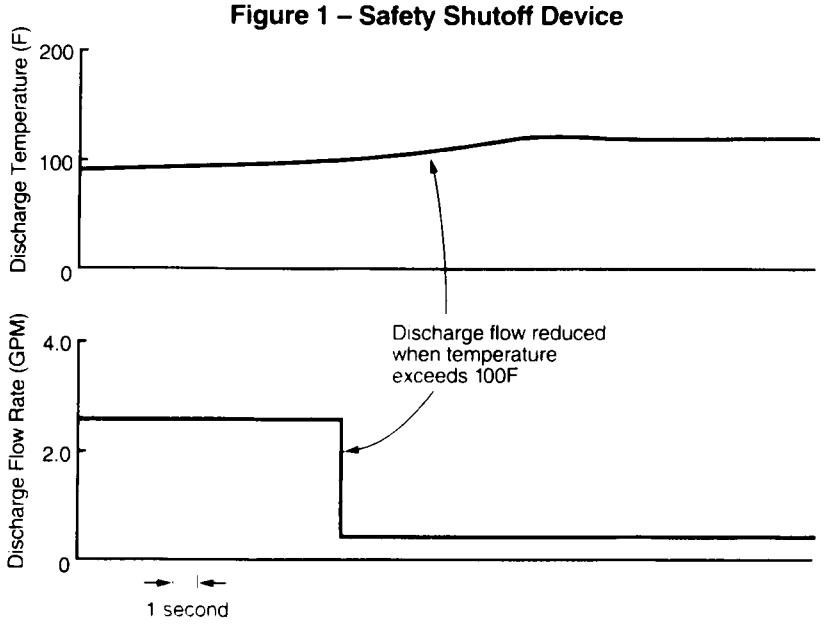
such as requiring low-consumption showerheads retrofitted on existing plumbing systems, may actually increase the severity of thermal shock. Restricting the flow in the showerheads to 3.0 gallons per minute and less increases the differential in the flow rate capacity between the supply valves and the showerhead restrictor. As this differential increases, the pressure drop across the supply valve is reduced, and fluctuations in supply pressures yield greater variations in water temperature through the showerhead.

Recognizing the danger of thermal shock, the model codes are beginning to mandate the use of pressure balancing or thermostatic valves in single family and multifamily dwellings. Plumbing engineers can meet those requirements by specifying products certified to meet standards established by the American Society for Testing and Materials F15 Committee for Consumer Products (F-15.03 Sub-committee), and the American Society of Sanitary Engineering.

ASTM F-444 for Scald Preventing Devices in Bathing Areas sets acceptable standards for devices that limit or regulate the discharge water temperature. It also covers products such as safety shut-off devices (Figure 1) that reduce or eliminate discharge flow at excessive temperatures. This standard mandates a maximum allowable discharge temperature of 120 F. In the event discharge temperature exceeds 120 F, the device must reduce discharge flow to a rate of 0.5 gpm in five seconds or less. It should be noted that some codes have set a maximum supply temperature of less than 120 F for bathing facilities. Designers should consult the jurisdictional code authority.

ASTM F-445 for Thermal Shock Preventing Devices in Showering Areas sets performance standards for devices that maintain a constant discharge temperature. F-445 also mandates a maximum discharge temperature of 120 F. This standard further requires that discharge temperatures vary no more than five Fahrenheit degrees, regardless of rapid fluctuation to the water supply.

Figure 1 – Safety Shutoff Device



ASSE 1016 is a technically complete product standard that sets forth a series of construction and performance requirements. ASSE 1016 is more strict than ASTM 445, as it mandates that discharge water temperature not vary by more than three Fahrenheit degrees, regardless of supply fluctuations. In fact, current plans are to incorporate ASTM F-444 and F-445 into ASSE 1016 to have one comprehensive standard for these control valves and devices.

ASSE 1016 classifies scald-prevention products into three categories and clearly defines test methods for each category:

1. Type P are pressure balancing valves. Pressure-balance valves employ mechanisms, usually spools or diaphragms, that react to changes in supply pressures on either side of the valve to "balance" the flow on the discharge side of the mechanism to maintain a constant discharge temperature (Figure 2).
2. Type T are thermostatic valves. These valves employ a "sensing" element that maintains discharge temperature by increasing or decreasing the hot and cold supply flow rates in response to changes in supply temperatures (Figure 3). The sensing element may be a bimetallic coil, a wax element, a fluid- or gas-filled capsule, or an electronic system. Type T valves also offer protection from pressure changes, since temperature changes resulting from a sudden drop in pressure will cause the sensing element to react and restrict the flow.
3. Type T/P are a combination of thermostatic and pressure-balance valves. This designation is reserved for the few thermostatic valves that cannot provide adequate scald protection against pressure fluctuations without a separate pressure-balance mechanism.

ASSE 1016 also requires that complying products employ an adjustable hot limit safety stop which limits the movement of the valve handle towards the hot position. A hot limit safety stop would have

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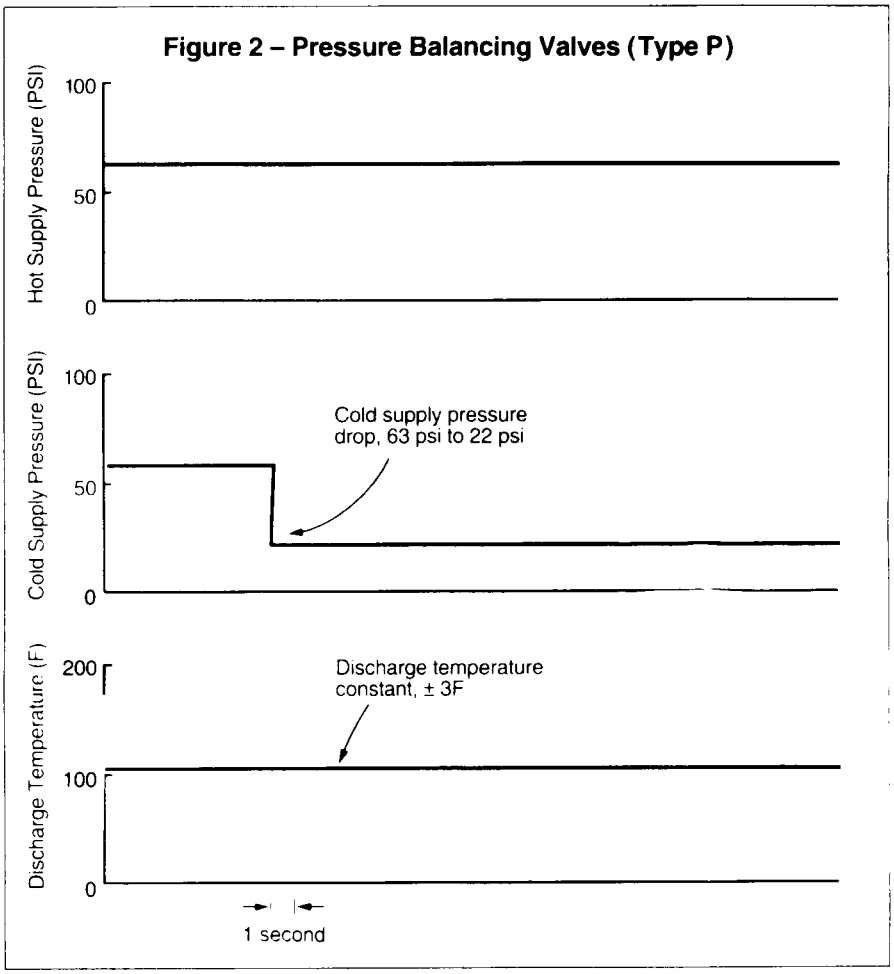
been helpful in the case of the four-year-old scalding victim, since restricting the handle can prevent accidental scalding if a child tries to play with the faucet.

It is critical that professionals who specify and install these devices understand that all three anti-scald standards recognize the importance of proper adjustment of the valves during installation. All three standards require that manufacturers "prominently display" in their installation instructions that the responsibility of these adjustments falls on the installer.

For example, if a plumber installs a faucet with an adjustable hot limit safety stop to restrict handle motion to the hot side, the plumber should set the stop to deliver water no hotter than 120 F, or the maximum allowed by the local code authority. A safe setting cannot be determined at the factory because of seasonal and regional variations in hot and cold water supply temperatures.

Figure 2 – Pressure Balancing Valves (Type P)



Risks of slips and falls

Most slip and fall injuries occur in and around bathing vessels, although smooth tile floors and wet feet can be an equally treacherous combination. Many injuries occur when the bather attempts to take a long step while exiting a bathing vessel attempting to step on a towel or mat placed too far away. Interestingly, some injuries have occured in hotel bathrooms where the common above-the-floor rough installations add vertical distance between the floor of the bathtub and the finished floor of the bathroom. While exiting the tub, hotel guests erroneously anticipate touching the floor while their feet are actually two inches above the floor.

Most bathing vessels and shower stalls employ a slip resistant textured surface. Some slip resistant surfaces are applied by sand blasting, while others are fired or molded onto the bathing surface. Slip resistant surfaces can be retrofitted by acid etching, chemical applications, and special appliques bonded onto the surface. These techniques vary greatly as to their effectiveness and durability.

Grab bars on and around bathing areas help prevent some slip and fall injuries. Some bathing vessels include grab bars as part of their trim; others are sold separately for placement around bathing areas. Grab bars are advisable to prevent users from reaching for towel bars or soap holders that were not designed and installed with the purpose of providing support. Inadequately installed grab bars, however, can be worse than no protection at all.

The American Society for Testing and Materials provides plumbing engineers with guidelines for selecting products to help protect bathers from slip and fall injuries.

ASTM F-462 for Slip Resistant Bathing Facilities addresses the slipperiness of bathing surfaces. The bathing surface is defined in the standard as "the portion of the sum of a bathing facility on which, by either common usage or design, a bather might be expected to step, stand, sit or come in contact with while bathing or showering."

To be in compliance with this standard, two measurements are taken in nine different measurement zones over the bathing surface using a device called a NIST (National Institute for Standards and Technology) Brungraber Tester. This device measures the static coefficient of friction between the bathing surfaces and a synthetic material representing human feet. Static coefficient of friction is defined as the ratio of force preventing two entities from

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sliding over each other to the force of the entities pressing against each other.

The test uses a soap solution poured onto the bathing surface to simulate the slipperiest possible conditions. Of the eighteen data points tested, none may have a static coefficient of friction less than 0.04. The product must be manufactured so that the bathing surface remains at or above this performance level for the duration of the manufacturer's warranty.

Furthermore, ASTM F-462 requires that slip resistant patterns and treatments cover a sufficient portion of bathing surfaces. A 1-1/2 by 3 inch rectangular template placed anywhere on the bathing surface must touch at least part of the slip resistant pattern. This is where most bathtubs on the market currently fall short of meeting the ASTM F-462 standard.

The ASME/ANSI Standard for cast iron plumbing fixtures, A112.19.1M-1987, mandates that the bathing surface of all cast iron bathtubs be treated in a manner that meets the requirements of ASTM F-462. The ASME/ANSI Standard for enameled steel plumbing fixtures, A112.19.4M-1987, currently allows for products that do not employ a slip resistant surface. If a steel slip resistant product is ordered or specified, however, it must conform to ASTM F-462 requirements.

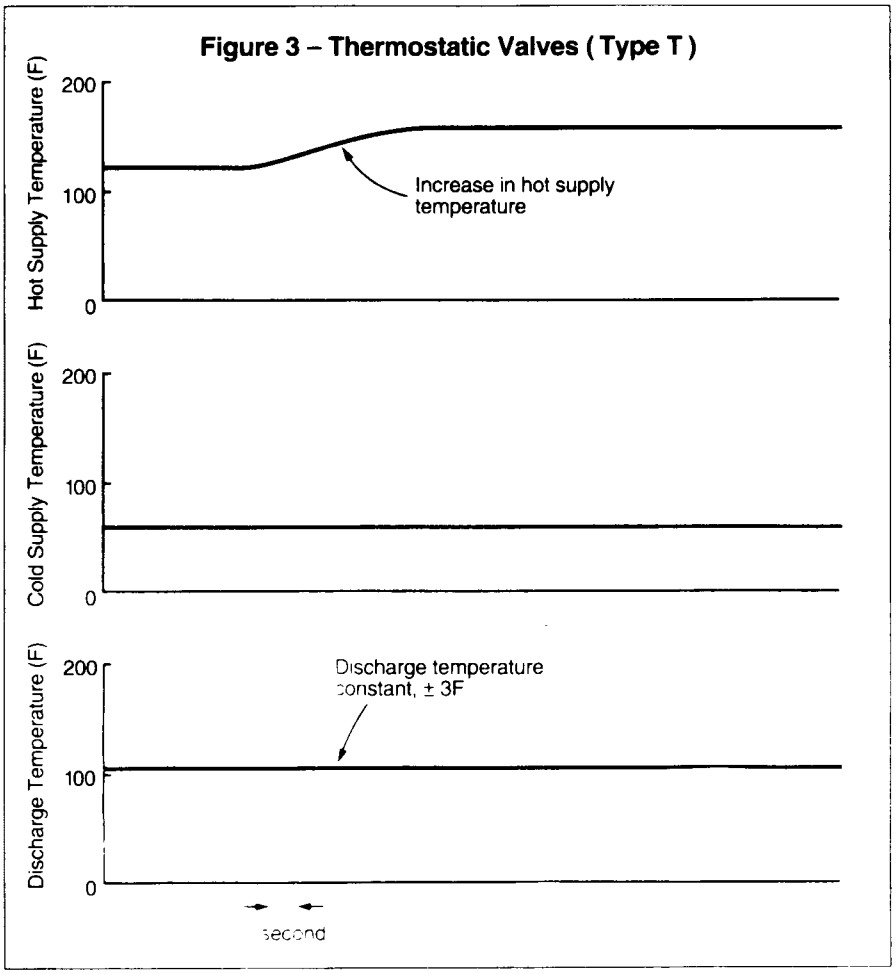
ASTM F-446 for Grab Bars and Accessories in the Bathing Area establishes requirements for the configuration, location and physical strength of towel bars, towel rings, soap holders, shelves or other devices installed on any wall that extend vertically from the outside edge of tubs or shower stalls.

Proper orientation and location for grab bars in the critical support area for recessed tubs and shower stalls are dimensionally defined in ASTM F-446. The critical support area is a rectangular space covering parts of the service wall, non-service wall, and the back wall.

The standard sets further criteria for accessories installed in the "potential hazard area," defined as "any surface within the bathing area—including the bathtub and shower receptor from the tub or shower floor, up to 66 inches, which could be contacted by the body in a slip and fall situation." Accessories installed in the potential hazard area that project more than one inch from the finished wall must be able to support a static load of 250 pounds when properly installed. Soap dishes without rails or bars are exempt when installed outside the critical support and potential hazard areas.

It is impossible to say how many accidents have been prevented with these consumer safety standards, because accidents that never happen cannot be reported. Plumbing engineers and manufacturers are at the forefront of ensuring safe bathrooms by taking a leadership role in educating clients about risks, responsibilities and resolutions in reducing danger in the bathroom. Using common sense in design, and specifying plumbing products that meet established safety standards will go a long way in repairing the bathroom's reputation as the most dangerous room in the house. □□

Figure 3 – Thermostatic Valves (Type T)



References

1. *U.S. Consumer Product Safety Commission—National Electronic Injury Surveillance System.*
2. *USA Today, May 28, 1992*
3. *For more information concerning the NIST—Brungraber Tester and its applications contact Dr. R. Brungraber, P.E., Ph.D. at (717) 524-0852.*