

# Thermal Expansion in Potable Water Systems

Most materials (solids, liquids, and gases) expand when heated. The amount of expansion depends on the type and the temperature of the material. Water is no exception. When water is heated in a storage tank, it expands in volume. Depending on the initial temperature and final temperature, the volume of the water can increase as much as 3–4 percent. This increased volume must go somewhere. In days gone by when no backflow devices were installed in domestic water systems to protect the water supply from contamination, the water expanded into the city mains. However, many municipalities now are installing backflow devices downstream of water meters to prevent water in buildings from entering the public water system. This makes the domestic water system a closed system, which usually can't absorb any increased volume due to the heating of the water in the water heater.

Section 607.3 of the 2003 International Plumbing Code (IPC) requires that "a means of controlling increased pressures caused by thermal expansion shall be provided where required" either because "pressure on the downstream side of the pressure-reducing valve exceeds the pressure-reducing valve setting" or "a backflow prevention device, check valve, or other device is installed on a water supply system utilizing storage water heating equipment such that the thermal expansion causes an increase in pressure." Section 608.3 of the 2003 Uniform Plumbing Code (UPC) requires that "any water system provided with a check valve, backflow preventer, or a pressure-regulating device which does not have a bypass feature at its source shall be provided with an approved, listed, and adequately sized pressure relief valve or a means to control expansion."

These codes have similar requirements that now mandate some kind of expansion device to control thermal expansion in a domestic water system. The water heater increases the pressure in the domestic water system, so many contractors and engineers ask me if the thermal expansion device should be installed on the water heater's hot water or cold water side. Most thermal expansion devices now are rated for temperatures up to 200°F, so it really doesn't matter. The best location for the thermal expansion device is between the water heater and the backflow device. Some contractors and even some engineers are under the impression that the thermal expansion device also can act as a water hammer arresters. However, I am aware of no thermal expansion devices that are also listed as water hammer arresters. If water hammer is an issue, install a water hammer arrester in the appropriate location and let the thermal expansion device be used only for controlling thermal expansion.

When backflow devices were not installed in the water supply, it was common practice to install water pressure-reducing valves with internal bypasses to allow the excess water pressure to dissipate into the city's water system. I still see plumbing engineers specifying internal bypasses in water pressure-reducing valves, even though they have other thermal expansion devices in the

domestic water system. I guess two safety devices are better than one.

Neither the 2003 IPC nor the 2003 UPC specifies any particular third-party listing for thermal expansion devices. Both codes require all devices installed in a plumbing system to be ANSI/NSF 61: *Drinking Water System Components—Health Effects* certified. ANSI/NSF 61 deals with only the components in contact with potable water. The International Association of Plumbing and Mechanical Officials (IAPMO) does have listings for thermal expansion devices, but neither plumbing code requires this listing.

What types of thermal expansion devices are available today? The most common device is the thermal expansion tank. This is usually a metal tank with a diaphragm. An air charge is on one side of the diaphragm, and potable water is on the other side. As the water expands, it compresses the air and allows additional water to enter the expansion tank.

Another common device is a full-port ball valve with an integral thermal expansion device. This ball valve is installed on the cold water inlet to the water heater. As the water expands the integral thermal expansion device opens and discharges water. Since water is being released, a small tube should extend from the ball valve to a floor drain. Because one end of the tubing is directly connected to the potable water system, the tubing should discharge through an air gap at the floor drain. When the valve is open, the amount of water lost is less than a few gallons.

A third common type of device is a water pressure-reducing valve with a thermal expansion control valve. This pressure-reducing valve normally is installed at the building water supply entrance. The thermal expansion control valve acts very similar to the thermal expansion device on the ball valve. The discharge from the thermal expansion control valve on the water pressure-reducing valve should be piped to a floor drain through an air gap. (Note: This type of device should be installed only at a building with excessive water pressure, as any backflow preventers installed for certain plumbing fixtures may cause insufficient water pressure.)

All potable water systems with a storage-type water heater require some kind of thermal expansion device. Which is the best device? The plumbing designer needs to evaluate the plumbing system and determine which device works best for that installation. **PSD**



**RAY MOORE** is a principal with Professional Engineering Services in Salt Lake City, ASPE vice president, legislative, and chair of the Utah Building Codes Commission Plumbing Advisory Committee. For more information or to comment on this article, e-mail [articles@psdmagazine.org](mailto:articles@psdmagazine.org).