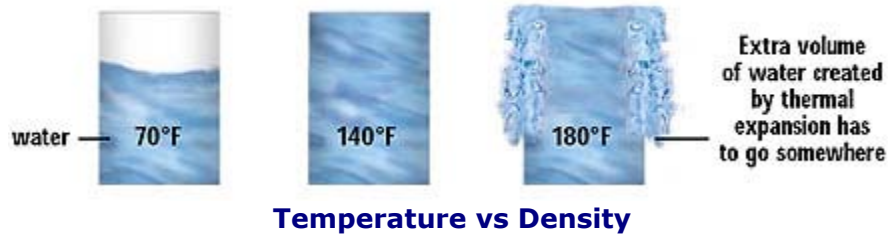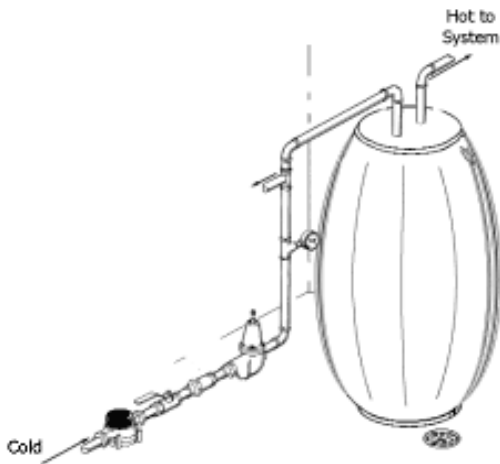# What is Thermal Expansion?

When water is heated it expands. For example, water heated from 90ºF to a thermostat setting of 140ºF in a 40 gallon hot water heater will expand by almost one-half gallon. This is because when water is heated, its density decreases and its volume expands (see below). Since water is not compressible, the extra volume created by expansion must go someplace. During no-flow periods in a system, pressure reducing valves, backflow preventers, and other one-way valves are closed, thus eliminating a path for expanded water to flow back to the system supply. Hence, system pressure increases.

water — 70°F   140°F   180°F   Extra volume of water created by thermal expansion has to go somewhere

Temperature vs Density

Thermal expansion of water in a closed plumbing system can create a number of annoying and potentially dangerous problems. These include: the build up of unusually high pressure in a system (even when a pressure reducing valve is installed); pressure surges; and the chronic or continuous dripping of a temperature and pressure (T&P) relief valve. In addition, dripping faucets and leaking toilet tank ball cock fill valves are also symptomatic of thermal expansion.

More serious problems can also occur due to thermal expansion. When dangerous pressures are built up in a water heater, internal parts may fail such as the internal flues, fittings or water connections. If a flue way collapses it can lead to the potential release of toxic gases, such as carbon monoxide into living spaces. Thermal expansion can also lead to a ruptured or distorted hot water heating tank and may void the manufacturer's warranty (see below).

Hot to System

Cold

Distorted Water Heater may void factory's warranty
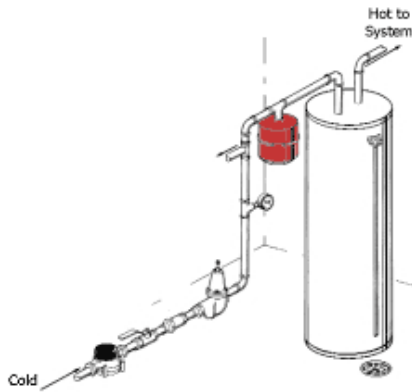
Installation of an expansion tank will protect water heater

Plumbing codes require you to address this safety problem. No matter what your thermal expansion problem may be, whether for new construction or for retrofitting or remodeling an existing system, there are cost effective solutions for you as outlined in the following pages of this guide.

Plumbing Code Requirements
Thermal Expansion Control

Plumbing codes require that thermal expansion control be addressed in plumbing systems. **A temperature and pressure relief valve is not considered a thermal expansion device**. This is because when water is allowed to continuously drip from the T&P relief valve, minerals from the water can build up on the valve, eventually blocking it. This blockage can render the T&P valve useless and potentially lead to hot water heater explosions. The International Plumbing Code (IPC), Uniform Plumbing Code (UPC) and Standard Plumbing Code all require thermal expansion control to be addressed.

Water Containment vs Water Relief Solutions

Water Containment solutions allow for thermal expansion while containing thermally expanded water in the plumbing system. The thermal expansion tanks are considered water containment devices. These products require no installation of discharge lines or drains.
Water Relief solutions discharge thermally expanded water at a pressure setting that is below the setting of the water heater's temperature and pressure relief valve. There are a variety of water relief solutions that can be installed on the system piping, in a water closet or on an outside faucet. These products must be piped to a suitable drain or discharge location.

How a Diaphragm Expansion Tank Works

When water is heated in a closed system it expands. Water is not compressible; therefore, the additional water volume created has to go someplace. When an expansion tank is installed the excess water enters the pre-pressurized tank (figure 1). As the temperature and pressure reaches its maximum, the diaphragm flexes against an air cushion (air is compressible) to allow for increased water expansion

(figure 2). When the system is opened again or the water cools, the water leaves the tank and returns to the system.
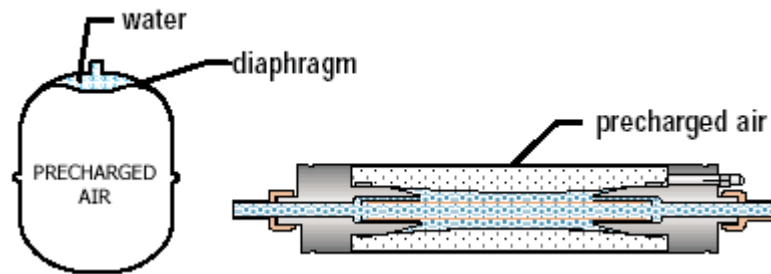

figure 1. As the water temperature increases, the expanded water is received by the tank.
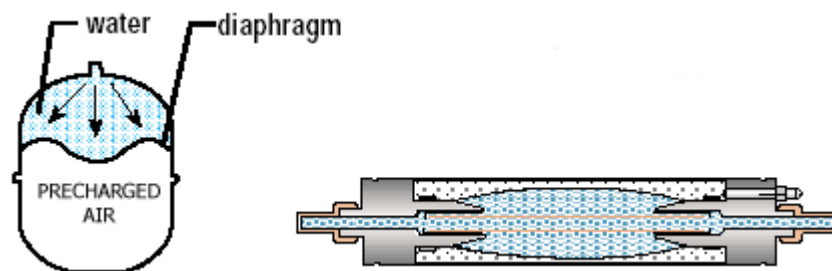

figure 2. As the water and pressure reaches its maximum, the diaphragm flexes against the air cushion (air is compressible) to allow for increased water expansion.

Other Potable Water Thermal Expansion Solutions

There are several other options for pressure relief besides expansion tanks. These products do not prevent against loss of water, like an expansion tank, but they do limit high pressure and prevent the annoying problems associated with thermal expansion. These products include the a combination toilet tank ball cock fill valve and thermal expansion relief valve; a calibrated pressure relief valve; a combination ball valve and relief valve and a hose connection pressure relief valve. These products are described in more detail in the following pages of this guide.

Ball Cock and Thermal Expansion Relief Valve

This product that solves three plumbing problems at once and offers the most cost effective way to ensure code compliance for domestic water systems. It is a thermal expansion/pressure relief valve/anti-siphon backlow preventer for your water closet.

Calibrated Pressure Relief Valves

These spring operated bronze relief valves are designed to be used only as protection from the build up of excessive pressure in systems containing water, oil or air. This product incorporates a calibrated adjustment feature for manually setting the valve to the relief pressure required.

Combination Ball Valve and Relief Valves

This combination ball valve and relief valve provides a unique and low cost solution for thermal expansion relief in domestic water heating systems, using a rugged ball valve design. The small and compact ball relief valve facilitates relief of thermal expansion and provides a tight shutoff valve for the supply to the water heater.

Hose Connection Pressure Relief Valve

This pressure relief valve, set at 80 psi or 100 psi, has a 3 /4 " hose connection inlet for ease of installation. The pressure relief valve should only be used in areas where the outside temperature does not fall below freezing year round.