The Temperature Pressure Relief Valve

by Kenny Hart

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The most important part of your client's domestic hot water system

"The steam-powered tank hurtled across the busy intersection at First Avenue South and South 152nd Street — over at least six lanes of traffic — before landing more than 439 feet away in the parking lot of a Pizza Hut."

This excerpt from a July 28, 2001, article in the Seattle Post-Intelligencer describes what happened when a water heater with a capped Temperature Pressure Relief (TPR) valve overheated and exploded.

According to a November 1, 2007, article posted on the WSOC TV Web site, a water heater landed 70 feet from a Kannapolis, North Carolina, home and did an estimated $20,000 worth of damage when it exploded. According to the report, the heater lacked a TPR valve altogether.

High limit controls

Water heaters have thermostatically controlled devices that keep them from overheating. Both gas and electric water heaters have temperature-limiting devices that shut off the energy source when their regular thermostat fails. Electric heaters have a high-limit switch that interrupts the power when overheating occurs. Many of us have seen and perhaps reset the device by pushing a small red button under the cover plate and just above the thermostat dial.

Thermostatically controlled gas valves found on most residential gas water heaters have a safety shutoff built into the gas valve itself. When they react to excessive temperature, the gas flow to the burner is stopped. Generally not resettable, the entire control valve has to be replaced to get the water heater up and running again.

These devices are the first line of protection against water heater explosion. Should they fail, a temperature pressure relief valve, which should be installed within the top 6 inches of the tank, should prevent the heater from suddenly becoming a bomb or launching like a rocket. In both of the explosion events described earlier, it appears a properly installed TPR valve would have prevented the carnage.

Photo: Electric thermostat with high limit. Photo © Camco Manufacturing, Inc.

Photo: A thermostatically controlled gas valve.

Pressure relief vs. Temperature Pressure Relief

The two contributing factors that cause water heaters to explode are excessive water temperature and a failing in the tank itself. The failing or weakness could be in the design or could be caused by a defect from extensive corrosion or just normal wear. Experts note that as long as the water temperature within the tank remains under 212°F, excessive pressure alone will not cause a water heater to explode. Water under excessive pressure will exploit a weakness within the tank and cause it to leak.Water will drip, spray or gush from the tank, but the violent burst we would call an explosion will not occur.

When heat energy is added to the water, especially when reaching temperatures in excess of 212°F, everything changes. As the temperature climbs, additional stress is put on the tank. Water inside the tank is under pressure, and this pressure will allow the water to be superheated or heated beyond the atmospheric boiling point. In some cases, temperatures can exceed 300°F. When the tank opens or splits at a weak point, the superheated water will rapidly escape, expanding in volume many times as steam, creating an explosion and often propelling the tank like a rocket.

In the past, water heaters and hot water storage tanks were merely protected by a pressure relief valve. You still occasionally see them installed in water lines near water heaters at older properties. Over the years, we learned how extremely inadequate pressure relief alone was for protecting water heaters from an actual explosion, and today combination

temperature pressure relief valves are required. The standard for the industry is set to open at 210°F (99°C) and/or 150 psi.

TPR valve basics and installation concerns

A properly installed TPR valve allows water to discharge through the device when conditions of excessive pressure, excessive temperature or both occur. When the valve opens, pressure from the tank, along with hot water, is released. As the water moves from the tank, the pressure drops and the exiting water is replaced with new much cooler water. This lowers the water temperature within the tank. When a safe level is reached, the safety valve should shut off. Unless the cause for overheating is corrected, a good TPR valve will continue to trip or open repeatedly each time the unsafe conditions are reached.

As stated earlier, temperature and pressure relief valves should be installed within the top 6 inches of the tank. Because of temperature stacking, this is where the hottest water in the tank is found. From time to time, I find the TPR valve installed in the hot water piping away from the tank. Though standard storage tank water heaters have an opening specifically for the safety valve, some water storage tanks do not. In this situation and on the rare occasion the valve opening is used for something else, manufacturers recommend that a tee be placed at the hot water outlet and that the TPR valve be screwed directly into the top of the tee. The heat sensor (thermostat) of the TPR valve should pass through the tee and be submerged in the upper 6 inches of the tank water. The side opening of the tee is fitted and piped to deliver hot water to the house.

On water heaters with very thick insulation, you'll sometimes encounter an issue with the TPR valve that is related to the insulation itself. Because of the depth of the insulation, the threaded opening is somewhat recessed within the jacket placed around the tank. Installers sometimes add a nipple and a coupling to the end of the TPR valve to bring it out beyond the insulation and jacket. This can cause the thermostat on standard-length TPR valves to line up inside the nipple, where it's unable to truly sense the water temperature. Special TPR valves with an extended shank should be used for this application. It not only gets the valve out beyond the insulation, but it is designed with an extended thermostat that keeps it well inside the tank surrounded by water. The extended shank is part of the valve itself, and no nipple is needed.

In recent years, many water heater manufacturers have relocated TPR valve openings. They have moved them from the top to the side of the tank. When older heaters are replaced with similar height units, installers occasionally will turn the valve so it can be realigned with the original discharge pipe that extends from the wall. This often results in the trapping of the valve, preventing it from draining by gravity. If the valve drips, mineral deposits can collect at the opening and create a mineral plug. This can restrict or block the opening altogether. Neither the TPR valve nor the discharge piping should ever be trapped and should always drain completely by gravity.

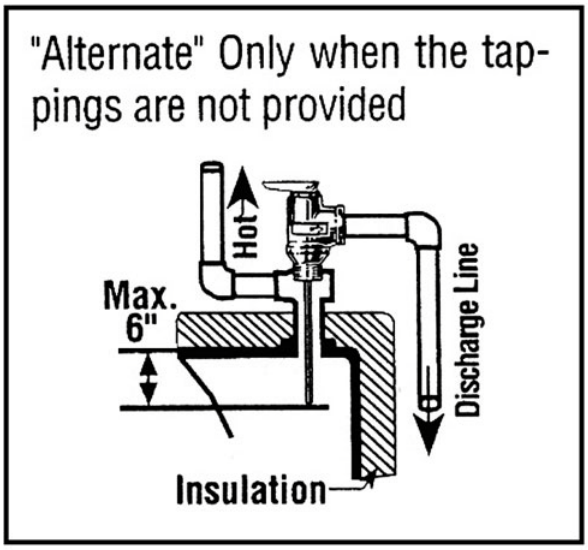

Illustration © Watts

Photo: Watts® L100XL is their model TPR valve for heavily insulated tanks. Photo © Watts®.

Photo: Trapped TPR valve. Photo by K. Hart.

Photo: Discharge pipe too short. Photo by K. Hart.


Photo: Camco runoff tube. Photo © Camco Manufacturing, Inc.

Discharge pipe issues

When it comes to water heater installation, Cash Acme, a manufacturer of TPR valves, states, “The most common problem is the absence of or an incorrectly installed drain line from the TPR valve.” As a plumber and home inspector, I agree. My personal observations lead me to believe that most installers understand the purpose of the device, but have no comprehension of just how dangerous the discharged water is when it leaves the tank. Failure to carry the pipe to a safe distance above the floor or other safe location ranks number one on my water heater defect list. Having actually seen a few discharges take place, I’m certain the few dollars saved in material costs is not worth the risk of scalding that could occur.

In a perfect world, all water heaters would be installed in a room with a concrete floor sloping to a nearby floor drain. The discharge from the TPR valve could be directed to the floor by a simple runoff tube, with no other piping necessary to get it to a safe place. But the fact is water heaters are installed in basements, garages, closets located in the middle of houses, over slabs, over crawl spaces and in attics just above beautiful ceilings. Because water heaters are not always located conveniently near a plumbing receptacle, the installation of the discharge piping for the heater’s TPR valve must carefully be considered. An improperly installed discharge pipe can sometimes be as dangerous as no pipe at all or as bad as removing the TPR valve from the tank and plugging the opening. The acceptable methods of carrying the discharge water from the heater are spelled out in plumbing codes and by manufacturers of water heaters and the safety valves themselves. Despite this, it still seems to be a challenge for some installers.

According to the 2006 International Plumbing Code, “The discharge piping servicing a pressure relief valve, temperature pressure relief valve or combination thereof shall not be connected directly to the drainage system.” This creates a cross-connection between the potable water and drain system. Under certain conditions, drain water could be pulled into the water heater and later be served up with a cup of coffee.

If the discharge line is tied directly to the drain system, it could be difficult to impossible to determine if the valve is leaking and in need of repair or replacement. Should a violent discharge occur, piping or fixtures could be damaged and individuals near the plumbing could be scalded or hurt in other ways.

Discharging through an air gap, to a plumbing receptacle such as floor drain or utility sink, eliminates the possibility of backflow contamination, increases the likelihood that a TPR valve in need of attention will be discovered and reduces the chance of a surprise scalding.

The discharge piping should not be reduced either by fittings, kinks or in any other way. Watts® Regulator Company, a maker of numerous water safety devices, states that

discharge piping in excess of 30 feet or the use of more than four 90° elbows will reduce the discharge capacity. Shorter is better.

Occasionally, you will find multiple heaters piped to a single discharge pipe or the discharge line tied to an AC condensate drain. This is common in older multi-family properties such as apartments or condominiums. The 2006 IPC states, “The discharge piping servicing a pressure relief valve, temperature pressure relief valve or combination thereof shall serve a single relief device and shall not connect to piping servicing any other relief device or equipment.”

I quickly can think of a couple reasons why combining TPR piping is problematic. The pipe may not be capable of handling the flow from more than one valve. Should a TPR valve discharge while another heater is being repaired or replaced, scalding water blasting through the line could injure the worker. As for connection to a condensate line, condensate lines are often blocked by sludge and are usually piped with PVC, an unacceptable piping material for TPR applications. Should the safety valve discharge in certain piping configurations, scalding water could shoot through an opened vent, common on condensate drains. If the water should push into a condensate pan, someone could be injured or equipment and/or structural damage could occur.

No valves or tees should be installed anywhere in the discharge piping. A valve mistakenly shut off renders the TPR valve useless and is extremely dangerous. In the past in some areas, it was common practice to install a tee with a restricted opening in one branch of the fitting. Plumbers called them freeze tees. The idea behind this setup was to provide an alternative direction for a release to take in the event water in the line had frozen and blocked the outlet.

Over the years, attention shifted from this makeshift discharge point to a more controlled one. When the possibility of freezing is a concern, the IPC says “… discharge piping shall first pass through an indirect waste receptor through an air gap located in a conditioned area.”

When a water heater is installed in a garage, attached storage room or similar location, simply extending the discharge pipe toward the floor is a common practice. So long as any discharged water will not cause structural damage, this is generally the preferred method of directing it to a safe location. The pipe should not terminate more than 6 inches above the floor because of splash concerns or closer than two pipe diameters to the floor, a potential cross-connection issue. A pipe too close to the floor could end up submerged and could siphon dirty water into the tank.

Photo: Water heater installed in a garage. Photo K Hart.

A common mistake with water heaters resting on raised platforms in garages is to stop the discharge pipe just above the platform instead of the floor. Should the valve discharge here, the spray or splash of the scalding hot water at this level could seriously injure anyone standing nearby. The pipe should be offset around the platform base and stopped above the floor.

Above all, the discharge from TPR valves should be directed to a location that will not cause personal injury or structural damage. The plumbing code requires the discharge point to be in a location that is readily observable; Watts® says “clearly visible.” The importance of this should not be overlooked. When the valve releases, sometimes it is done as a blast; other times, as a trickle. If the occupants of the home are unable to see this happening, the sound can be mistaken for a toilet refilling or some other event less important than a safety valve release.

My own personal experience underscores why the discharge pipe should never stop in the crawl space, an area certainly not routinely readily observable by your average occupants of the house. Once, during a property inspection, I noticed extensive mold-related, structural damage as I entered the crawl space of an apartment building. This was a surprise since the property was located at the beach, was built over sand and was high enough for me to walk under. As soon as I entered the area, I heard a large blast of water begin slapping the ground. I turned and realized that the TPR valve had been discontinued in the crawl space and was releasing at that very moment. I snapped a picture (*see photo below)*. Within two or three minutes, a cloud of steam filled the entire crawl area.

Photo: Discharging TPR valve in a crawl space. Photo by K. Hart.

After questioning the tenants, it seemed this periodic release of superheated water had been going on for quite some time and though they could hear the water flowing through the plumbing, no one associated it with the water
one associated it with the water heater. There was more than $30,000 in structural damage to that steam-soaked crawl space. It could have been avoided if the discharge pipe had been extended to the outside.

It's human nature to want to stop a water leak. Because of this, discharge piping should not terminate with a threaded connection as it provides an easy means of capping the line, making the valve unable to discharge. In my experience, threaded outlets tend to be more common with the D-I-Y installer since precut threaded sections of steel pipe can be purchased from the local hardware or big box store, then simply screwed into the valve's outlet. If the valve drips or water is found at the floor, a trip to the junk drawer often produces a ¾-inch cap to hold back the water until the plumber arrives. When a cap is not located, it's sometimes realized that, with a little coaxing, a garden hose can be connected to direct the water outside. Scalding water and garden hoses do not mix. If the hose collapses, the result is a 25-foot-long plug attached to the pipe.

Approved piping materials

Another common mistake made by the weekend warrior is to use PVC pipe to handle the discharge from TPR valves. Polyvinyl chloride (PVC) is not a water distribution pipe. In plumbing, PVC is primarily used for water service and DWV applications. CPVC is a water distribution pipe and both the 2006 IPC and the Plastic Pipe and Fitting Association state that TPR discharge piping is an acceptable application for the pipe. The PPFA states that a metal-to-CPVC transition fitting should be used at the TPR valve connection.

Though polybutylene, cross-linked polyethylene (PEX) and some derivatives of these very flexible piping materials are listed under table 605.4 in the IPC, the table that defines acceptable pipe for TPR discharge, you should check with your local authority for a list of approved materials. Because of the difficulty in securing and maintaining proper

slope without some trapping and because these pipes sometimes use insert fittings, they can restrict and reduce the flow. They may not be approved in your area or have some restrictions if used.

Photo: Constructed of old garden hose, a non-approved piping material, the discharge pipe on this garage
located water heater was simply replaced with a runoff tube that terminated a couple of inches above the floor. Photo left K. Hart.

Finally, not all, but much, of what is generally called out for TPR valve violation defects is covered in the instructions found on or in the box containing the valve. Watts® places its information on the box and on a rugged yellow tag that hangs from the valve itself. With this in mind, why not spend the $15 or $20 needed to put a boxed TPR valve in your tool bag? When questioned about a call you make in the field, along with explaining the implications of your find, sometimes you can cite a highly placed authority. Cite the installation instructions.

Beyond the Scope

Some TPR valve manufacturers recommend that the lever be lifted immediately after installation and at least once a year to ensure that the waterways are clear. By lifting the lever, water is allowed to flow through the safety valve and should flush out the discharge pipe. A professional inspection of the device by a qualified plumber is recommended every three years. Feel free to point this out to your clients, but inspectors should not lift the lever during the home inspection. As a plumber, I can tell you that in many cases the valve will not seat following the test and will continue to pour water or drip water. There is no repair for this defect. The TPR valve will have to be replaced.

If you point out the recommended test procedure to your clients, also inform them that if water does not flow through the valve or fails to shut off when reset, they immediately

will need to turn off the power or gas to the water heater and hire a plumber to replace the device.
