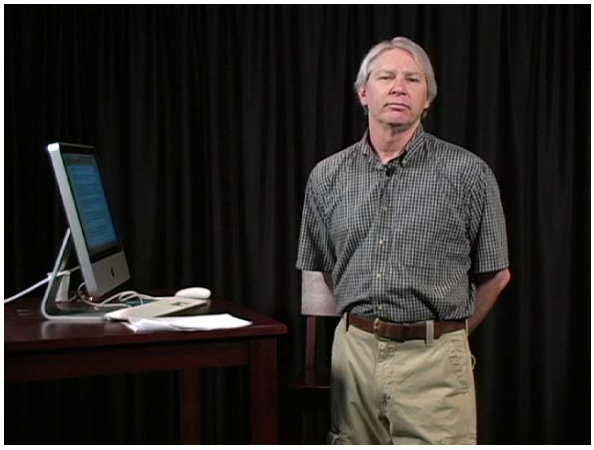
Inspecting Water Heater Tanks in Residential Dwelling Units

Including Electric Water Tanks and Gas Water Tanks
with Flammable Vapor Ignition Resistance Systems



Course title: "Inspecting water heater tanks in residential dwelling units."

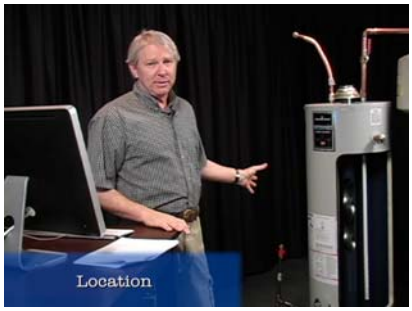
Course objective: To obtain an understanding of how to inspect the water heater tanks in a single residential dwelling unit, including fuel and electric water heater tanks.

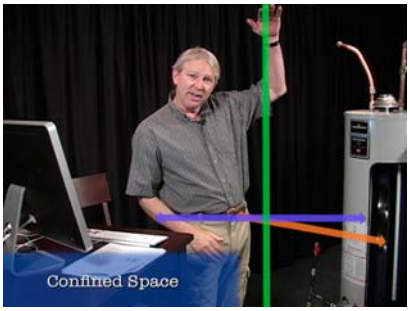
Completing this course should enable an inspector to identify components of gas-fired and electric water heater tanks, recognize defects and safety hazards in relation to modern standards and requirements, explain how a flammable vapor ignition resistance system (FVIR) works, the importance of temperature-and-pressure relief valves, and checking confined spaces.

This is not a code compliance course. There are many codes, and they change regularly. This level of inspection is beyond what an inspector would do on a general home inspection and exceeds InterNACHI's Standards of Practice.

We will read text from modern building standards, we will apply those standards in a mock-up studio setting, and then we will perform inspections of hot water tanks at existing residential homes. We will watch and learn from a master plumber as he inspects two hot water tanks - one gas and one electric.

At the end of the course, we will go over some suggested language that can be used in an inspection report. An inspection report should describe and identify in written format the inspected components of the system and should identify defects that were observed.





Water Heater

1.0 General Comments

A water heater is any appliance that heats potable water and supplies heated water to the distribution system. Some water heaters can be used for space heating. Water heaters are potential explosion hazards if not properly installed. There are instances where hot water tanks with improperly installed safety devices have been propelled through floor and roof structures and over 100 feet into the air.

Because of the potential hazards, there are standards that regulate the materials, design, and installation of water heaters and their related safety devices. Certification marks from approved agencies on water heaters are required to indicate compliance with approved standards.

Most tanks are insulated steel cylinders with an enamel coating on the inner surface. They are referred to as glass-lined tanks. The lining helps prevent corrosion. Conventional residential water heaters have life expectancies that vary greatly.

2.0 Water Heater As a Space Heater

If a water heater has a dual purpose of supplying hot water and serving as a heat source for a hot water space heating system, the maximum outlet water temperature for the potable hot water system is limited to 140 °F (60 °C). A master thermostatic mixing valve should be installed to limit the water the water temperature to 140 °F (60 °C) or less.

A water heater used as a part of a space heating system, such as an under-floor radiant system, must be protected from any conditions that could cause contamination of the potable water system. If the water heater is part of the potable water system, materials used in the heating system must be for use in a potable water system. The water potability must be maintained throughout the system. Chemicals of any type must not be added to the heating system, because this would directly contaminate the water supply.

3.0 Sacrificial Rod

Water circulating through a hot water circulation system becomes chemically inert and does not corrode the piping. But water heaters have a constant supply of fresh water with lots of corrosion-causing oxygen. Because of this, water heaters are prone to corrosion. As a result, water heaters usually have an anti-corrosion rod or sacrificial rod installed. Sacrificial anodes are typically magnesium or aluminum. The rod is immersed inside the water heater tank, allowing the chemical reaction from the fresh water to attack it rather than the tank. In some areas, rods are replaced regularly.



4.0 Drain Valve

A water heater must have a drain valve installed for service, maintenance, sediment removal, repair, and replacement. The valve inlet is ¾-inch (19 mm) nominal pipe size. The outlet is a standard ¾-inch (19 mm) male hose thread and a straight-through waterway of at least ½-inch (13 mm) diameter.

5.0 Access

Water heaters should be **accessible** for routine inspections, maintenance, adjustment, repairs, and replacements. Manufacturers usually make access recommendations. "Accessible" means to reach the water heater by possibly first removing a panel, door, or similar obstruction. "Accessible" does not include the removal or destruction of finish materials, such as drywall, paneling, or built-in cabinets. A walkway, workspace, or platform may be necessary to provide a safe access path to travel to and work on a water heater.

6.0 Water Heater Labeling

All water heaters must be certified by a third party, approved agency, such as ANSI and UL. The certification mark indicates that the heater has been tested and has been determined to perform safely when installed and operated properly in accordance with the manufacturer's recommendation. If the water heater is electric or oil, it should conform to UL standards. If it is natural gas, it should conform to ANSI standards.

The labeling on the hot water tank could list the manufacturer, the tank size, the serial number, model number, fuel type, BTU ratings, and proper clearances required for the tank.

7.0 Pressurized Expansion Tanks

A pressurized expansion tank is a sealed cylinder divided by a flexible diaphragm. An expansion tank provides space for the water to expand as it is heated and assists in keeping the water pressure in the normal pressure range while the water heater is operating.

The expansion tank is designed and intended for water storage at a maximum pressure of 150 psi and a maximum temperature of 200˚F. This tank should be pre-charged at 40 psi. The tank should not exceed 80 psi. air charge; otherwise the tank could be damaged. The tank can accept one to three gallons of water, depending upon the tank size.

The best location for installing an expansion tank is near the hot water source, hanging downwards. The 2nd optional location is *not* hanging but standing upwards. The 3rd best optional location is a horizontal installation, but support straps are needed since the tank and water can weigh 15 to 35 pounds depending upon the size of the tank.

A "closed" water distribution system with a check valve installed on the main water line coming into the house requires a thermal expansion control device, such as an expansion tank. When water heats up inside the tank, it expands. Since it cannot expand out to the street because of a check valve, the expansion tank will absorb the expansion.

8.0 Tankless Water Heaters

Tankless (point-of-use) water heaters have become increasingly popular in recent years for heating potable water in residential homes in the U.S. There are several major factors in the trend of installing tankless water heaters. One is an increasing demand for continuous unlimited streams of hot water for simultaneous operation of hot water consuming appliances and fixtures. Another is a desire to save floor space and to conserve energy by reducing standby losses.

There are many different models of fuel-gas and electric tankless water heaters, each having a specific rating. Tankless water heaters are rated at so many gallons per minute (gpm) at so many degrees of water temperature rise.

8.1 Tankless Temperature Control

Since tankless water heaters can discharge water at an uncertain range of temperatures at any given time, depending on the use, a temperature control device is needed to protect the user from scalding water being discharged. A tempering valve can be adjusted to deliver water at a maximum temperature of 140 °F (60 °C), or the heater can be equipped with a temperature-limiting device or thermostat that has the maximum setting. When a tankless water heater supplies a shower or tub/shower combination, the maximum temperature of the outlet control valve of the shower or tub/shower must be at 120 °F (49 °C).

8.2 Tankless Size

One challenge in sizing a tankless water heater is to determine the demand in gallons per minute. The second challenge is determining what temperature rise is required for that flow. Because tankless water heaters are designed to accommodate a given maximum flow, there is a pressure loss associated with flows in excess of a unit's usable flow rating. In a house with a tankless water heater, it's possible to have a fixture with almost no flow of water if too many faucets are opened simultaneously. Occupants may have to adjust their expectations concerning when and to what extent simultaneous demands for hot water can be made before temperature and flow of hot water is affected.

9.0 Tankless Coils in Boilers

Tankless coils are indirect method of heating potable water with the use of a boiler. A cold water supply pipe extends into the hottest part of the boiler water. The water in the copper tube is kept hot by the boiler water. When there is demand for hot water, water flows through the tube through the hot boiler water, and water is delivered to the fixture.

9.1 Indirect Water Heaters

Indirect water heaters offer an efficient choice for many homes, even though they require a storage tank. An indirect water heater uses the main furnace or boiler to heat a fluid that's circulated through a heat exchanger in the storage tank. The energy stored by the tank allows the furnace/boiler to turn off and on less often, and that saves energy. Therefore, when an indirect

water heater is used with a high-efficiency boiler and well-insulated tank providing hot water can be very inexpensive. Indirect systems can be gas, oil, propane, electric, solar energy, or a combination.

10.0 Water Heater Tank Locations

Installation of water heater tanks which use solid, liquid, or gas fuel should not be permitted in a room containing air-handling machinery when such room is used as a plenum. If there's a malfunction of the water heater or its venting system, there is a potential for toxic combustion byproducts to spread throughout the dwelling. The air-handling system can also produce negative and positive air pressures and affect the drafting or venting of the water heater. The negative pressure produced by a plenum could overcome the natural draft of the heater's venting system, and pull flue gases into the room.

10.1 Located in Storage Closets, Bedrooms, and Bathrooms

Fuel-fired water heaters should not be installed in a room used as a storage closet. Fuel-fired water heaters should not obtain combustion air from sleeping rooms, bathrooms, or toilet rooms. There are two exceptions: 1) water heaters located in bedrooms or bathrooms could be installed in a sealed enclosure so that combustion air will not be taken from the living space, and a solid weather-stripped door and a self-closing device should be provided; 2) water heater could be installed in a room that is not a confined space and the building is not of unusually tight construction.

10.2 Located in Garages

Gasoline leakage or spillage in a garage is a possible danger. Gasoline fumes will evaporate from liquid puddles at the floor level. Any potential ignition source should be elevated to keep open-flame or spark-producing elements above the gasoline fume level.

A hot water tank with an open source of ignition should be elevated not less than 18 inches (457 mm) above the floor of a garage. There is an exception for appliances that are listed as flammable vapor ignition resistant (FVIR).

10.3 Located in Attics

A suitable access opening, passageway, and work space is required when a water heater is installed in an attic. The opening, passageway, and workspace should be large enough to accommodate the removal and replacement of a water heater.

The access opening should be at least 20 inches by 30 inches (508 mm by 762 mm) to allow the removal of the water heater.

The passageway should be at least 30 inches (762 mm) high and 22 inches (559 mm) wide. The passageway should not be longer than 20 feet (6,096 mm) when measured along the centerline of the passageway from the opening to the water heater. The passageway should have continuous solid flooring not less than 24 inches (610 mm) wide.

There should be a level workspace that is at least 30 inches (762 mm) deep and 30 inches (762 mm) wide at the service-side of the water heater.

11.0 Confined Space and Combustion Air

Confined space. If the volume of space in which the appliance is located is less than 50 cubic feet of space per 1,000 Btu per hour of aggregate input of the appliance, then it is a confined space. (50 cubic feet = 2.5 ft. x 2.5 ft. x 8 ft.)

Unconfined space. In unconfined spaces in buildings, infiltration may be adequate to provide air for combustion, ventilation and dilution of flue gases. However, in buildings of tight construction (for example, weather stripping, heavily insulated, caulked, vapor barrier, etc.), additional air may need to be provided.

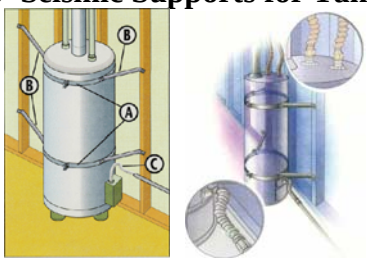
Solution. Two permanent openings to adjacent spaces could be provided so that the combined volume of all spaces meets the requirements. If the building is sealed so tightly that infiltration air is not adequate for combustion, combustion air then should be obtained from outdoors.

All air from inside the dwelling. If all combustion air is taken from the inside of the dwelling, then two permanent openings should be installed. One opening should be within 12 inches (305 mm) of the top and one within 12 inches (305 mm) of the bottom of the space. Each opening shall have a free area equal to a minimum of 1 square inch per 1,000 Btu/h (2201 mm^2/kW) input rating of all appliances installed within the space, but not less than 100 square inches (64415 mm^2).

All air from outdoors. If all combustion air is taken from the outdoor air, then one opening should be within 12 inches (305 mm) of the top and one within 12 inches (305 mm) of the bottom of the space. The openings are permitted to connect to spaces directly communicating with the outdoor air, such as a ventilated crawlspace or ventilated attic space. Each opening should have a free area of at least 1 square inch per 4,000 Btu/per hour (550 mm^2/kW) of total input rating of all appliances in the space when using vertical ducts (2,000 Btu/per hour if using horizontal ducts).

Louvers. In calculating the free area of combustion air openings fitted with louvers, metal louvers obstruct about 25 percent of the opening. Wooden louvers obstruct 75 percent.

12.0 Seismic Supports for Tanks



In those areas determined to have high earthquake risk, it is important that a water heater be fastened in place with two straps to avoid damage. Strapping should be at a point within the upper one-third and lower one-third of the tank's vertical dimension. At the lower point, the strapping should maintain a minimum distance of 4 inches (102 mm) above the controls. Water heater supports and piping supports should be designed to resist seismic loads. Failure of water heater supports has been shown to be a threat to health and safety. In addition to strapping, approved flexible connectors should be used.

13.0 Water Valves for Water Heater Tanks

A valve should be installed on the cold-water branch line from the main water supply line to each hot water storage tank or water heater. The valve should be conspicuously located and near the water heater, accessible from the same floor level as the water heater that it serves. The valve is to be installed so that if the heater is taken out of service, the other portions of the water distribution system are not disrupted.

13.1 Inspect the Valve.

An inspector should verify that a full-open valve is installed on the cold water supply line. Full-open valves are shutoff valves that in the full-open position have a straight-through flow passageway. Unlike shutoff valves and stops, full-open valves add little resistance to flow and little effect on supply pressure. Ball valve are commonly found at hot water tank. The handle clearly shows whether the valve is open or closed.

14.0 Dip Tube Hole

A typical design of a water heater tank includes a cold-water 'dip' tube. The tube directs the cold water to the bottom of the tank. At the top of the tank, a hole is installed in the dip tube to prevent water from being siphoned from the tank through the tube. The hole is required to be located within 6 inches of the top of the tank. A vacuum relief valve may be installed in lieu of an antisiphoning hole in the dip tube.

15.0 Fuel Shutoff Valves or Electric Disconnects

A fuel shutoff valve is required for all fuel-fired water heaters. An electric disconnect should be installed for all electric water heaters. They are necessary for service, repair, or emergency shutdown.

16.0 TPR Valves

Combination temperature and pressure relief (T & P Relief or TPR) valves do two things: **1)** they open and release water out of the tank if the temperature exceeds **210˚F** (just below the boiling point), and **2)** they will open if the pressure in the tank exceeds **150 psi** (the maximum normal operating pressure for a water heater.)

Relief valves must be third-party tested. The certification mark is the indicator that the valve has been tested. Temperature relief valves must be set at a maximum temperature of 210°F (99°C). The valve is designed to dissipate energy at a rate (BTU rating) equal to or greater than the energy/heat input rate (BTU rating) of the water heater. A relief valve opens in proportion to the temperature and pressure forced upon its closure disk. The higher the temperature or pressure, the greater the force, and the more the valve opens.

The valve must be set to 25 psi (172 kPa) above the system, but not over 150 psi (1035 kPa). This setting should not exceed the tank's rated working pressure. An undersized valve would not be able to prevent pressure from exceeding the maximum capacity, and a dangerous situation could result. The result could be an explosive tank rupture accompanied by an instantaneous release of enormous thermal energy stored in superheated water inside the tank. It could propel a water heater like a rocket through multiple stories and the roof of a dwelling.

A temperature and pressure relief (T&P Relief or TPR) valve should be installed on all storage water heaters operating above atmospheric pressure. Tankless water heaters must have TPR valves installed. Water heaters without this protection can produce explosions and have been responsible for many deaths.

Boilers should be equipped with pressure-relief valves with minimum rated capacities for the equipment served. A boiler operates at a maximum water pressure of 160 psig and at a maximum water temperature of 250°F (121°C). Pressure-relief valves should be set at the maximum rating of the boiler. Discharge should be piped to drains by gravity to within 18 inches (457 mm) of the floor or to an open receptor.

Some gas water heaters use temperature cut-outs, such as the Watts 210 valve. This is a valve installed in the gas supply line to the water heater. There is a temperature probe in the top of the water heater. The Watts 210 valve will shut off the gas supply to the water heater if the water temperature exceeds 210˚F. Once the water is cooled, the valve can be reset manually to restore the gas flow.

16.1 Location of TPR Valve on Hot Water Tank

In order to properly sense the tank's water temperature, the TPR valve should be located in the tank water in the upper 6 inches of the hot water tank, where all of the hottest water is located. The location is more important for temperature than pressure, since the pressure is uniform throughout the tank. To prevent heating the water above 210˚ F, the TPR valve must be installed in the hot water within the top 6 inches of the tank. Typically water heater tanks have an opening in the tank shell installed by the manufacturer.

16.2 Relief Valve Importance

Water is essentially an incompressible solid. It has no latent heat energy within itself to expand when released, unless the water is superheated. Water above 212˚ F is superheated water, and superheated water would really like to turn into steam at atmospheric pressure. It possesses latent heat energy, which can flash into steam and create a force that is not unlike an explosion.

Water would normally boil at 212 ˚F, but inside a tank it can't expand anywhere so it can't boil off into steam. Water in a "closed" system and under pressure, such as inside a hot water tank, has a much higher boiling point. For example, where water supplied to a tank is at 50 psi, the boiling point is 297.7˚ F.

Let's assume a water heater tank has 30 gallons of superheated water inside it. Assume 50 psi and the water temperature is superheated at 300 ˚F. Remember that superheated water really wants to turn into steam. If the tank ruptures, then 30 gallons of superheated water will instantaneously turn into steam in an outwards direction through the rupture.

There is a tremendous amount of energy released as the superheated water is exposed to atmospheric pressure and immediately turns into steam. Every cubic inch of water becomes a foot of steam!

Below is a chart showing the explosive energy created in a 30 gallon hot water tank at various pressures and temperatures.

Energies developed in a 30-gallon hot water tank		
Pressure psi	**Water will boil at**	**Foot-pounds of energy released when 30 gallons of water is exposed to atmospheric pressure**
0	212.0˚ F	0
10	239.5˚ F	479,800
30	274.0˚ F	1,305,000
50	297.7˚ F	2,021,900
70	316.0˚ F	2,642,000
90	331.2˚ F	3,138,400

Note that at 50 psi, water flashes into steam at 297.7˚ F, and the energy released equals more than 2 million foot-pounds of energy, similar to the explosive energy released by one pound of Nitroglycerin. A 16-inch gun on a USS Iowa class battleship produced a 7,500,000 foot-pounds of energy.

This is why it is essential to avoid excessively high water temperatures and pressures at a water heater tank.

17.0 Expansion Tank on a Boiler


Hot water boilers should be provided with expansion tanks. There are two types of expansion tanks for use with the residential boiler system. A nonpressurized tank is simply a cylinder filled with air at atmosphere pressure. A pressurized tank is a sealed cylinder divided by a flexible diaphragm. An expansion tank provides space for the water to expand as it is heated and keeps the water pressure in the normal operating range while the boiler is operating.

18.0 Discharge Pipe on T&P Relief Valve

There are thirteen requirements for a discharge pipe serving a TPR valve. They are as follows:

1) The pipe should not be directly connected to the drainage system;

2) The pipe should discharge through an air gap located in the same room as the water heater;

3) The pipe should be constructed of materials tested, rated, and approved for such use;

4) The pipe should not be smaller than the diameter of the outlet of the valve served and should discharge full size to the air gap;

5) The pipe should not have valves or tee fittings installed;

6) The pipe should not have a threaded end;

7) The pipe should serve a single relief device and should not connect to piping serving any other relief device or equipment;

8) The pipe should discharge to the floor, to an indirect waste receptor or to the outdoors. Where discharging to the outdoors in areas subject to freezing, discharge piping should be first piped to an indirect waster receptor through an air gap located in a conditioned space;

9) The pipe should not terminate more than 6 inches (152 mm) above the floor or waste receptor;

10) The pipe should discharge in a manner that does not cause personal injury or structural damage;

11) The pipe should be installed so as to flow by gravity;

12) The pipe should discharge to a termination point that is readily observable by the building occupants; and

13) The pipe should not be trapped.

The termination of a relief valve discharge pipe should always be visible and conspicuous. An air gap is necessary to prevent backflow and contamination of the potable water system. The discharge pipe must not be reduced in size, and must not be less than the size of the relief valve outlet. A reduction in size will act as a restriction and would impede the flow rate of the discharge. Relief valves must not be exposed to freezing temperatures. The slow drip of a leaking valve in freezing temperatures would cause ice to form and restrict the discharge and disable the valve.

The discharge pipe should have a minimum pressure rating of 100 psi (690 kPa) at 180 °F (82 °C). Water heater temperature-relief valves are usually set to open and discharge at 210 °F (99 °C).

19.0 Water Leak Catch Pan



A water heater tank should be installed inside a pan in locations in a dwelling where a leak from the tank could cause damage to the structure or property. The pan is intended to catch water leaks from the tank or associated connections, or condensate from the tank.

The pan should be galvanized steel or other listed material for that use, with a minimum thickness of 24-gauge (0.016 inch) (0.4 mm). Prefabricated aluminum and plastic pans are common and widely used. Aluminum and plastic pans may not be allowed by the authority having jurisdiction (AHJ) or code official, because they are not galvanized steel. Some tank manufacturers require the use of a metal pan only.

A relief-valve pipe terminating into a water leak catch pan is not permitted, because the pan is not an indirect waste receptor. Most pans have only a ¾ inch-diameter (19 mm) drain outlet, which is not capable of gravity draining the pressurized discharge of the relief valve at full flow.

The pan should not be less than 1.5 inches (38 mm) deep. The pan should be of sufficient size and shape to catch all dripping water or condensate leaks. The pan should be drained by an indirect waste pipe having a minimum diameter of ¾ inch (19 mm). The pan drain must not be reduced in

size over its entire length, because a reduction will act as a restriction and will impede the discharge.

The pan must not connect directly to the drainage system. The pan should terminate over a suitably located indirect waste receptor or floor drain or extend to the exterior. An air gap must be provided to prevent backflow when the pan drain terminates into an indirect waster receptor or a floor drain. When the pan terminates to the exterior of the dwelling, it should terminate at least 6 inches (152 mm) and at most 24 inches (610 mm) above the adjacent ground surface. This makes the pan low enough not to be a nuisance and high enough to prevent the pan drain from becoming blocked by vegetation, snow, and ice.

20.0 Defects at a Water Heater Tank

Check for physical damage to the tank, particularly rust and corrosion on the bottom of the tank. Check for water marks on the floor of the tank. Check for a leaking TPR valve. The covers at the electric heating elements should not be disturbed. Corrosion can be found where the water pipes are connected to the top of the tank. The electricity or the fuel may be shut off. There could be scorching at the burner cover area. The heat roll out shield should be in place. Confirm that the drip tube is installed. The draft hood and vent connector are often loosely attached. All tanks should be accessible with at least 24 inches (609 mm) of working space around them. Check the burner and flame. A damaged baffle (helix) could fall down on the burner.

Tankless coils inside boilers can leak. The coil can damage the boiler. The coil is prone to clogging. There should be a temperature control valve installed to control the scalding water coming from the coil in the boiler.

21.0 Hot Water



Hot water is defined as water of a temperature of 110°F (43°C) or greater. Tempered water ranges from 85°F to 110°F (29°C to 43°C), and the device supplying the tempered water must limit the temperature to 110°F (43°C).

If the distribution piping distance between the hot water source and any fixture is greater than 100 feet (30,480 mm), then the hot water supply system should have a method of maintaining the temperature of the water. Otherwise, water is wasted at the point of use while the user is waiting for the desired temperature to be reached.

Pipe insulation is not required on all hot water distribution pipes, but insulation of the hot water distribution pipes on a return circulation system should be installed.

22.0 Flammable Vapor Ignition Resistant (FVIR) Water Heater

In 2003, a new standard for water heaters was developed and phased in. It says, “The water heater should not ignite flammable vapors outside the water heater created by the spilling of gasoline onto the floor.” The Consumer Products and Safety Commission found thousands of fires,

injuries and deaths were related to water heaters. Most of these cases were because of improper storage or handling/spillage of gasoline.

If the tank is in compliance with the FVIR standards, it does not have to be raised 18 inches in garages or similar locations, unless required by the manufacturer or local code authorities.

A FVIR water heater has the following components: 1) a device to prevent ignited vapors from passing out of the combustion chamber, 2) a one-way intake system to control the movement of makeup air into the combustion chamber, 3) an inner door and burner assembly to create a sealed junction with the combustion chamber, preventing combustion air and flammable vapors from entering the chamber through the front of the water heater.

All FVIR water heater tanks have things in common. 1) **A flame arrestor plate**. Located under the burner, the metal plate is designed to allow combustion air into the combustion chamber but keep flames from escaping downward and igniting flammable vapors below. 2) **Thermal cutoff switch**. It is designed to shut down the heater if it senses excessive temperatures caused by inadequate combustion air inside the chamber. Inadequate combustion air can be caused by an explosion of flammable vapors, inadequate venting, inadequate makeup air or the accumulation of lint, dust, or oil on the screen. 3) **A lint, dust, and oil screen**. The screen is designed to protect the combustion process from lint, dust, or oil. The screen openings can become clogged, especially when the tank is located in a basement or utility room.

23.0 FVIR System on a Bradford White Defender Water Tank

During normal operation, air for combustion is drawn into the water heater through the openings in the jacket. This air travels down and around the combustion chamber and enters through holes in the very bottom of the corrosion-resistant combustion chamber. The air then travels up through the oriented flame arrestor plate louvers, where the velocity of the air is increased and its direction altered. The air then mixes in a normal manner with the supplied gas and is efficiently combusted, producing very low NOx emissions (nitrogen oxides).

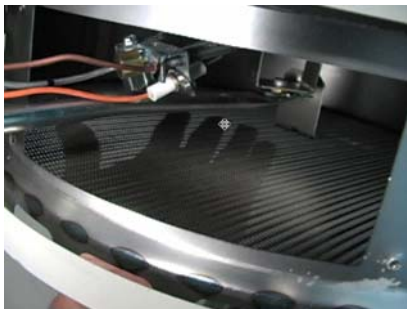
In the case where trace amounts of flammable vapors are present in the air flowing into the chamber, the vapors are harmlessly ignited by the burner/pilot flame. If flammable vapors are in sufficient quantity to prevent normal combustion, the burner/pilot flame is shut down.

Should the flammable vapors continue to the burner, the flame arrestor plate prevents the flames from traveling backwards and igniting vapors outside of the combustion chamber. The calibrated, multipurpose thermal switch recognizes this and shuts down the pilot and main burner. This switch also deactivates the burner and pilot in the unlikely event of restricted airflow caused by severe lint, dust, or oil accumulation on the arrestor plate.

24.0 Maintenance Recommendations

- Bradford White suggests a few things to do to maintain the tanks.
- Every 6 months, check the burner, pilot, and flame color.
- Annually check the operation of the thermostat.
- Clear the jacket slots of dirt, dust, or other restrictions.
- For electric, check the seal around the heating elements and check the operation of the thermostats.
- For a gas-fired tank, annually remove the cover, inner door, and main burner assembly to clean orifices and related parts of any dirt or other foreign material; clean the burner ports and the combustion chamber with a wire brush and vacuum.

- Once a year, check the TPR valve.
- Monthly drain a gallon of water from the tank to remove silt and sediment.
- Every two years inspect the anode rod and replace when necessary.
- The use of a water softener may increase the speed of the anode consumption, so more frequent inspections are recommended.
- Inspect the vent system at least once a year.


25.0 Suggested Narrative Language

The drain valve is leaking. A water heater must have a drain valve installed for service, maintenance, sediment removal, repair, and replacement. Correction and further evaluation recommended.

The water heater is not accessible. “Accessible” does not include the removal or destruction of finish materials, such as drywall, paneling, or built-in cabinets.

An expansion tank is needed at the water heater tank. A “closed” water distribution system with a check valve installed on the main water line coming into the house requires a thermal expansion control device, such as an expansion tank. When water heats up inside the tank, it expands. Since it cannot expand out to the street because of a check valve, the expansion tank will absorb the expansion. Correction and further evaluation by a plumber is recommended.

The water heater is inappropriately located. Fuel-fired water heaters should not be installed in a room used as a storage closet. Fuel-fired water heaters should not obtain combustion air from sleeping rooms, bathrooms, or toilet rooms. Correction and further evaluation by a plumber is recommended.

The water heater is located in an attic space. A suitable access opening, passageway, and work space is required when a water heater is installed in an attic. The opening, passageway, and workspace should be large enough to accommodate the removal and replacement of a water heater.

The water heater tank is located in the garage. A hot water tank with an open source of ignition should be elevated not less than 18 inches (457 mm) above the floor of a garage. There is an exception for appliances that are listed as flammable vapor ignition resistant (FVIR).



Conclusion

In completing this course, we learned how to identify components of gas-fired and electric water heater tanks, recognize defects and safety hazards in relation to modern standards and requirements, explain how a flammable vapor ignition resistance system (FVIR) works, measured and identify confined spaces, we learned the importance of temperature-and-pressure relief valves, we learned from a master plumber.

Exam Questions for Water Tanks Course

1. This Water Heater Tanks course is not a code compliance course.
2. Water heaters have a constant supply of fresh water with lots of corrosion-causing oxygen. Because of this, water heaters are prone to corrosion.
3. A water heater must have _____ installed for service, maintenance, sediment removal, repair, and replacement.
4. The outlet is a standard _____ (19 mm) male hose thread.
5. Water heaters should be _____ for routine inspections, maintenance, adjustment, repairs, and replacements.
6. _____ means to reach the water heater by possibly first removing a panel, door, or similar obstruction.
7. All water heaters must be certified by a third party, approved agency.
8. The labeling on the hot water tank could list the manufacturer, the tank size, the serial number, model number, fuel type, BTU ratings, and proper clearances required for the tank.
9. A pressurized expansion tank is a sealed cylinder divided by a _____.
10. The best location for installing an expansion tank is near the hot water source, _____.
11. An _____ uses the main furnace or boiler to heat a fluid that's circulated through a heat exchanger in the storage tank.
12. Installation of water heater tanks which use solid, liquid, or gas fuel should be permitted in a room containing air-handling machinery when such room is used as a plenum.
13. Fuel-fired water heaters should not be installed in a room used as a _____.
14. With a couple exceptions, fuel-fired water heaters should not obtain combustion air from sleeping rooms, bathrooms, or toilet rooms.
15. A hot water tank with an open source of ignition should be elevated not less than ___ inches (457 mm) above the floor of a garage.
16. There is an exception for raising a hot water tank with an open source of ignition in a garage that is listed as _____.
17. Water heaters are not permitted to be installed in an attic.
18. When a water heater is installed in an attic. The opening, passageway, and workspace should be large enough to accommodate _____.
19. There should be a level workspace that is at least ___ inches (762 mm) deep and ___ inches (762 mm) wide at the service-side of the water heater.
20. If the volume of space in which the appliance is located is less than 50 cubic feet of space per 1,000 BTU per hour of aggregate input of the appliance, then it is a _____.
21. _____ permanent openings to adjacent spaces could be provided so that the combined volume of all spaces meets the requirements.
22. If the building is sealed so tightly that infiltration air is not adequate for combustion, combustion air then should be obtained from _____.
23. If all combustion air is taken from the inside of the dwelling, then two permanent openings should be installed. One opening should be within _____ of the top and one within _____ of the bottom of the space.
24. If all combustion air is taken from the _____, then one opening should be within 12 inches (305 mm) of the top and one within 12 inches (305 mm) of the bottom of the space.

25. In calculating the free area of combustion air openings fitted with louvers, metal louvers obstruct about ____ percent of the opening. Wooden louvers obstruct _____ percent.
26. In those areas determined to have high earthquake risk, it is important that a water heater be fastened in place with _____ straps to avoid damage.
27. Strapping should be at a point within the _____ and _____ of the tank's vertical dimension.
28. A _____should be installed on the _____ branch line from the main water supply line to each hot water storage tank or water heater.
29. An inspector should verify that a full-open valve is installed on the cold water supply line.
30. At the top of the tank, a ____ is installed in the dip tube to prevent water from being siphoned from the tank through the tube.
31. Combination temperature and pressure relief (T & P Relief or TPR) valves do two things: 1) they open and release water out of the tank if the temperature exceeds ____˚F (just below the boiling point), and 2) they will open if the pressure in the tank exceeds ____ psi (the maximum normal operating pressure for a water heater.)
32. A temperature and pressure relief (T&P Relief or TPR) valve should be installed on all storage water heaters operating above _____.
33. Some gas water heaters use temperature cut-outs, such as the Watts 210 valve. This is a valve installed in the _____ line to the water heater.
34. In order to properly sense the tank's water temperature, the TPR valve should be located in the tank water in the upper _____ inches of the hot water tank, where all of the hottest water is located.
35. Water is essentially an incompressible solid.
36. There is a tremendous amount of energy released as the superheated water is exposed to atmospheric pressure and immediately turns into steam. Every cubic ____ of water becomes a _____ of steam!
37. Hot water boilers should be provided with expansion tanks.
38. The TPR discharge pipe should discharge through _____ located in the same room as the water heater.
39. The TPR discharge pipe could have a threaded end.
40. The TPR discharge pipe should not terminate more than _____ above the floor or waste receptor.
41. The TPR discharge pipe should be installed so as to flow by _____.
42. The TPR discharge pipe should be trapped.
43. The termination of a temperature-pressure relief valve discharge pipe should always be visible and _____.
44. A water heater tank should be installed inside _____ in locations in a dwelling where a leak from the tank could cause damage to the structure or property.
45. A relief-valve pipe terminating into a water leak catch pan is not permitted, because the pan is not an _____.
46. An _____ must be provided at the discharge pipe of a TPR valve to prevent backflow when the pan drain terminates into an indirect waster receptor or a floor drain.
47. Hot water is defined as water of a temperature of _____°F (43°C) or greater.

48. In 2003, a new standard for water heaters was developed and phased in. It says, "The water heater should ignite flammable vapors outside the water heater created by the spilling of gasoline onto the floor."
49. All FVIR water heater tanks have things in common: 1) a flame arrestor plate, 2) thermal cutoff switch, 3) and a lint, dust, and oil screen.
50. Located under the burner of a FVIR tank, the metal plate is designed to allow combustion air into the combustion chamber but keep flames from escaping downward and igniting flammable vapors below is called a _____.
51. A _____ is designed to shut down a FVIR water heater if it senses excessive temperatures caused by inadequate combustion air inside the chamber. Inadequate combustion air can be caused by an explosion of flammable vapors, inadequate venting, inadequate makeup air or the accumulation of lint, dust, or oil on the screen.
52. The _____ on a FVIR water heater tank is designed to protect the combustion process from lint, dust, or oil. The screen openings can become clogged, especially when the tank is located in a basement or utility room.
53. The result of a tank rupture accompanied by an instantaneous release of enormous thermal energy stored in superheated water inside the tank could propel a water heater like a rocket through multiple stories and the roof of a dwelling.
54. A _____ is required for all fuel-fired water heaters.
55. An electric disconnect need not be installed for all electric water heaters.
56. The anti-siphone hole in a dip tube of a water heater tank is required to be located within ____ inches of the top of the tank.
57. If all combustion air for a water heater tank is taken from the outdoor air, then _____ permanent openings should be installed.
58. Each opening should have a free area of at least 1 square inch per 4,000 Btu/per hour (550 mm^2/kW) of total input rating of all appliances in the space when using _____ ducts (2,000 Btu/per hour if using _____ ducts).
59. A suitable access opening, passageway, and work space is required when a water heater is installed in an attic. The passageway should have continuous solid flooring not less than ____ inches (610 mm) wide.
60. If there's a malfunction of the water heater or its venting system, there is a potential for _____ to spread throughout the dwelling.
61. A "closed" water distribution system with a check (backflow) valve installed on the main water line coming into the house requires a _____, such as an expansion tank.