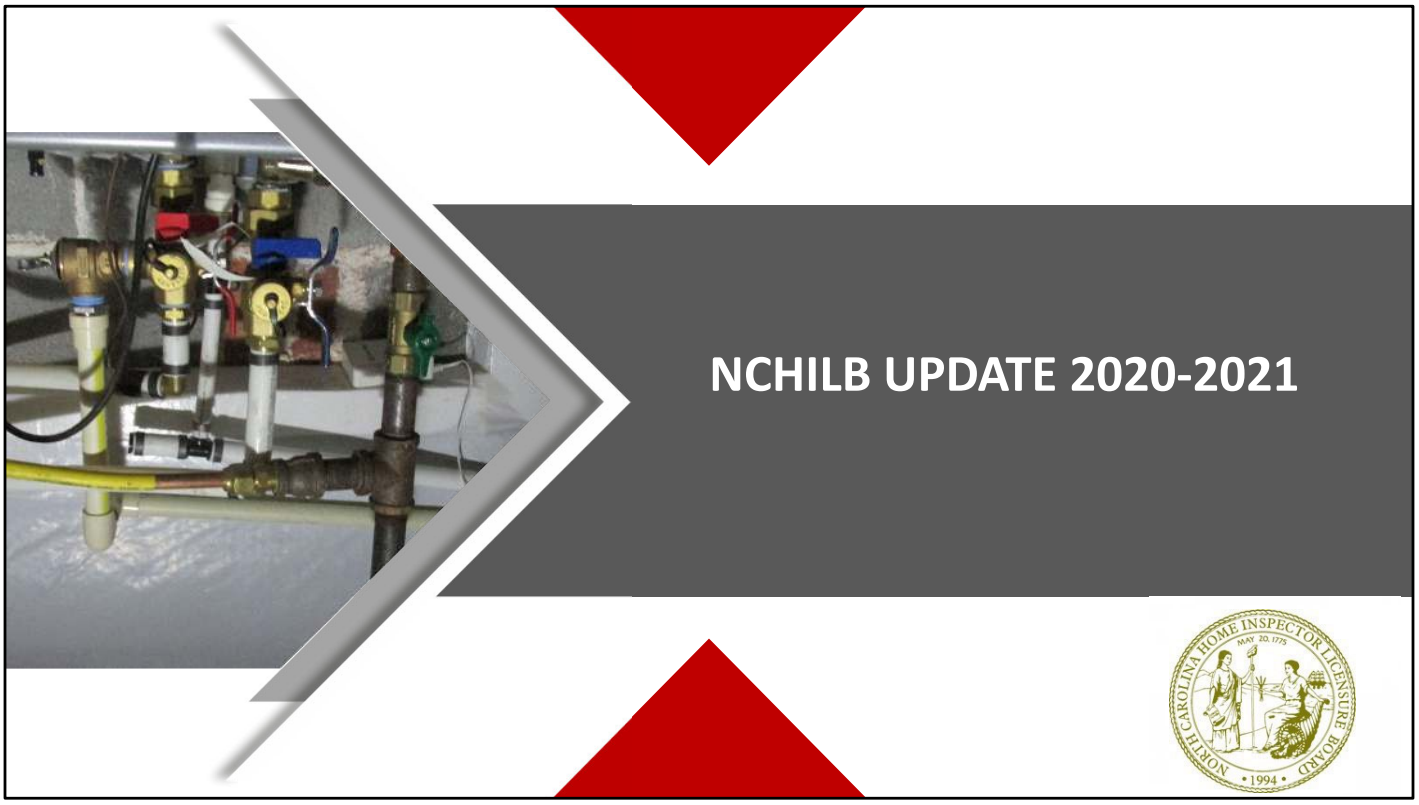



Please contact
Bonnie Gregory
336 350 8970
GregoryEngineers@cs.com

# Hot Water Systems

Class Survey
What are the Home Inspector's Inspection and Reporting Duties related to the hot water systems of a home?
What defines the system?

1. The actual unit? Where does NC SOP mention "water heater or water heating equipment"?
2. The fixtures?
3. The piping?




Survey

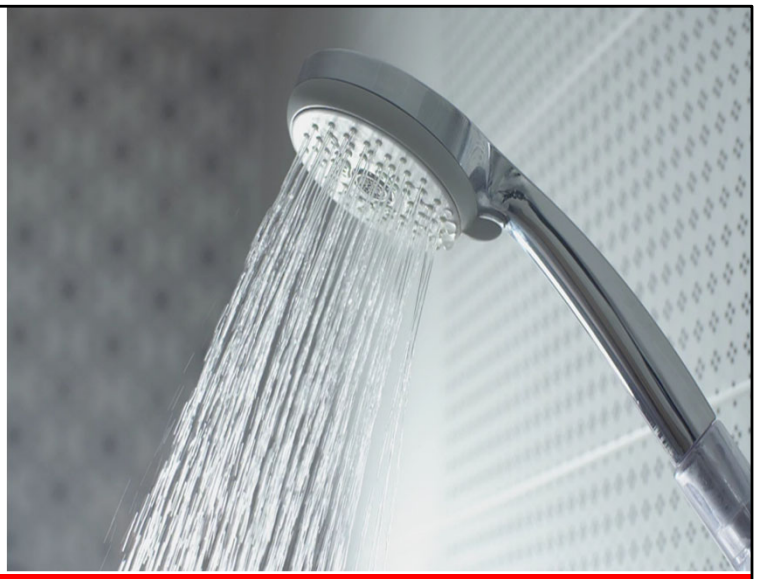
**Please record and save the Student answers for next year's Update!**

How many inspectors have had a call related to a problem with a water heater?

The unit?

The adequacy?

**.1109 PLUMBING**
**(a) The home inspector shall inspect:**
**(3)** Hot water systems including: water heating equipment; normal operating controls; automatic safety controls; and chimneys, flues, and vents;



The North Carolina Home Inspector Licensure Act
Standards of Practice

Review the Standard of practice
**Please record and save the Student answers for next year's Update!**
Ask the Following questions; lead the students to the answers: record or present the answer to the students
What automatic safety controls are present for a water heating system?

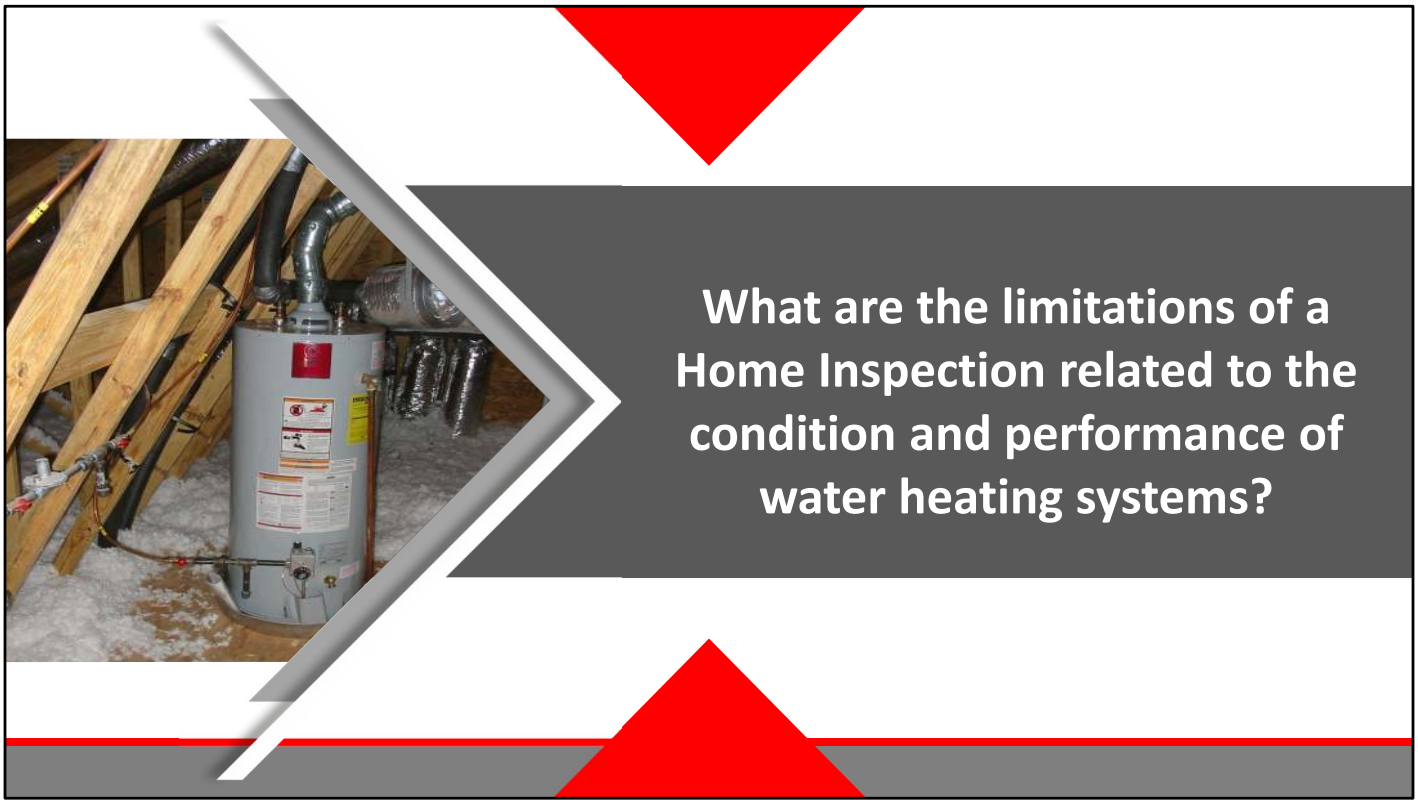
**.1109 PLUMBING**
**(b) The home inspector shall describe:**

(3) Water heating equipment, including fuel or power source, storage capacity or tankless point of use demand systems, and location; and



## The North Carolina Home Inspector Licensure Act Standards of Practice

Review the Standard of practice
Ask the Following questions; lead the students to the answers: record or present the answer to the students
**Please record and save the Student answers for next year's Update!**
What is a point of use demand system?
Is a point of use demand system considered tankless?
Is an expansion tank required?
Is a TPRV required?




Review the Standard of practice

**Please record and save the Student answers for next year's Update!**

## CLASS SURVEY

Why is the simple inspection of a water heater so difficult?

Could the required report confirmation statements be misleading?

What do we report the capacity of the water heater?



## Limitations verses Expectations

| SOP: Information Home Inspector must report | Goal / Purpose of Report Statements |
|---|---|
| Location of the Unit | Needed for Service and Maintenance |
| Capacity | Informational; comparison; Reference |
| Energy Source | Informational; comparison; Reference |

Explore the Board's reason for requiring the documentation of the capacity and power source of the water heater
Class Survey
Review the Standard of practice
**Please record and save the Student answers for next year's Update!**

**What factors can determine if the capacity of the water heater is adequate for the needs of a family?**



Start a survey list with the class to answer this question
**Please record and save the Student answers for next year's Update!**




**What determines how much hot water is needed for a typical family?**

Start a survey list with the class to answer this question
Push the list toward people and then back to the unit  installation and or condition
**Please record and save the Student answers for next year's Update!**

# What Information Can Be Provided?

**What information can be determined?**

**What information cannot be determined?**

**Start a survey and make a list**
**Please record and save the Student answers for next year's Update!**
**What information can be determined?**
**Confirmation that the unit was functioning to heat the water during the inspection.**
**Information about the general condition of the unit.**

**What information cannot be determined?**
**How long the unit will continue to operate.**
**If the unit can meet the demands of the new family.**

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**How long the unit will continue to operate.**
**If the unit can meet the demands of the new family.**

# How are we protected?

**.1109 PLUMBING**

(d) The home inspector is not required to:

(5) Inspect:

(H) Solar water heating equipment

(6) Inspect the system for proper sizing, design, or use of materials.

(7) Report on the absence or presence of thermal expansion tanks; or,

(8) Report on the adequacy of the reported water heater capacity.

**Start the discussion: Are the limitations in the SOP enough?**
**What else can a home inspector do?**

# SOP

**.1109 PLUMBING**

**(a) The home inspector shall inspect:**

(3) Hot water systems including: water heating equipment; normal operating controls; automatic safety controls; and chimneys, flues, and vents;

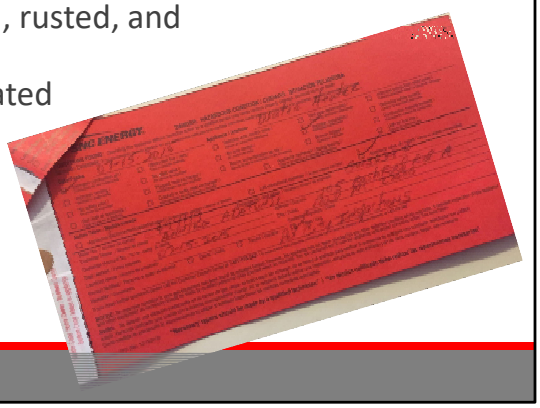
**(b) The home inspector shall describe:**

(3) Water heating equipment, including fuel or power source, storage capacity or tankless point of use demand systems, and location; and

List all other sections and definitions in the SOP that involve hot water

# Complaints

1. Gas company came to light the pilot and stated improper installation.
    a. Improper combustion air
    b. Installation in bedroom closet
    c. Flue was incorrect, missing, disconnected, rusted, and etc…
    d. Unit stand was not approved/ properly rated
    e. Unit was unprotected in the garage
    f. Unit was not raised 18”
    g. Unit labeled unsafe



What does it mean when an appliance is red flagged or shut down by the gas company? This is a list of the most common conditions that result in a unit being red flagged

# Consumer Complaints

1. Gas Company red tagged the unit.
2. The water is never hot.
3. The home inspector said the unit was ??? Years old and it was much older.
4. The water stopped working a few days after we moved in.
5. Hot water is discolored, ruined our white clothes.
6. Unit is rusted and looks terrible, felt inspector should have informed
7. The pilot goes out on a daily basis
8. The water heater will not produce enough hot water…
    a. to fill the bathtub
    b. for everyone in our family to shower

This is a list of the most common consumer complaints.

Which consumer complaints related to the Gas company violations?

# Plumbing Codes

As an introduction to water heaters, we will review the plumbing, mechanical and building codes that apply to residential installations in order to develop inspection procedures.

The main areas of focus will be

North Carolina State Building Code:

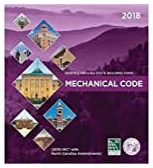
Residential Code: Chapter 20, 24, & 28

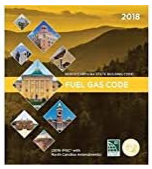


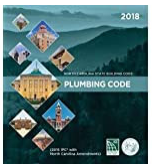
The instructor should be very familiar will all code sections related to water heaters, gas lines, fixture/appliances, and exhaust/combustion air. This course will cover key points, but questions from the Inspectors may come from sections not covered.
It is also suggested that you be familiar with the International Code and know the variances from the NC Codes and from the NC Residential Code.
Don't forget Energy Code, just in case you have questions in this area.

# Building Codes

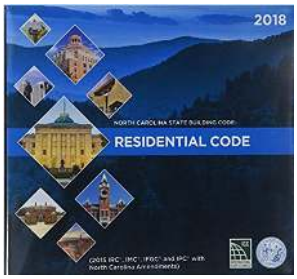













**What is the purpose of the Residential Code?**

Be able to Discuss Relationships between the Building Code volumes and compare to Residential Code.

1. Can the code official require the installer to meet both the plumbing code full and or the residential abridged.
2. Be able to list 3 to 4 known variances between the two codes:  Such as relief valve used for thermal expansion

Residential Code
Chapter 28: Water Heaters: P2801

**Residential Plumbing**

P2801.1 Required

Hot water shall be supplied to plumbing fixtures and plumbing appliances intended for bathing, washing and culinary purposes.

Discuss Relationships between Residential plumbing and the full plumbing codes, intent and purpose  Note the different scopes
Site 3 to 4 variances and 3 to 4 differences

Plumbing Code
Chapter 5: Water Heaters

501.1 Scope.

The provisions of this chapter shall govern the materials, design, and installation of water heaters and the safety devices and appurtenances.

Discuss Relationships between Residential
What is the focus? How does this differ from Full Plumbing Code

# Plumbing Codes vs R. Chapter 28

**P2803.2 Temperature Control**
Where a combination water heater-space heating system requires water for space heating at temperatures exceeding 140°F (60°C), a master thermostatic mixing valve complying with ASSE 1017 shall be installed to temper the water to a temperature of not greater than 140°F (60°C) for domestic uses.

**P2803.1 Protection of Potable Water**
Piping and components connected to a water heater for space heating applications shall be suitable for use with potable water in accordance with Chapter 29. Water heaters that will be used to supply potable water shall not be connected to a heating system or components previously used with nonpotable-water heating appliances. Chemicals for boiler treatment shall not be introduced into the water heater.

**501.2 Water heater as space heater.**

Where a combination potable water heating and space heating system requires water for heating at temperatures higher than 140°F (60°C), a master thermostat mixing valve complying with ASSE 1017 shall be provided to limit the water supplied to the potable hot water distribution system to a temperature of 140°F (60°C) or less.

The potability of the water shall be maintained throughout the system.

The instructor should be prepared to summarize

1. System types for this code application
2. ASSE 1017 specifications
3. How do two code sections differ?

# Plumbing Code

P2801 (501.3) Drain valves. Drain valves for emptying shall be installed at the bottom of each tank-type water heater and hot water storage tank.



Inspection Tip

1. Plastic line entering burner chamber indicates that this is a closed burner with electronic ignition.
2. Are other penetrations gas line and drain valve gasketed or sealed?

We will explore the significance of this information later in the course

**The instructor will be charged with the duty of developing an Inspection procedure as the class progresses**

The goal of this course is to review key codes, discuss why the codes were developed, and develop an inspection procedure for water heater systems step by step

A running list of inspection procedures should be kept until the end of the class. At the end of the class, the inspection procedure list should be accessible to the students.

Start leaning the students toward using inspection procedures

## Defects

1. **Deterioration of Plastic valves**
2. **Leaking Valves**
3. **Capped valves**
4. **Corroded Tank connection**
5. **Deteriorated casing gasket/ wet insulation**







Review the structure of the water heater construction
Difference in manufacture of penetrations for Flue Categories.
Build Inspection Steps






## History of Leaking

Survey Students
Evidence of ongoing or past leaks or wet environment

# Location

Water heaters and storage tanks should be located and connected so as to provide access for observation, maintenance, servicing and replacement.

What limitations can the location of a water heater create for a home inspector?

Class Survey
**Start a survey and make a list**
**Please record and save the Student answers for next year's Update!**

How many inspectors have reported
1. Not being able to locate or access the water heater?
2. What about having a limited view of the unit?

## Limitations

If you can not see the top and all sides of the water heater, should a report statement be included as a limitation in the report?

The visual inspection of the water heater was limited due to:

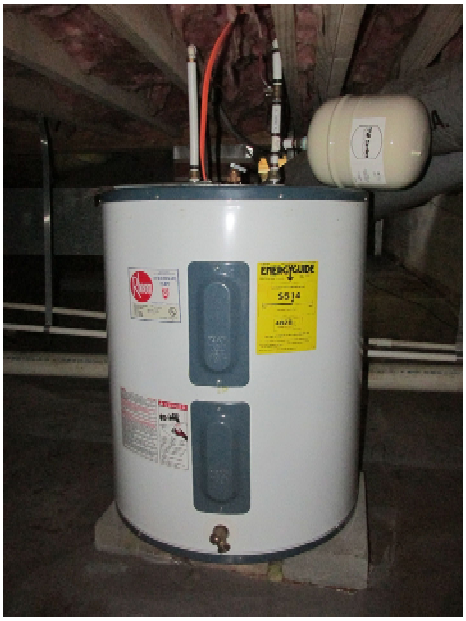




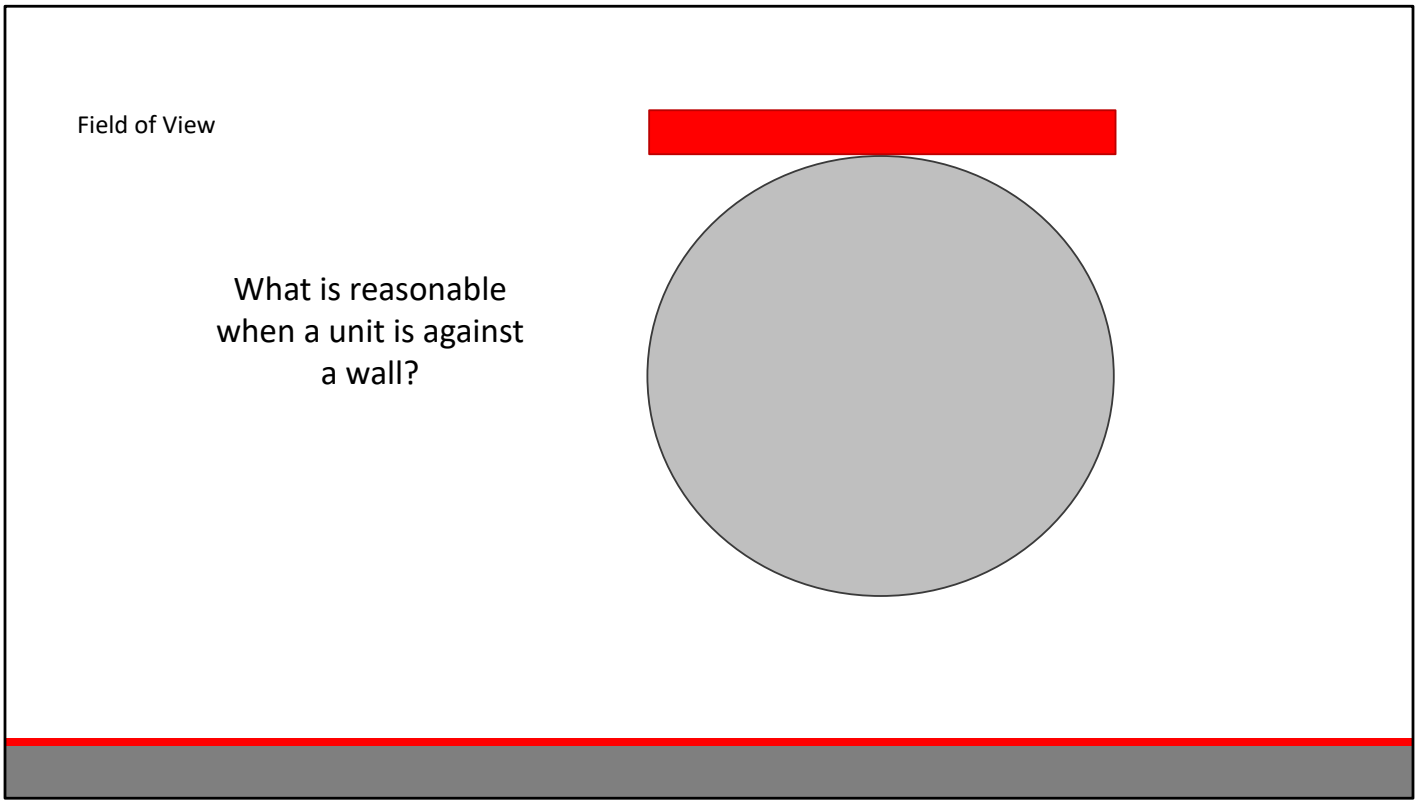


Start class survey list of limitations…
**Start a survey and make a list**
**Please record and save the Student answers for next year's Update!**




Discuss the different points of view



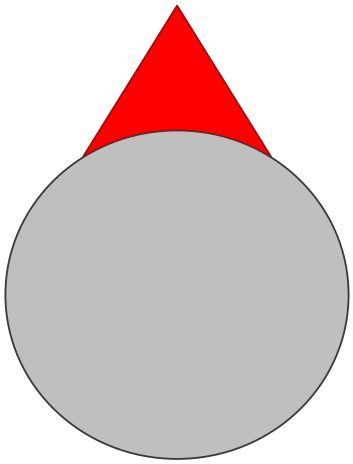

Demonstration:  small water heater is needed

Field of View

Key Inspection Points

1. Top, bottom, and sides of the unit
2. Controls panels/ Burner Chambers
3. Supply lines
4. TPRV
5. Drain Valve
6. Power or Fuel turn off



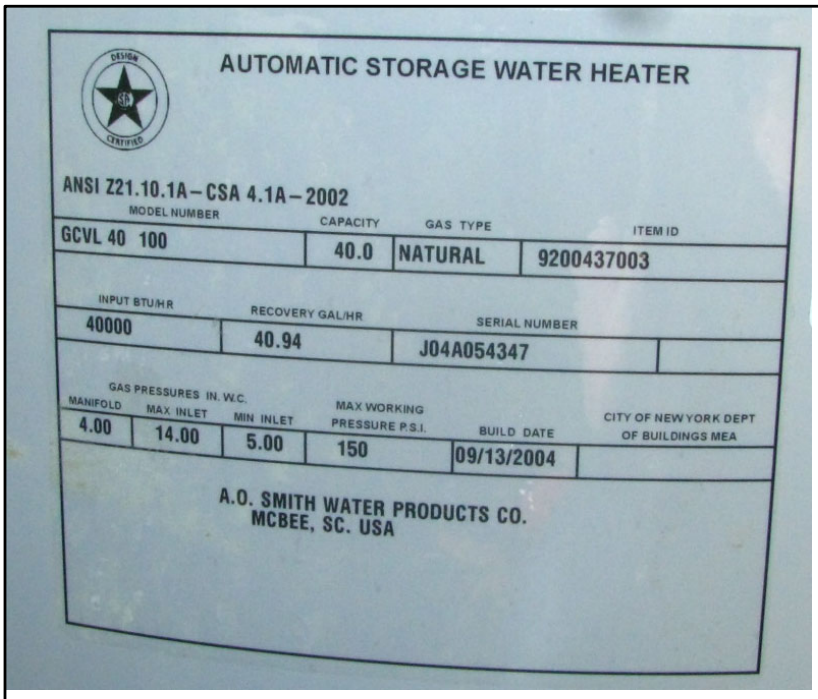


**Inspection Procedure List : Starter Base: Build Procedures: 4 Paths based on flue category and energy type**

# Limitations: What Do you See?




Make a list with the class of all visible defects
Make a list of possible defects that can not be seen
Review safety protocols related to water heaters in the crawl space




The data plate is the first point of inspection.

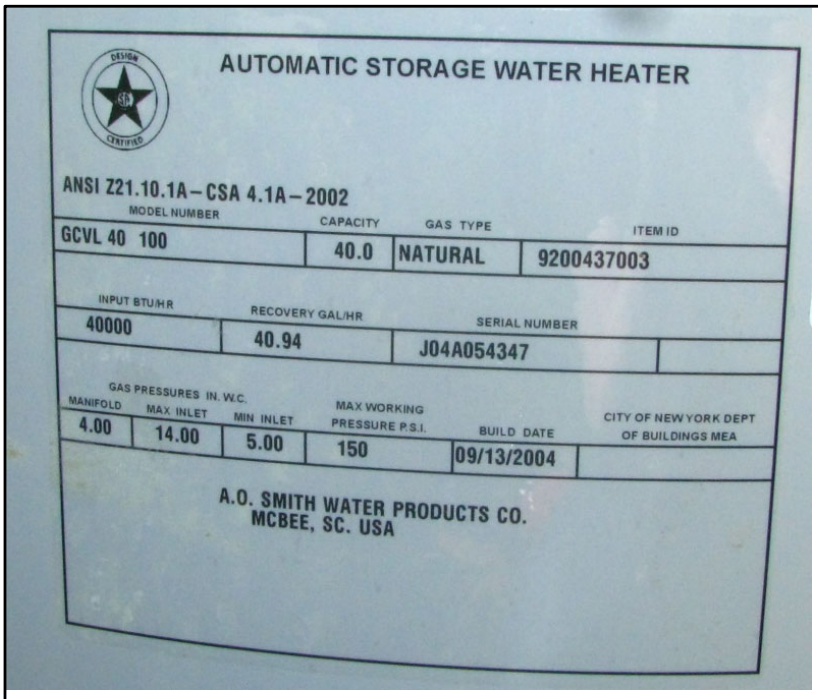
What information can we gather?

1. Unit Type
2. Power or Fuel
3. Capacity
4. ANSI Standard
5. Build Date

**Max working pressure is 150 psi, the unit operates at the pressure of the household water supply.**

**Discuss the related to labeling for Natural Draft verses Direct Vent**

**Introduce ANSI, standard scope and significance: will discuss more later**




Are data plates required?

**Max working pressure is 150 psi, the unit operates at the pressure of the household water supply.**
**Discuss the related to labeling for Natural Draft verses Direct Vent**
**Introduce ANSI Z21 we will discuss in later section**

Let’s In Inspect

What do you see?

When would this be required?

Are there other uses?



Review history of cold changes that resulted in the use

# Mixing Valve







Discuss Function and installation
What is a tank extender?
The instructor should have a display for demonstrations: Small electrical 5 gallon water heater with mixing valve installed
Demonstration water heater and install tank extension valve. Make sure you purchase and use approved products only

# Codes

**Residential Plumbing**
P2803.2 Temperature control. Where a combination water heater-space heating system requires water for space heating at temperatures exceeding 140°F (60°C), a master thermostatic mixing valve complying with ASSE 1017 shall be installed to temper the water to a temperature of not greater than 140°F (60°C) for domestic uses.

**Residential Mechanical**
M2004.1.2 (1002.2.2) Temperature limitation. Where a combination potable water-heating and space-heating system requires water for space heating at temperatures higher than 140°F (60°C), a temperature-actuated mixing valve that conforms to ASSE 1017 shall be provided to temper the water supplied to the potable hot water distribution system to a temperature of 140°F (60°C) or less.

Review codes and how temperature –actuated valve works

# Plumbing Code

**501.8 Temperature controls**. All hot water supply systems will be equipped with automatic temperature controls capable adjustments from the lowest to the highest acceptable temperature settings for the intended temperature operating range.

In water heating systems where temperatures exceed 140 F a means such as an approved mixing valve shall be installed to temper the water for domestic uses

What other codes mention the requirement for mixing valves?

# Plumbing Code

**501.6 Water temperature control in piping from tankless heaters**. The temperature of water from tankless water heaters will be a maximum of 140 °F (60°C) when intended for domestic uses. This provision shall not supersede the requirements for protective shower valves in accordance with Section 424.3.

**501.8 Temperature controls.** All hot water supply systems will be equipped with automatic temperature controls capable adjustments from the lowest to the highest acceptable temperature settings for the intended temperature operating range.

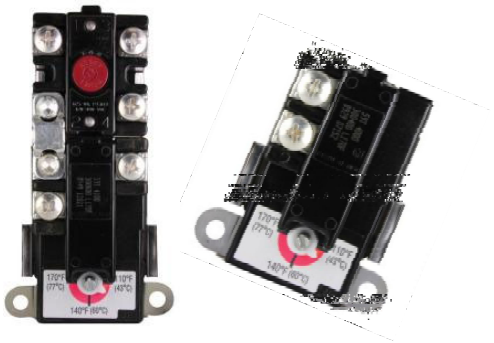
In water heating systems where temperatures exceed 140 °F a means such as an approved mixing valve shall be installed to temper the water for domestic uses

Make sure Code is Identified as Plumbing Code
Instructor Should Summarize Section 424.3 " Requirements for Scald Preventative valves

# Automatic Temperature Controls



GAS water heater thermostats



Electric water heater thermostats

Instructor Should Explain: You should have one of each type for demonstration: Webinar or in person hands on objects are important for this class!

1. Safety features of each control

# Automatic Temperature Controls







Electric water heater thermostat

Discuss the Smart Energy System and Signal Codes
Discuss order of operation of the Electric water heater upper and lower thermostats
Discuss Label Significance

# Codes

**Residential Plumbing**

P2804.8 (501.9)

NCGS 66-27.1 “Certain automatic hot water tanks or heaters to have approved relief valves; installation or sale of unapproved relief valves forbidden”

(a) No individual, firm, corporation or business shall install, sell or offer for sale any automatic hot water tank or heater of 120-gallon capacity or less, except for a tankless water heater, which does not have installed thereon by the manufacturer of the tank or heater an American Society of Mechanical Engineers and National Board of Boiler and Pressure Vessel Inspectors approved type pressure-temperature relief valve set at or below the safe working pressure of the tank as indicated, and so labeled by the manufacturer's identification stamped or cast upon the tank or heater or upon a plate secured to it.

Discuss the relationship between the  Residential Code, the gas code. plumbing and energy code
What controls the manufacture of water heater systems?
Why are storage tank type units under different specifications?

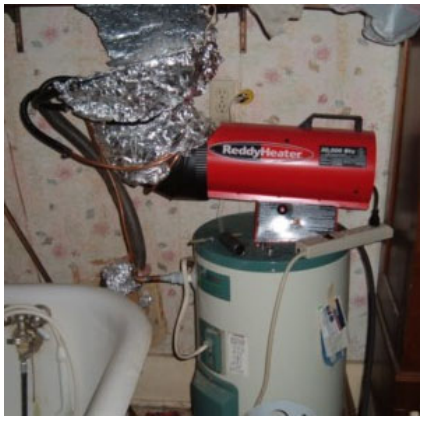
# Plumbing Code

(b) No individual, firm, corporation or business shall install, sell, or offer for sale any relief valve, whether it be pressure type, temperature type or pressure-temperature type, which does not carry the stamp of approval of the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel Inspectors.


Tankless Water Heater ?
FOR SALE!
Photographs provided by NC Licensed Home Inspector








Photographs provided by NC Licensed Home Inspector

# Scald Burns

UNSAFE HOT WATER

# Codes

**Residential Plumbing**

P2804.8 (501.0) Reprint of N.C.G.S 66-27.1A. Water heater thermostat settings.

(a) The thermostat of any new residential water heater offered for sale or lease for use in a single-family or multifamily dwelling in the State shall be preset by the manufacturer or installer no higher than approximately 120 degrees Fahrenheit (or 49 degrees Celsius). A water heater reservoir temperature may be set higher if it is supplying space heaters that require higher temperatures. For purposes of this section, a water heater shall mean the primary source of hot water for any single-family or multifamily residential dwelling including, but not limited to any solar or other hot water heating systems.

# Plumbing Code

**Residential Plumbing**

P2804.8 (501.0) Reprint of N.C.G.S 66-27.1A

N.C.G.S 66-27.1A. Water heater thermostat settings.

(b) **Nothing in this section shall prohibit the occupant of a single-family or multiunit residential dwelling with an individual water heater from resetting or having reset the thermostat on the water heater.** Any such resetting shall relieve the manufacturer or installer of the water heater and, in the case of a residential dwelling that is leased or rented, also the unit's owner, from liability for damages attributed to the resetting.

# Plumbing Code

N.C.G.S 66-27.1A Water heater thermostat settings.

(c) A warning tag or sticker shall be placed on or near the operating thermostat control of any residential water heater. This tag or sticker shall state that the thermostat settings above the preset temperature may cause severe burns. This tag or sticker may carry such other appropriate warnings as may be agreed upon by manufacturers, installers, and other interested parties.




What section of the SOP do warnings for personal safety fall under?

# Thermometer

The type of thermometer most available, appropriate, and practical for checking the hot water is a dial stem-type food thermometer or electronic thermometer that has a self calibration setting.









The inspector is reminded to make sure that the hot water supply is on the left of each fixture, including the shower. This is accomplished by bringing hot water up first at each fixture. Many new inspectors measure the water temperature and record levels over 120ºF. After 3 minutes of operation, experienced inspectors judge water temperature by feel and use measurement to confirm elevated temperature.

It is also important to ensure that cold and warm water can be obtained. It is not unheard of to have hot to both fixture sides or that a mixing valve does not function.

**What mistakes can be made?**

# Test the Tester

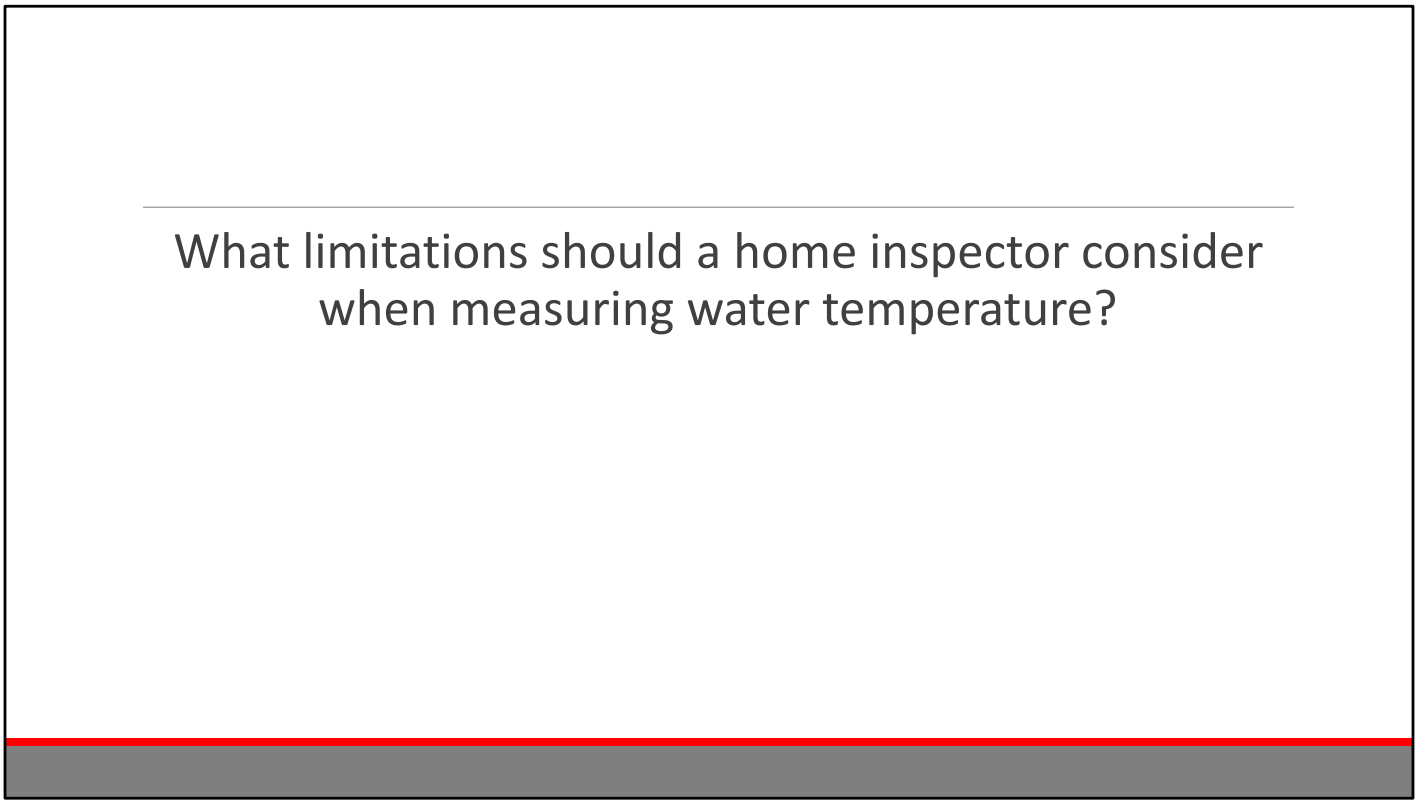
If thermometers are used on a continual basis, they should be checked at least once a week. They should also be calibrated whenever the thermometer is dropped and before it is first used. The owner's manual should be consulted for correct calibration methods.

Remember the inspector is not recording exact measurements, the inspector is using the thermometer to confirm the opinion that the water temperature is too high.

1. Estimate water temperature after operating fixture for three to five minutes. At 120ºF the water should not turn skin red until after 5 minutes.
2. Use Thermometer to confirm temperature is over 120ºF, not an exact reading.

Section out a level the inspection procedures list
Outline steps for accurately measuring fixture water temperatures:

1. Procedures
2. Tools
3. Timing




Survey the class and start a list

# Why Test Water Temperature?

Is a home inspector ensuring safe conditions or verifying the system is functioning as intended.
What does a reported temperature mean?
Should a temperature be reported?

# Scald Burns

Although scald burns can happen to anyone, young children, older adults and people with disabilities are the most likely to incur such injuries. Most scald burn injuries happen in the home, in connection with the preparation or serving of hot food or beverages, or from exposure to hot tap water in bathtubs or showers. Bathtub injuries are most serious because a larger percentage of the body is exposed.

American Burn Association
SCALD INJURY PREVENTION
Educator's Guide
A Community Fire and Burn Prevention Program Supported by the
United States Fire Administration Federal Emergency Management Agency

The severity of a scald injury depends on the temperature to which the skin is exposed and how long it is exposed. The most common regulatory standard for the maximum temperature of water delivered by residential water heaters to the tap is 120 degrees Fahrenheit/48 degrees Celsius. At this temperature, the skin of adults requires an average of five minutes of exposure for a full thickness burn to occur. When the temperature of a hot liquid is increased to 140ºF it takes only five seconds or less for a serious burn to occur (1).

*(1)Moritz, AR, Herriques, FC Jr. Studies of thermal injuries: II The relative importance of time and surface temperature in the causation of cutaneous burns. Am J Pathol 1947; 23:695-720. 2Stone, M, Ahmed J, Evans J. The continuing risk of domestic hot water scalds to the elderly. Burns 2000; 26:347-350.*

## Time and Temperature Relationship to Severe Burns[4]

| *Water temperature* | | *Time for a third degree burn to occur* |
|---|---|---|
| 155° F | 68° C | 1 second |
| 148° F | 64° C | 2 seconds |
| 140° F | 6 0° C | 5 seconds |
| 133° F | 56° C | 15 seconds |
| 127° F | 52° C | 1 minute |
| 124° F | 51° C | 3 minutes |
| 120° F | 48°C | 5 minutes |
| 100° F | 37° C | safe temperature for bathing |

*(4)Moritz, AR, Herriques, FC Jr. Studies of thermal injuries: II The relative importance of time and surface temperature in the causation of cutaneous burns. Am J Pathol 1947; 23:695-720. 2Stone, M, Ahmed J, Evans J. The continuing risk of domestic hot water scalds to the elderly. Burns 2000; 26:347-350.*

# Tankless Water Heaters




Remember tankless water heaters are allowed to be set to 140º F. Just like standard water heaters, tankless systems provide the hottest water to the fixtures closest to the unit. The inspector should be aware of the water temperature at all locations, and take extra caution when a tankless unit is present.

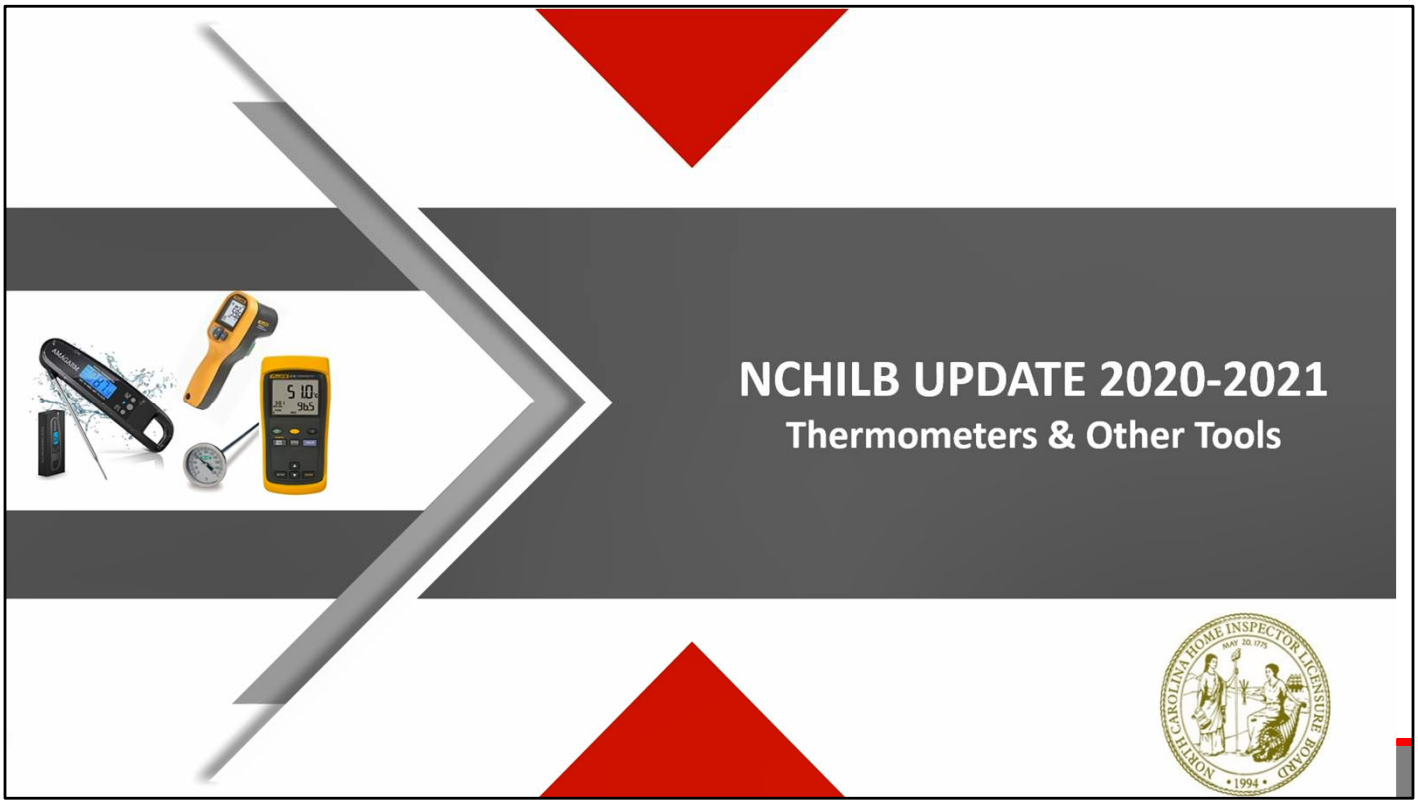
*When the temperature of a hot liquid is increased to 140ºF it takes only five seconds or less for a serious burn to occur (1).*

Should a home inspector report the absence or presence of anti scald devices when a tankless unit is present?

# Burns from water



| First Degree Burns<br>Superficial epidermal burns | |
|---|---|
| 120ºF | 5 minutes |
| 130ºF | 15 seconds |
| 140ºF | 5 seconds |
| 150ºF | 1 seconds 2nd degree with blisters |




VIDEO :
How does the E rating on the camera change the readings?
Discuss the importance of the setting?

# To Report or Not Report

The hot water supply in this home was noted to be higher than normally expected. The water temperature should be adjusted to prevent burn or scald injury. The standard recommended temperature is 120 ºF for adults and 100ºF for homes with small children and elderly.

SHOULD THE WATER HEATER SETTING BE LOWERED TO 100ºF FOR SAFETY?

Is this a good statement?
Do we protect by lower the water heater?

# The Inspection

In some cases, the water temperature is too high because the homeowner has changed the thermostat setting, however, a defect in the unit thermostat can also result in a dangerous condition.

The home inspector should never instruct the client to simply adjust the thermostat.

What is the inspector's primary duty?

What is the main duty? Functioning as intended




Should the home inspector report abandoned units?
Can an abandoned unit be used for storage in the existing water heating piping system?
Review 2018 Code Existing Buildings

# Code

Water heaters installed in attics. Attics containing a water heater shall be provided with an opening and unobstructed passageway large enough to allow removal of the water heater.

Is this always true in the home inspection world?

# Plumbing Code

**Residential Plumbing**

P2801.10 (502.3) Water heaters installed in attics

Water heaters installed in attics. The passageway shall not be less than 30 inches high and 22 inches wide and not more than 20 feet in length when measured along the centerline of the passageway from the opening to the water heater.

If 6 feet of headroom is provided along the centerline of the passageway from the opening to the water heater, the length of the passageway is permitted to exceed 20 feet.

The passageway shall have continuous solid flooring not less than 24 inches wide. A level service space at least 30 inches deep and 30 inches wide shall be present at the front or service side of the water heater. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches where such dimensions are large enough to allow removal of the water heater.




Discuss codes related to the clearance from wood framing

# Building Code
# 307.4 Alterations to trusses.

Truss members and components shall not be cut, drilled, notched, spliced or otherwise altered in any way without written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, water heater) shall not be permitted without verification that the truss is capable of supporting such additional loading.



## REQUIREMENTS

- Continuous solid flooring not less than 24 inches wide
- Service space 30 x 30 Wide
- 20 inches by 30 inches access opening
- Engineering plan review to make sure water heater load was considered

Water

8.345 pounds per gallon

75 gallons= 625.9 lbs

64

# Codes

**Residential Plumbing**

P2801.7 (502.5) Water heaters installed in garages.

Water heaters having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the garage floor.

Appliances shall be located or protected so that they are not subject to physical damage by moving vehicle.

The ignition source would apply to both electric and gas water heaters. The ignition source (not the bottom of the water heater) shall be elevated to minimum of 18 inches (457 mm) above the garage floor.

***Exception:*** *Elevation of the ignition source is not required for appliances that are listed as flammable vapor ignition-resistant.*

# Codes

**Residential Mechanical**

M1307.3 (304.3) Elevation of ignition source. Appliances having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in garages.

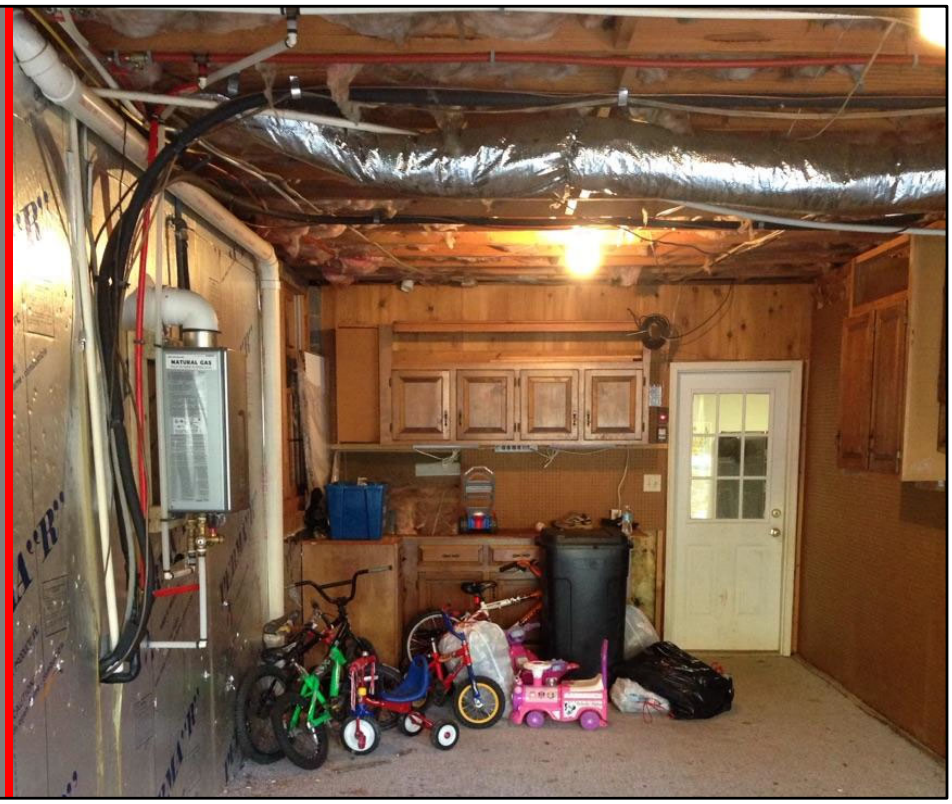
*For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate with a private garage through openings shall be considered to be part of the garage*.

Exception: Elevation of the ignition source is not required for appliances that are listed as flammable-vapor-ignition resistant.

# Garage Installation: Let's Inspect

**Protected from damage?**

**What is the path of the vehicle?**



# Codes

**Residential Mechanical**

M1307.3.1 Protection from impact. Appliances located in private garages and carports shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor. *Appliances located out of the normal path of travel are not required to be protected.*

Exception: The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section M1307.3.

# Crawl Space Installation

**P2801.11 (502.6) Installation in crawl spaces.**

Under-floor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest component of the appliance. The passageway shall not be less than 22 inches high and 36 inches wide, nor more than 20 feet in length when measured along the centerline of the passageway from the opening to the equipment. A level service space not less than 30 inches deep and 30 inches wide shall be present at the front or service side of the appliance.

# Crawl Space Installation

The clear access opening dimensions shall be a minimum of 22 inches by 30 inches where such dimensions are large enough to allow removal of the largest component of the appliance.

Exceptions:

1. The passageway is not required where the level service space is present when the access is open and the appliance is capable of being serviced and removed through the required opening.

2. Where the passageway is not less than 6 feet high for its entire length, the passageway shall not be limited in length.

# Crawl Space Installation

**P2801.12 (502.7) Under floor and exterior grade installation.**

**P2801.12.1 Exterior Grade Installations.** Equipment and appliances installed above grade level shall be supported on a solid base or approved material a minimum of 2 (51 mm) inches thick.

**P2801.12.2 Underfloor installation.** Suspended equipment shall be a minimum of 6 inches (152 mm) above the adjoining grade.

**P2801.12.3 Crawl space supports.** The support shall be a minimum of a 2-inch (51 mm) thick solid base, 2-inch (51 mm) thick formed concrete, or stacked masonry units held in place by mortar or other approved method. The water heater shall be supported not less than 2 inches(51 mm) above grade.

**P2801.12.4** Drainage. Below-grade installations shall be provided with a natural drain or an automatic lift or sump pump. Existing installation that can be terminated outdoors must terminate outdoors. Where the installation is such that outdoor termination is impossible, indoor termination is allowable.

P2801.12.3 Crawl space supports. In a crawl space, a minimum of 4x8x16 inch block or brick supports shall be held in place with mortar. Formed concrete or approved prefabricated steel units are acceptable.

# Crawl Space Installation

**Residential Mechanical**

**M1305.1.4.2 (303.7) Pit locations**. Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back not less than 12 inches (305 mm) from the appliance. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry.

Such concrete or masonry shall extend not less than 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse.

The appliance shall be protected from flooding in an approved manner.



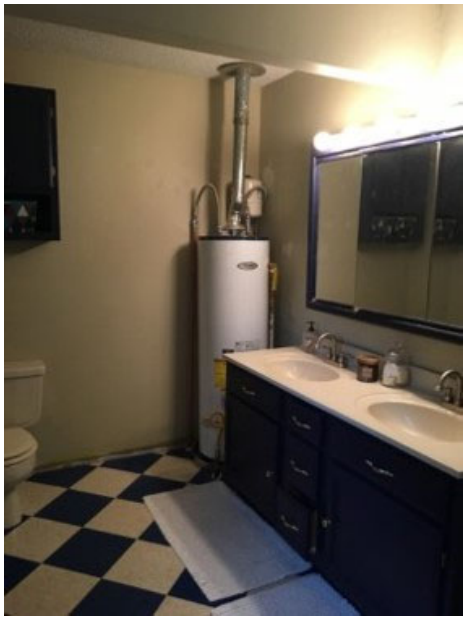

Crawl space installations should be raised off the grade

# Prohibited installations.

**Residential Plumbing**

**P2801.13 (502.8) Prohibited installations.** Water heaters, (using solid, liquid or gas fuel) with the exception of those having direct vent systems, shall not be installed in bathrooms and bedrooms or in a closet with access only through a bedroom or bathroom. However, water heaters of the automatic storage type may be installed as replacement in a bathroom, when approved by the plumbing official, provided they are vented and supplied with adequate combustion air.

Exception: When a closet, having a weather-stripped solid door with an approved closing device, has been designed exclusively for the water heater and where all air for combustion and ventilation is supplied from outdoors.



Define all features of a direct vent unit

**Residential Mechanical**

**M2005.2 Prohibited locations.** Fuel-fired water heaters shall not be installed in a room used as a storage closet. Water heaters located in a room or space accessed only through a bedroom or bathroom shall be installed in accordance with Section G2406.2. Installation of direct-vent water heaters within an enclosure is not required.

**Residential Gas**

**G2406.2 (303.3) Prohibited locations.** Appliances shall not be located in sleeping rooms, bathrooms, toilet rooms, closets used for storage or surgical rooms, or in a space that opens only into such rooms or spaces, except where the installation complies with one of the following:
1. The appliance is a direct-vent appliance installed in accordance with the conditions of the listing and the manufacturer's instructions.
5. The appliance is installed in a room or space that opens only into a bedroom or bathroom, and such room or space is used for no other purpose and is provided with a solid weather-stripped door equipped with an approved self-closing device. All combustion air shall be taken directly from the outdoors in accordance with Section G2407.6.

# In a Closet

When is combustion air required to be taken from outdoor spaces for a gas water heater placed in a closet?

Would a small louvered grill be enough for safe operation?



# The inspection

During the home inspection, the first indication of improper combustion air is the physical condition of the unit.

Signs of Improper Combustion

1. Presence of soot
2. Evidence of condensation or sweating on the walls of the closet, door or the unit.
3. Rust in the burner chamber and or on the flue.
4. Extreme confined space conditions could even result in enough condensation at the flue to rust the top of the unit at the supply lines and or at the connection to the TPRV.

The most dangerous rust location on a water heater is at the connection where the TPRV screws into the tank.

# Air Needed to Burn the Fuel

When thinking about combustion air there are two areas of concern.
1. Air needed for the unit to burn
2. Available air in the room or appliance location.

The rule for combustion air for an appliance can use a calculation or a simple rule.

Let's explore the simple rule.

# Combustion Air

To provide air to a gas appliance through an opening from another interior room....

(never a bedroom or sleeping room)

We need an opening size based on the BTU rating of the unit…

For example:

1 square inch per 1000 BTU's,

but never less than 100 square inches.

# Air to burn

Now there is one more specification, the interior room that is to supply the air must have a minimum volume of 50 cubic feet per 1000 BTU's.

If the room does not have the required available air volume, we will need to bring air in from an outside source.



G2407.5.1 Indoor Combustion Air; Standard method
Also be familiar with G2407.5.2 Known Infiltration

# Outside Air

When required outside air can be provided by Five basic methods. No matter the method the minimum dimension of an air opening can not be less than 3 inches.

1. Upper and lower permanent opening
2. One permanent opening
3. Combination of Indoor and Outdoor
4. Engineered Installations
5. Mechanical Combustion Air Supply

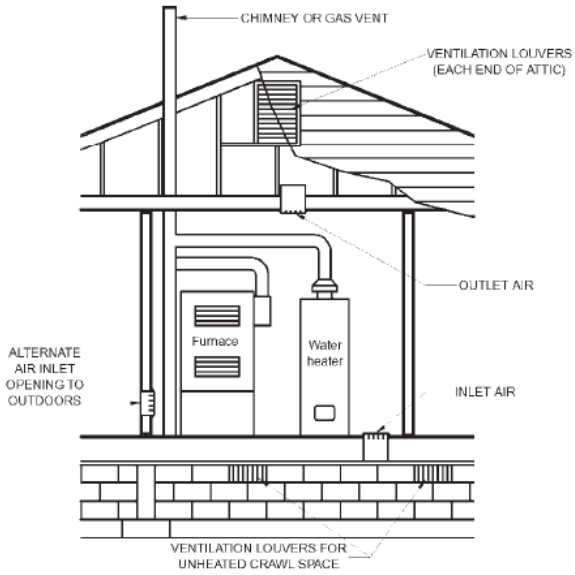
# Few Facts: Combustion Air Sources

Grills and Louvers

1. Fixed open position
2. Mechanical louvers must be interlocked with appliance operation
3. Screen mesh not smaller than ¼ inch
4. Wood vents average 25% free area based on actual
5. Metal vents average 75% free area based on actual

Ducts

1. Materials: Metal
2. Service Single enclosure
3. Not allowed to be screened
4. Horizontal duct shall not slope downward air source
5. Lowest side not less than 12 inches from the grade




minimum free area of
1 square inch per 4,000 Btu/h
of total input rating of all appliances in the enclosure.

**FIGURE G2407.6.1 (1) {304.6.1(1)}**
**ALL AIR FROM OUTDOORS—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC**
**(see Section 304.6.1)**

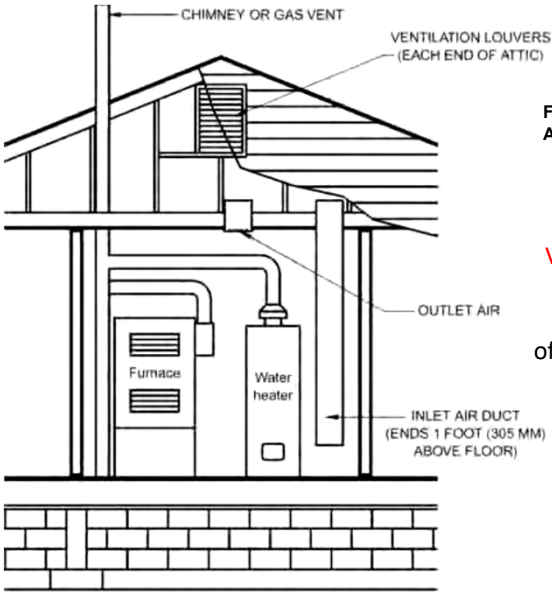



**FIGURE G2407.6.1 (2) {304.6.1(2)}**
**ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC**

Vertical ducts, each opening shall have a minimum free area of
1 square inch per 4,000 Btu/h
of total input rating of all appliances in the enclosure.

Two Permanent Opening

Horizontal ducts, each opening shall have a minimum free area of not less than

1 square inch per 2,000 Btu/h

of total input rating of all appliances in the enclosure

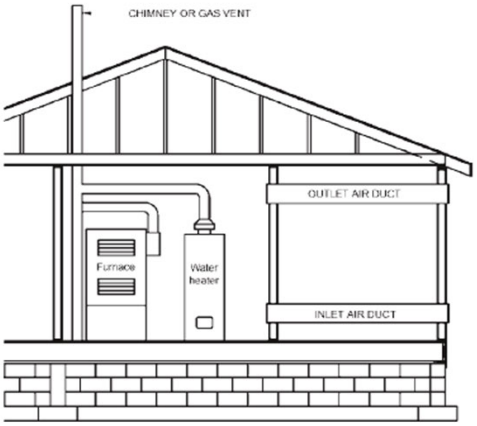



**FIGURE G2407.6.1 (3) {304.6.1(3)}**
**ALL AIR FROM OUTDOORS**

One Permanent Opening:

shall have a minimum free area of

1 square inch per 3,000 Btu/h

of the total input rating of all appliances located in the enclosure and not less than the sum of the areas of all vent connectors in the space.

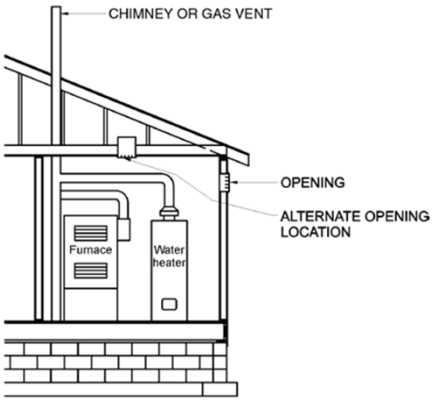



**FIGURE G2407.6.2 {304.6.2}**
**ALL AIR FROM OUTDOORS**

# TPRV

REQUIREMENTS & INSPECTION PROCEDURES

# Code

**P2804.1 Relief Valves Required**

Appliances and equipment used for heating water or storing hot water shall be protected by one of the following:

1. A separate pressure-relief valve and a separate temperature-relief valve.
2. A combination pressure-and-temperature relief valve.



# Code

**P2804.6 Installation of Relief Valves**

A check or shutoff valve shall not be installed in any of the following locations

1. Between a relief valve and the termination point of the relief valve discharge pipe.
2. Between a relief valve and a tank.
3. Between a relief valve and heating appliances or equipment.



Discuss low and high setting of the TPRV

# Inspection Points

1 .General condition of the valve

2.Connection point where valve is threaded into the tank

3.Front access area and burner shield in older units.









# Leaks Inside the Unit





# TPRV

REQUIREMENTS FOR WATER DISPOSAL

# Plumbing Code

**P2804.6.1 Requirements for discharge pipe.**

The discharge piping serving a pressure-relief valve, temperature relief valve or combination valve shall:

1. Not be directly connected to the drainage system.
2. Discharge in the same room as the water heater either on the floor, into an indirect waste receptor or into a water heater pan.
   a. Discharge through an air gap or air gap fitting to a remote termination point that is observable by the building occupants.
3. Not be smaller than the diameter of the outlet of the valve served and shall discharge full size to the air gap.
4. Serve a single relief device and shall not connect to piping serving any other relief device or equipment.
5. Discharge to the floor, to the pan serving the water heater or storage tank, to a waste receptor or to the outdoors.

# Plumbing Code

6. Discharge in a manner that does not cause personal injury or structural damage.

7. Deleted.

8. Not be trapped.

9. Be installed to flow by gravity.

10. Terminate not more than 6 inches (152 mm) and not less than two times the discharge pipe diameter above the floor or waste receptor flood level rim.

11. Not have a threaded connection at the end of the piping.

12. Not have valves or tee fittings.

13. Be constructed of those materials indicated in Section P2906.5 or materials tested, rated and approved for such use in accordance with ASME A112.4.1

14. The discharge pipe shall be clamped or otherwise supported with not less than one clamp or support within 12 inches (305 mm) of the point of discharge.

# What locations do not meet the rules for indirect waste?

P2706.2 Prohibited waste receptors. Plumbing fixtures that are used for washing or bathing shall not be used to receive the discharge of indirect waste piping.
Exceptions:
1. A kitchen sink trap is acceptable for use as a receptor for a dishwasher.
2. A laundry tray is acceptable for washing machines

# Indirect Waste

**INDIRECT WASTE RECEPTOR**. A plumbing fixture designed to collect and dispose of liquid waste from other plumbing fixtures, plumbing equipment or appliances that are required to discharge to the drainage system through an air gap. The following types of fixtures fall within the classification of indirect liquid waste receptors: floor sinks, mop receptors, service sinks and standpipe drains with integral air gaps.

**P2706.2 Prohibited waste receptors**.

Plumbing fixtures that are used for washing or bathing shall not be used to receive the discharge of indirect waste piping.

Exceptions:

1. A kitchen sink trap is acceptable for use as a receptor for a dishwasher.

2. A laundry tray is acceptable for washing machines

# Defects







*Defect photographs provided by North Carolina Licensed Home Inspectors*

# Most Common Defects




1. TPRV not piped for waste disposal
2. Corroded fittings

# Common Defects

1. TPRV  not piped at all
2. TPRV of two units piped together
3. TPRV plugged or capped
4. TPRV piped in manner not to gravity drain
5. TPRV piped down with a line smaller than ¾

# Do TPRV require service?
# Yes, Let's review a Watts unit label

WARNING: Following installation, The valve lever MUST be operated AT LEAST ONCE A YEAR to ensure that the water-ways are clear. Certain naturally occurring mineral deposits may adhere to the valve, rendering it inoperative. When manually operating the lever, water will discharge and precautions must be taken to avoid contact with hot water and to avoid water damage. BEFORE operating lever, check to see that a discharge line is connected to this valve directing the flow of hot water from the valve to a proper place of disposal otherwise personal injury may result. If no water flows, valve is inoperative. TURN OFF THE WATER HEATER AND CALL A PLUMBER IMMEDIATELY.

This device is designed for emergency safety relief and shall not be used as an operating control.

# Do TPRV require service?

WARNING: REINSPECTION OF T&P RELIEF VALVE:

Temperature and Pressure Relief Valves should be reinspected AT LEAST ONCE EVERY THREE YEARS by a licensed plumbing contractor or authorized inspection agency, to ensure that the product has not been affected by corrosive water conditions and to ensure that the valve and discharge line have not been altered or tampered with illegally. Certain naturally occurring conditions may corrode the valve or its components over time, rendering the valve inoperative. Such conditions are not detectable unless the valve and its components are physically removed and inspected. Do not attempt to conduct this inspection on your own. Contact your plumbing contractor for a reinspection to assure continuing safety.

FAILURE TO REINSPECT THIS VALVE AS DIRECTED COULD RESULT IN UNSAFE TEMPERATURE OR PRESSURE BUILD-UP WHICH CAN RESULT IN SERIOUS INJURY OR DEATH AND/OR SEVERE PROPERTY DAMAGE.

## To Inspect

To inspect means to observe, not to operate. The home inspector should not test the TPRV. The inspection of safety a device should be visual only.

1. General Condition
2. Connection at tank
3. Extension Type and Condition
4. Evidence of Corrosion or leaks
5. Set Up to drain by gravity only

# Plumbing Code: Pan Required?

**P2801.6.1 Pan size and drain.**

Where water heaters or hot water storage tanks are installed in: (a) remote locations such as suspended ceilings, (b) attics, (c) above occupied spaces or (d) unventilated crawl spaces, (e) a location where water leakage from the tank will cause damage to primary structural members, the tank or water heater shall be installed in a galvanized steel or aluminum pan having a material thickness of not less than 0.0236 inch (0.6010 mm) (No. 24gage for steel or No. 26 gage for aluminum), or other pans approved for such use.

1. Electric water heaters may rest in a high impact plastic pan of least 1/16 thickness.
2. Water heater mounted on concrete floor for floor drains.

# Plumbing Code

**P2801.6.1 Pan size and drain.**

The pan shall be not less than 1 1/2 inches (38 mm) deep and shall be of sufficient size and shape to receive dripping or condensate from the tank or water heater.

The pan shall be drained by an indirect waste pipe of not less than 1 inch (25.4 mm) diameter.

Piping for safety pan drains shall be of those materials indicated in Table P2906.5. Where a pan drain was not previously installed, a pan drain shall not be required for a replacement water heater installation.

Note this is 2018 change from ¾”
P2906.5 is potable supply materials, please review that list to ensure you understand the allowed materials

# Plumbing Code

**P2801.6.2 Pan drain termination.**

The pan drain shall extend full-size and terminate over a suitably located indirect waste receptor or shall extend to the exterior of the building and terminate not less than 6 inches (152 mm) and not more than 24 inches (610 mm) above the adjacent ground surface.



Pan Required?
✓ Attic Location
Pan Type for Gas
✓ Metal
✓ At least 1.5 deep
✓ 1”(3/4”prior to 2018)
✓ drain to exterior
✓ CPVC

# Heating Water

When water is heated three changes occur.

1. The temperature increases
2. The pressure increases
3. The water expands: Thermal Expansion

# TPRV

The TPRV Valve is the primary safety feature

for the water heater.

The *temperature* portion of the T & P relief valve is designed to open and vent water to the atmosphere whenever the water temperature within the tank reaches approximately 210º F Venting allows cold water to enter the tank.

# TPRV

The *pressure* portion of a T & P relief valve is designed to open and vent to the atmosphere whenever water pressure within the tank exceeds the pressure setting on the valve. The TPRV is normally pre-set at 150 psi.

So what happens if the pressure is not relieved? . . .As the pressure increases so does the temperature. The TPRV is typically set at 150 PSI and 210º F. The valve opens when the tank pressure or temperature reaches the valve set point. After enough water has passed through the valve the pressure in the tank drops, cold water enters to lower the temperature and the valve closes again.

What if the TPRV does not function?

What would cause the TPRV not to function?

# Heating Water

When water is heated three changes occur.

✓Temperature increases = system protected by TPRV

✓Pressure increases = system protected by TPRV

Thermal Expansion ?

The water expands due to added heat:

Thermal Expansion

# Thermal Expansion

One of the physical properties of water is that the volume increases when it is heated, such as within the hot water tank. To appreciate how much it will expand; the water in a typical residential hot water tank holding 40 gallons will increase by about a half a gallon when heated by 70 degrees.

In an open system city supply or a home on a well, the volume of water caused by the expansion will simply push out of the water heater into the main water supply line.

If the water is restrained from expanding by the plumbing devices such as pressure reducing valves or back flow valves the results will be an increase in pressure. The resulting pressure can be enough to damage the hot water tank or plumbing.

# Plumbing Code: Thermal Expansion

**P2903.4 Thermal expansion control**. A means for controlling increased pressure caused by thermal expansion shall be installed where required in accordance with SectionsP2903.4.1 and P2903.4.2.

**P2903.4.1 Pressure-reducing valve.**

For water service system sizes up to and including 2 inches (51 mm), a device for controlling pressure shall be installed where, because of thermal expansion, the pressure on the downstream side of a pressure-reducing valve exceeds the pressure-reducing valve setting.

**P2903.4.2 Backflow prevention device or check valve.**

Where a backflow prevention device, check valve or other device is installed on a water supply system using storage water heating equipment such that thermal expansion causes an increase in pressure, a device for controlling pressure shall be installed.

Is an expansion tank require for a tankless system? A home with a well?

# General Statutes

NCAC 13.0412 EXPANSION TANKS

(a) Hot water heating systems shall allow for thermal expansion and contraction of the piping to prevent excessive stress from being introduced into the pipe or connected equipment.

(b) When new equipment is installed and a backflow prevention system is installed or already exists on a potable water supply line for a hot water supply boiler or water heater, expansion tanks shall be installed.

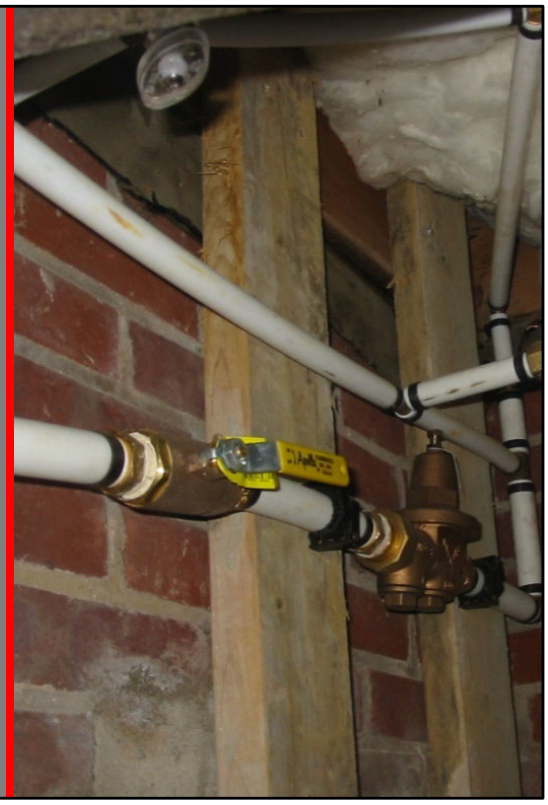
*Authority G.S. 95-69.11; 95-69.14;*
*Eff. January 1, 1995;*
*Amended Eff. July 1, 2011; July 1, 2006.*

When are expansions tanks required to be insulated?

## Thermal Expansion

If a system has a pressure reducing valve, a hot water system thermal expansion tank is required.

The home inspector is not required to determine if an expansion tank is required or not!



Discuss County Ordinances and importance of knowing when unit are flagged by gas company

Ask a SURVEY question, and bring for the next year Update.

Do you report absence of Expansion Tank?
Does the Gas Company in your area require an expansion tank for unit restart?

# Thermal Expansion

If a system has a backflow prevention device or check valve a thermal expansion tank is required.



**Where should an expansion tank be installed in relation to the hot water heater?**
Functionally it can be installed anywhere on the cold inlet line as long as there is no valve or fixture between the tank and the water heater.

**Where would the water heater be located for this to be a correct installation?**

**What about the required water heater turn off valve?**

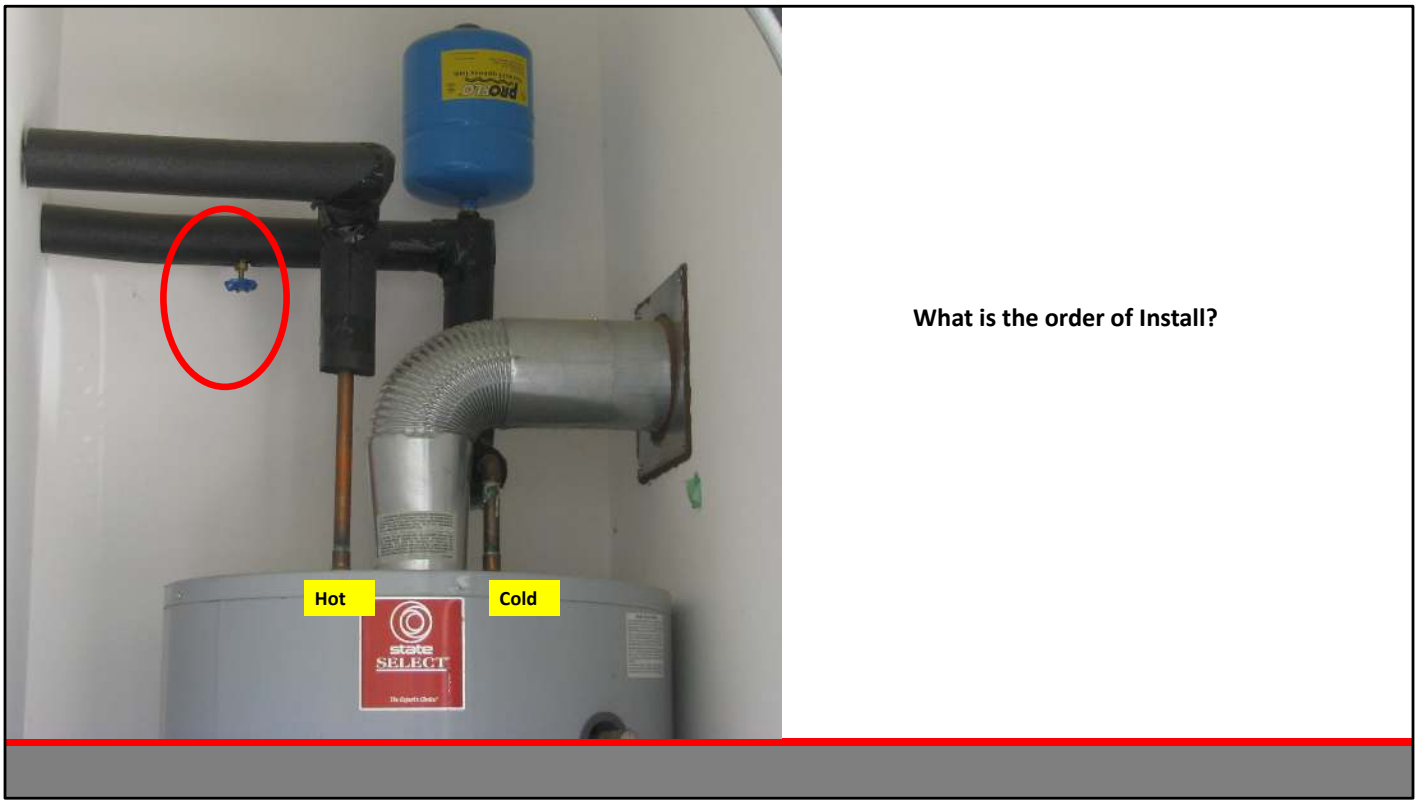
# Cold Water Line

**P2805.1 (503.1) Cold Water Line Valve**

The cold water branch line from the main water supply line to each hot water storage tank or water heater shall be provided with a valve, located within 3 feet of the equipment and serving only the hot water storage tank or water heater.

The valve shall not interfere or cause a disruption of the cold water supply to the remainder of the cold water system.

The valve shall be provided with access on the same floor level as the water heater served.


Hot
Cold
state
SELECT
What is the order of Install?

**Can the expansion tank be installed at any angle?**

**Let's Inspect**





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# TPRV for Thermal Expansion?









Review valve types and how they work

## Plumbing Code

504.4 Relief valve. All storage water heaters operating above atmospheric pressure shall be provided with an approved, self-closing (levered) pressure relief valve and temperature relief valve or combination thereof. The relief valve shall conform to ANSI Z21.22.

The relief valve shall not be used as a means of controlling thermal expansion.





Although not mentioned in the Residential code, the use of TE valves for TRPV should be questioned by the home inspector.

# The Inspection

Expansion Tank:

1. Not holding excessive water
2. No valve between water heater and tank
3. No indications of leaks
4. Properly supported

Add Expansion tank inspection procedure to developing list

# Thermal Expansion

For all water heaters installed in or after 2006

---

If a system has a Pressure Reducing valve , Backflow prevention device ,or check valve and a hot water system; a thermal expansion tank is required.

The Home Inspector is not required to make the determination of absence or presence of an expansion tank.

# How are we protected?

**.1109 PLUMBING**

(d) The home inspector is not required to:

(5) Inspect:

(H) Solar water heating equipment

(6) Inspect the system for proper sizing, design, or use of materials.

(7) Report on the absence or presence of thermal expansion tanks; or,

(8) Report on the adequacy of the reported water heater capacity.

**Start the discussion: Are the limitations in the SOP enough?**
**What else can a home inspector do?**

# The Inspection

Most home inspectors report the absence of a thermal expansion tank on a home with a pressure reducing valve or back flow preventer as a safety concern.

# Water Heater Types

STORAGE OR NO STORAGE

# Water Heaters

The home inspector will commonly deal with two types of water heating systems.

1. Storage Tank units
   a. Gas
   b. Electric
2. Tankless units
   a. Gas
   b. Electric

Add two levels to the Inspection Procedure list with 2 sub categories each

Continue to build inspection procedures

# Combustion Air : Water Heater Types

1. Open Burner : Natural Draft
2. Closed Burner: Direct Vent
3. Closed Burner: Direct Vent Fan Assist
4. Closed Burner: FVIR: Natural Draft
5. Closed Burner: FVIR: Fan Assist

Discuss water heater types and inspection procedures
For each type discuss combustion air paths and exhaust requirements

## Natural Draft

**A draft hood is critical to the operation of a gas water heater. It is attached between the heater's flue outlet and the vent pipe.**

**When properly installed, the draft hood cools the combustion products by introducing fresh air and allows them to flow safely from the building.**

**It also protects heater operation during updrafts and downdrafts that are caused by indoor/outdoor air pressure differences.**

**What are key inspection points for the natural draft water heater?**



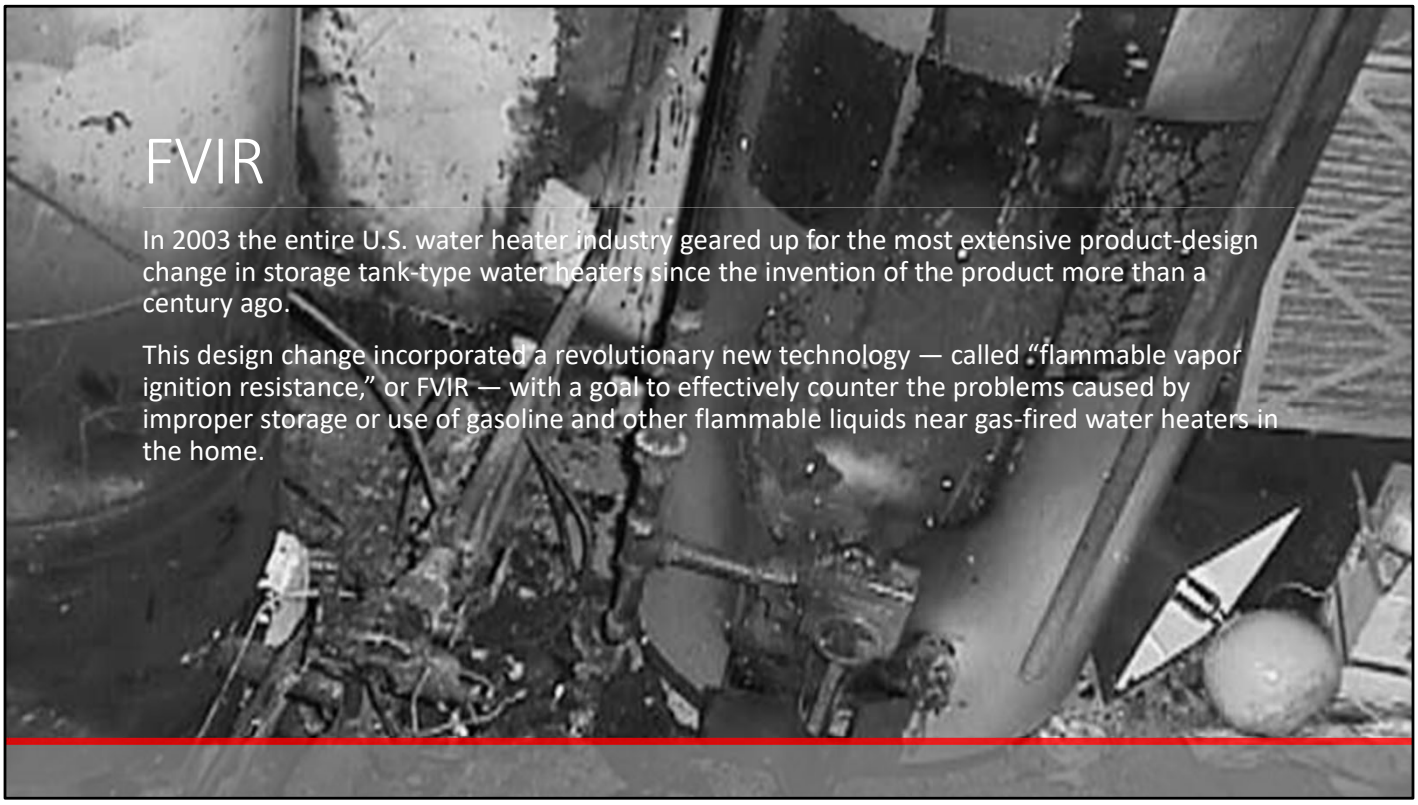
Review Key Inspection Points for a natural draft unit
Add inspection steps based on Chapter 8
Discuss at 4 aspects of the draft
Flue Slope
Flue Height
How does this difference from balanced flue





Open Burner Type Units: Take combustion air from the burner chamber inspection door area.
The main concern is that the flame will move out of the unit if a flammable material or fuel is available.

Continue Inspection Procedure Steps




You should have a copy of ANSI standards and be familiar with the changes and requirements.

# FVIR

The new ANSI standard stated in part: "The design of the water heater shall be such that it shall not ignite flammable vapors outside the water heater created by the spilling of both winter and summer blends of gasoline onto the floor of the test room.

In later editions. A bench standard that requires protection of the water heater from lint, dust, and oil, or LDO, was attached to the flammable vapor standard. It says in part that the water heater must pass a 20-plus hour LDO test. To pass: –The water heater must endure the entire test and continue to burn clean (carbon monoxide levels must stay below 400 parts per million) or - –The water heater must shut down safely prior to producing high levels of carbon monoxide.

# How do FVIR Water Heaters Work?

Air enters through the one way intake system, passes through the flame arrestor plate, and normal combustion occurs in the sealed combustion chamber.

In the event that flammable vapors are introduced, the vapors are drawn into the combustion chamber where they ignite in the sealed environment. Due to the flame arrestor plate, the flames are contained within the combustion chamber and cannot escape back out of the heater.

Most manufacturers have built in additional features that shut off the flow of gas and seal off the combustion air in the event of a flammable vapor event since the standard requires safety controls.



Does the ANSI standard require only bottom intake?
What other systems have you seen in the field



This is a standard natural draft unit with FVIR: Flame Vapor Ignition Resistant Burner
Air for combustion passes through the bottom of the water heater into the combustion chamber. The burner chamber is sealed to prevent flame roll over.



FVIR: Flame Vapor Ignition Resistant

Is this a balanced flue unit?

FVIR Inspection




VIDEO:

Add this step to your list?
What about side intake?



**Combustion Air Source?**

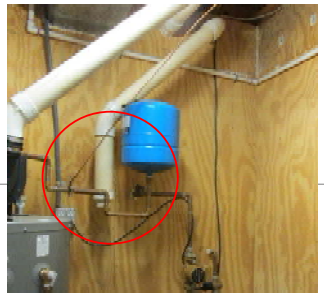
**Combustion Chamber Intake?**

Next Question and most important

How does it get into the burner chamber?




Follow inspection procedures from your list to inspect this unit:  Next slides are close ups of important areas








Direct Vent?

No Combustion air is from the room

Can combustion air supply duct be PVC?

Follow inspection procedures from your list to inspect this unit



**Combustion Air Source?**

**Combustion Chamber Intake?**


Combustion Air Source?
Combustion Chamber Intake?


Combustion Air Source?
Combustion Chamber Intake?



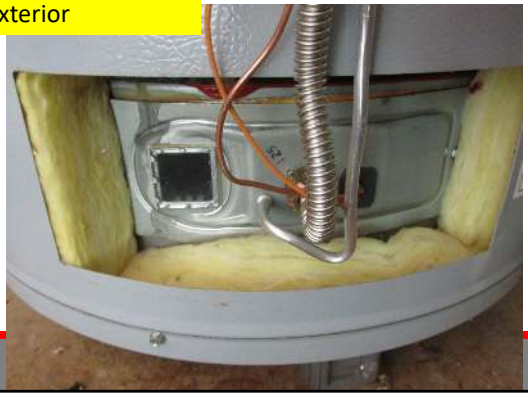
Find the combustion air path





Direct Vent: Combustion Air from the Exterior







Combustion air on sealed units is taken from a concentric flue. The concentric flue is a double lined flue pipe, one section for exhaust and one section for combustion air.

This unit is a direct vent unit.

DIRECT VENT:

1. Exhaust outside
2. Combustion Air from the outside





# Combustion Air Path




VIDEO”

ADD at least 8 steps for the combustion air paths and flue requirements for Direct vent and for Natural Draft



Corrosion should be reported whether the leak is active or not.



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# The Inspection

A very common defect for the water heater is corrosion of the supply and discharge lines where they enter the top of the tank. The water lines are welded into the tank and extend up through the steel decorative casing. The water lines are often steel.

When copper fittings are directly attached to the steel lines, a corrosion due to galvanic action occurs.

Galvanic corrosion : sometimes called dissimilar metal corrosion, is the process by which the materials in contact with each other oxidizes or corrodes. There are three conditions that must exist for galvanic corrosion to occur.

1. First there must be two electrochemically dissimilar metals present.
2. Second, there must be an electrically conductive path between the two metals.
3. Third, there must be a conductive path for the metal ions to move from the more anodic metal to the more cathodic metal.

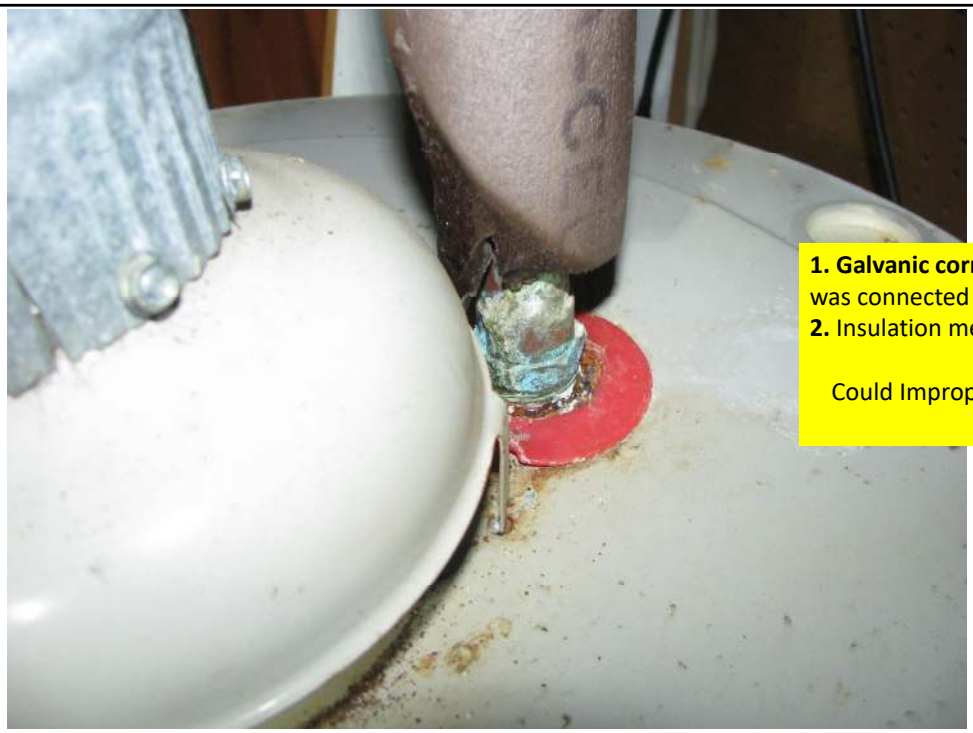
If any one of these three conditions does not exist, galvanic corrosion will not occur.

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# Codes

**Residential Mechanical**

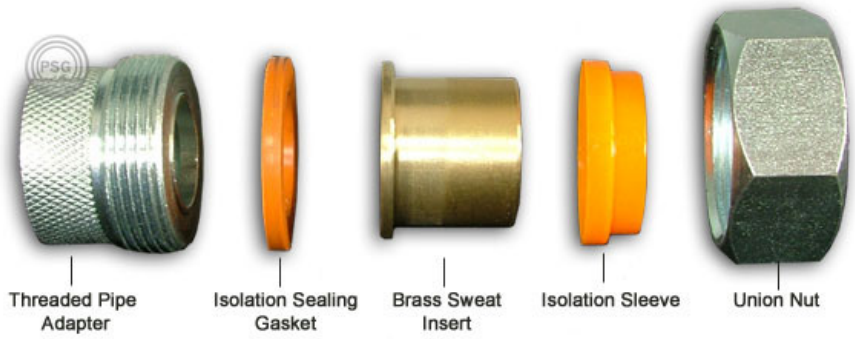
M2202.9.1 (1303.1.1) Joints between different piping materials. Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved **dielectric fittings or brass converter fittings.**



**1. Galvanic corrosion** because copper was connected directly to the steel?
**2.** Insulation melted, is it too close to flue

Could Improper Exhaust Exit Result in Corrosion?

# Di-electric Fitting





**The plastic insert insulates the two metals from each other.**

**Teflon tape (plumber's tape) creates tight seal to prevent leaks**

*The use of Teflon tape performs a lubricating function, which more easily allows the threads to be screwed together, to the point of deformation, which is what creates the tight seal.*


NCHILB UPDATE 2020-2021
Galvanic Corrosion
Di-electric Connections

VIDEO

# Rust or Corrosion

In a wet environment, rust or corrosion of the tank jacket will not cause the unit to leak until it reached the interior tank and in most cases is an indication of other concerns and defects.

1. Corrosion on the bottom of the unit could also indicate a seeping leak from the enter tank.
2. Flooded water heaters are not considered reliable or safe.
3. Flooded water heaters are not covered by warranties.

# Flooded Units

When is a unit considered flooded?

When water penetrates the steel casing and wets the insulation, electronic, or surfaces behind the steel outside casing.




Water heaters are often subject to wet conditions that rust or deteriorate the outside steel jacket.
Notice this unit is resting on a concrete pad, but is not protected from crawl space drainage.

Note 2018 code change related to appliance elevation

# Flooded Appliances

The standard warranty on residential and commercial water heaters both state that warranty is void if the heater has been in a flood. If the damage was due to a flood, no warranty reimbursement for tank, parts or labor will be provided regardless of age of the heater. The home/business owner should look to their insurance for reimbursement.

Any residential gas or electric water heater that has been flooded must be replaced. Rebuilding of the heater is not allowed.

# The Inspector

What should a home inspector do?

As always report what you see, request further evaluation to protect the client.



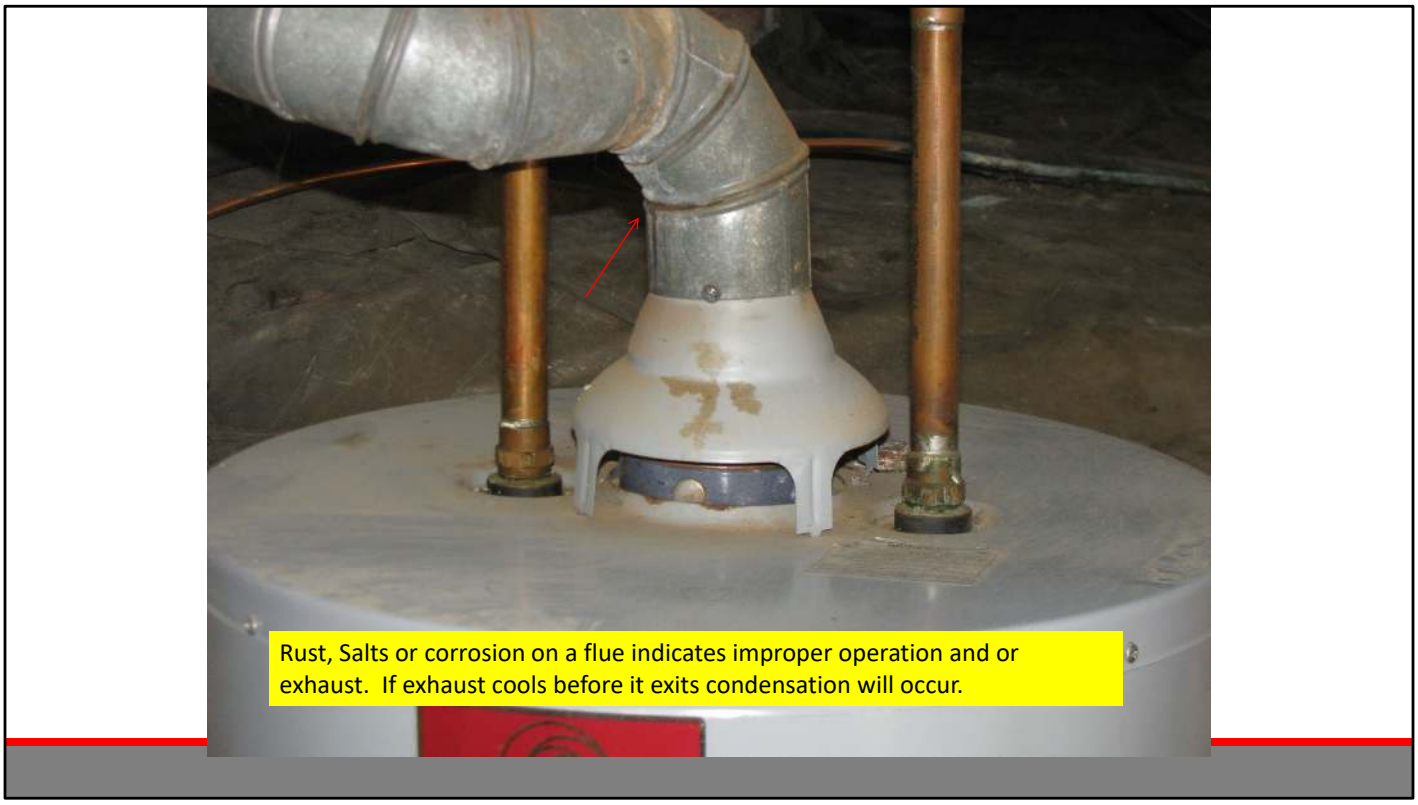
**This is a gas unit in a cellar area, notice the water lines, Is this a different situation as compared an electric unit?**

**Once flooded gas units have to be placed out of service. They can not be serviced or repaired.**

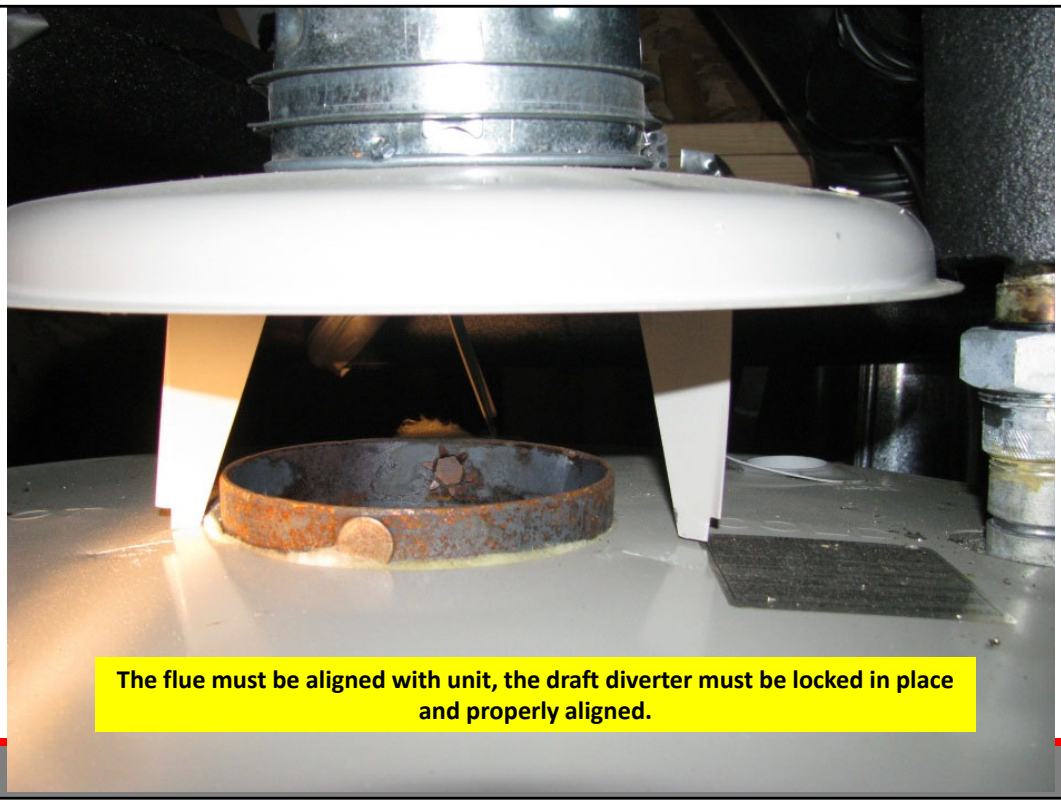
# The Inspection: Gas

1. Hot water available
   a. At all required fixtures
   b. On left side of sinks
   c. Temperature?
2. TPRV present, no corrosion, and correctly piped down to prevent injury ( see rules).
3. Fittings for water supply on top of tank in good condition.
4. No indications of leaks or corrosion.
5. Unit resting on an appropriate base, raised 18 inches in garage if required
6. Proper exhaust: no indication of condensation, If present draft diverter properly aligned, follow flue from unit to exit.
7. Combustion air source: Natural Draft: Direct Vent:
8. Burner condition
9. Condition of bottom of tank

Summary of base procedures
Instructors should have at least 20 point of inspection
Use inspection procedures to answer question for the unit shown




Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths




Cover inspection procedures for shown components
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Cover inspection procedures for shown components
What question need to answered?
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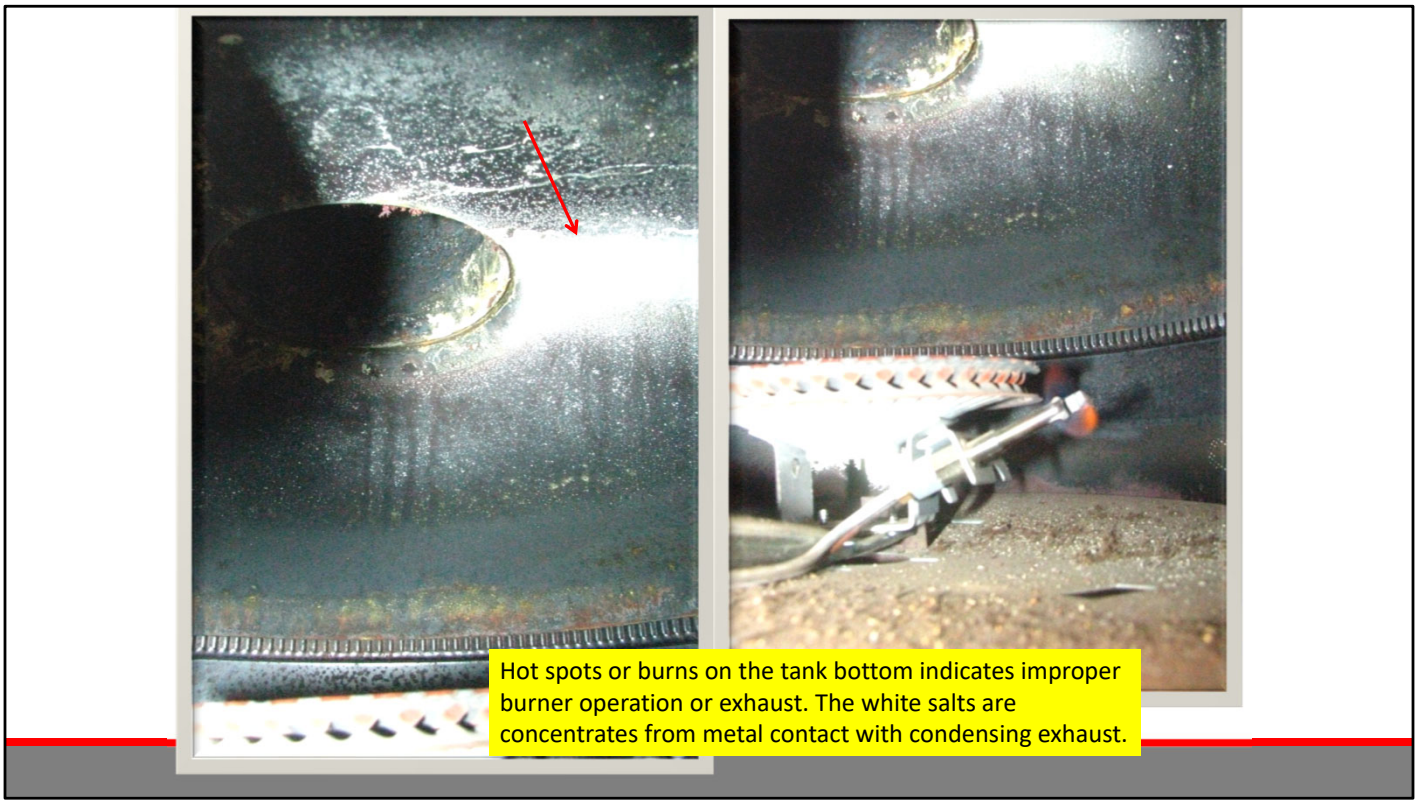



Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths



1. Condition of the burner: covered with rust. The rust falls from inside the flue or bottom of the tank
2. Notice the pile of rust.

Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths




Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths



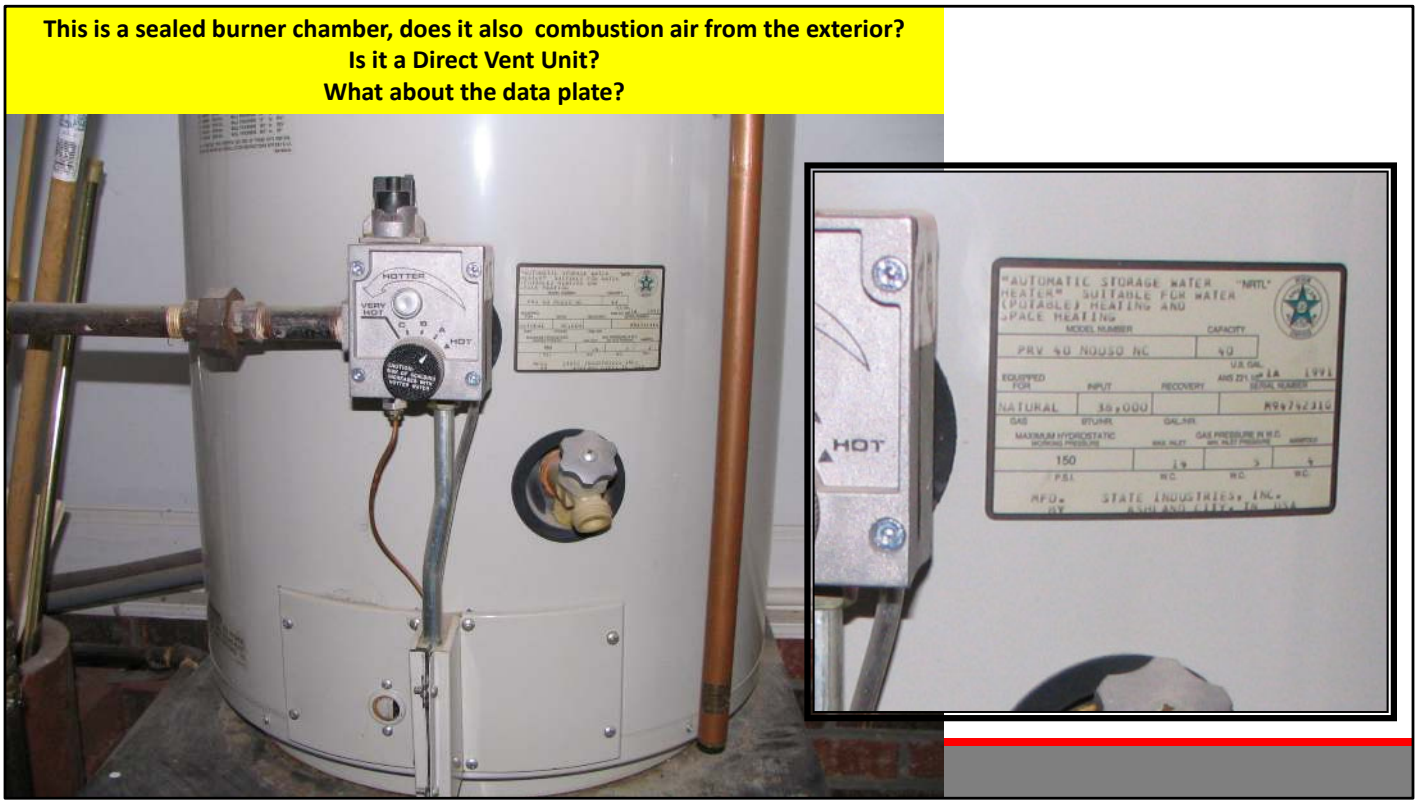
The white salts are concentrates from metal contact with condensing exhaust. This unit is in a hut, the flue is disconnected and exhausting into the hut. When the exhaust enters the hut, the unit starts to burn its own exhaust. The flue has no draft, flames enter the chamber and roll out of the burner chamber.



Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths

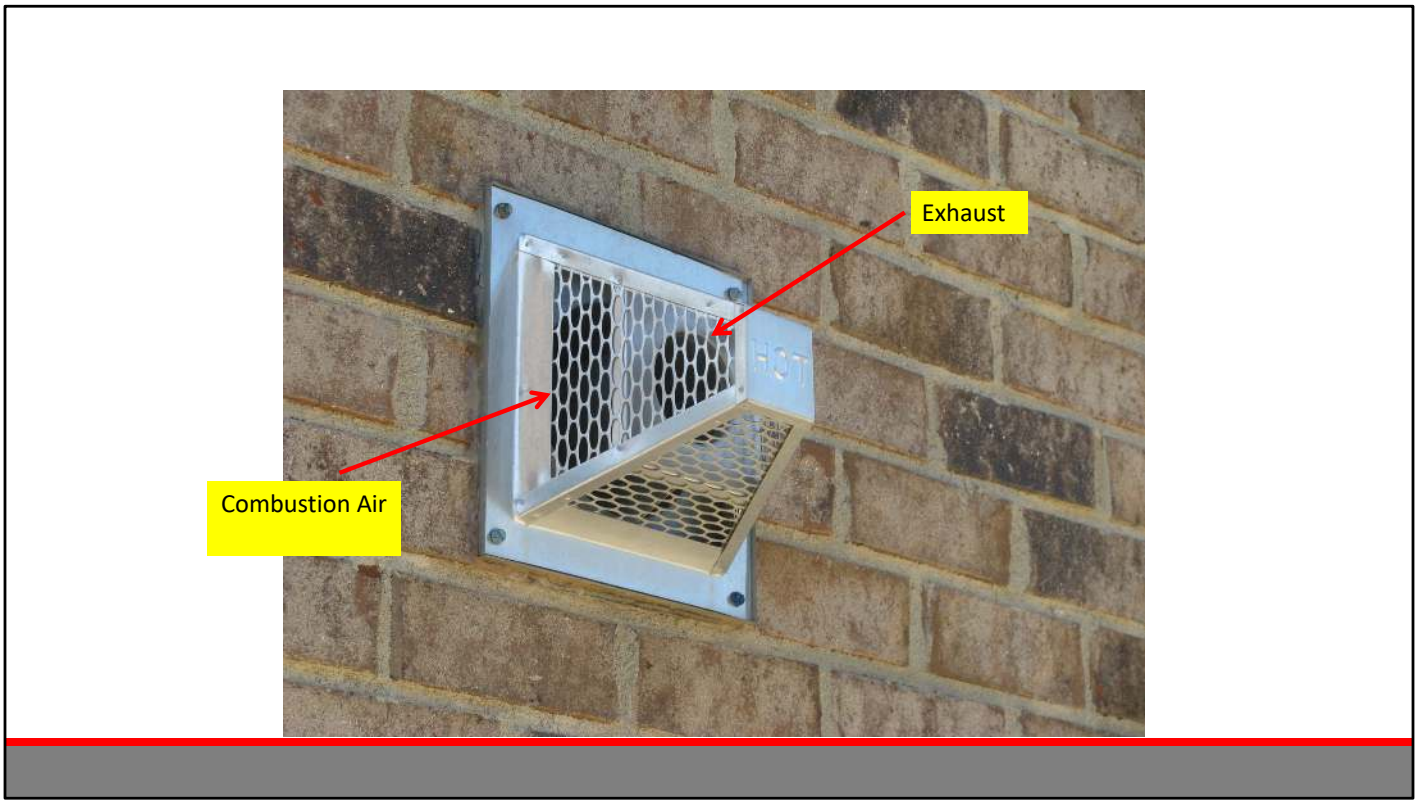


Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths




Older units that were also approved for space heat, may not have “Direct Vent” in the label.
Label will be included with patent list in another location
What should be do to verify?
Follow your inspection steps


A concentric double pipe flue takes combustion air from the exterior.
Is this a true Direct vent unit?
What defects do you see?


Exhaust
Combustion Air
HOT



**FVIR unit takes in combustion air from under the unit. The burner is closed to prevent flame roll out.**
**Don't mistake a FVIR unit with a direct vent.**
**Don't forget to inspect the flame arrestor plate.**



Natural draft unit with FVIR

# Direct Vent



What am I?





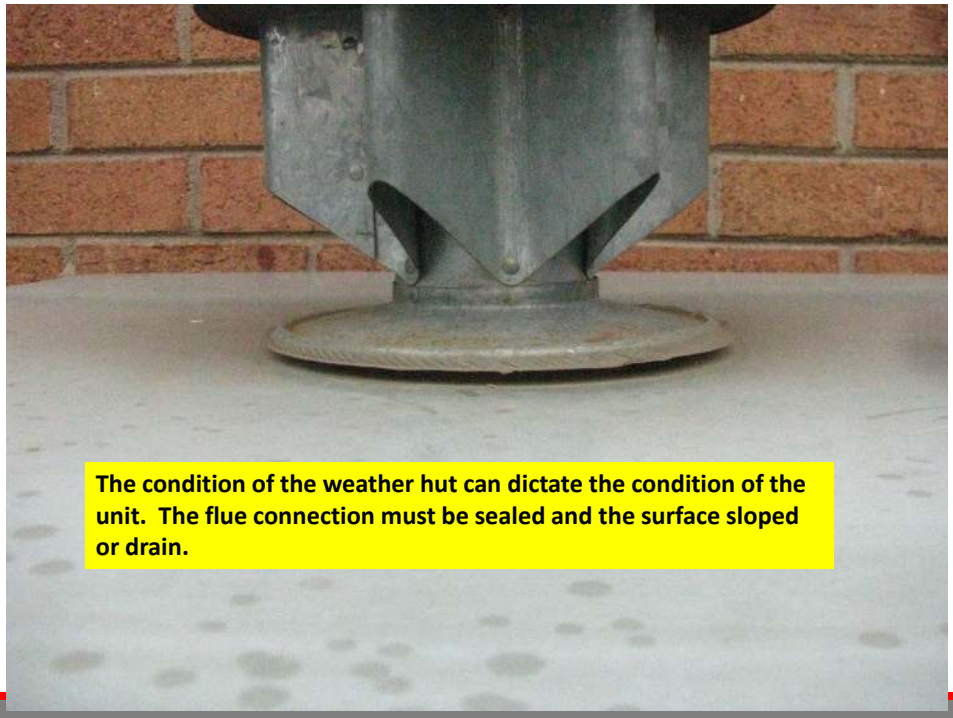
Cover inspection procedures for shown components
What question need to answered?
Flue, burner, Combustion air paths




The hut is a great way to install a water heater outside.

1. Hut must be water tight
2. Upper and lower combustion air vent clear
3. Unit is level and stable





**The condition of the weather hut can dictate the condition of the unit. The flue connection must be sealed and the surface sloped or drain.**



**Water entering the flue can result in excessive rust.**


Water entering the flue can result in excessive rust.

# Tankless Water Heaters

# Tankless Water Heaters

Tankless models don’t store hot water. When hot water is needed, water flows through the device and the flow sensor fires the burner. Water lines around the heat exchanger warm the water to the desired temperature. When the hot-water valve is closed, the flow sensor turns off the burner. The flow must be fast enough, typically a half-gallon per minute, to turn on the sensor. Capacity is expressed in gallons per minute.

# Flow rate

The flow rate is the number of gallons of water that can be delivered per minute.

For example:

Flow rate: 11.1GPM

Minimum flow rate: 0.5 GPM

This is a nominal flow rate and depends on system install and piping design.

What should be reported as the capacity?

**1** Exhaust

**2** Heat exchanger

**3** Burner

**4** Fan

**5** Control panel

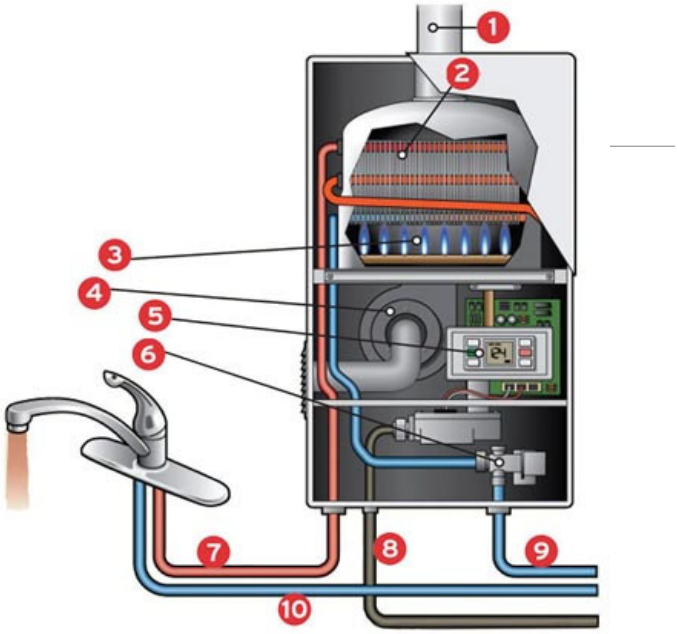
**6** Flow sensor

**7** Hot water to Fixture

**8** Gas supply

**9** Cold water coming in

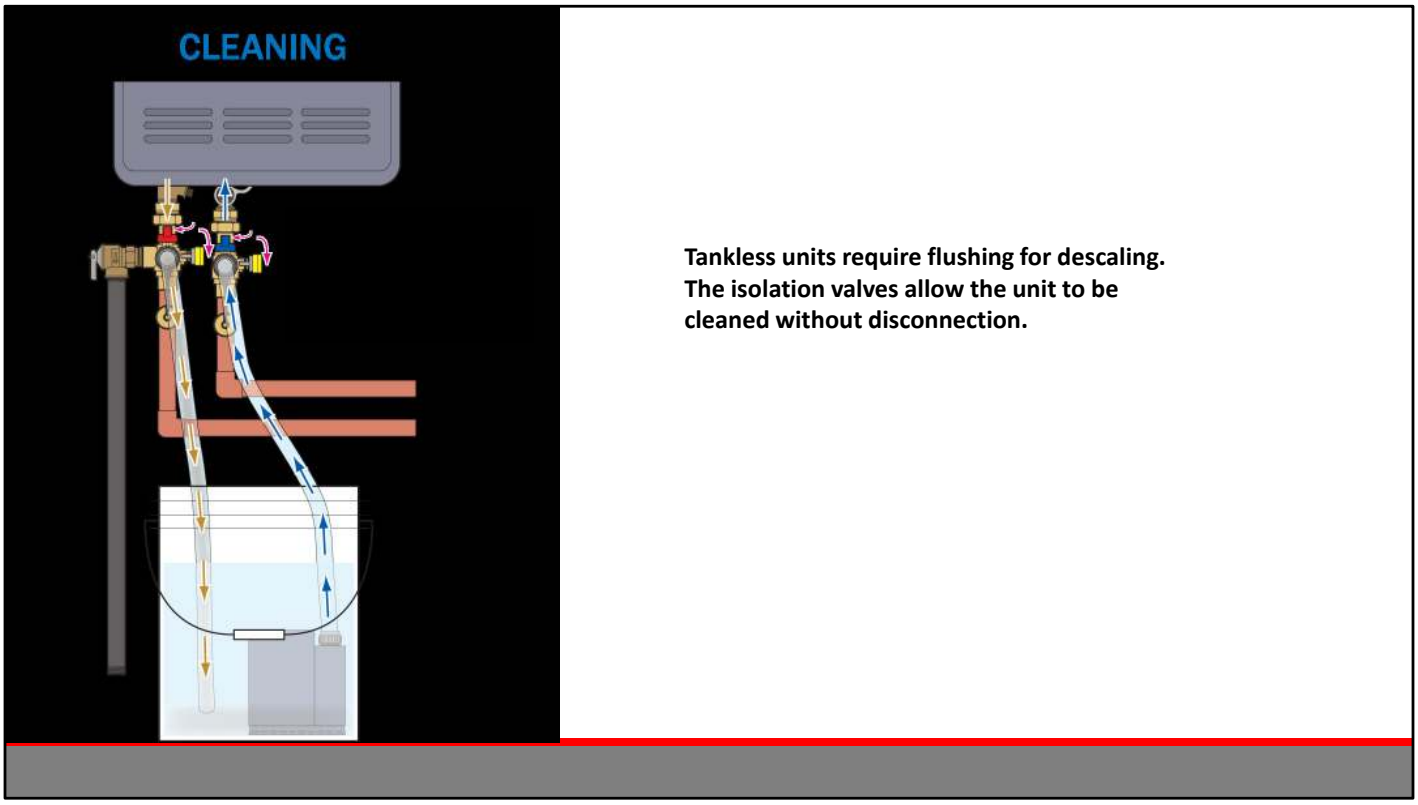
**10** Cold water to faucet

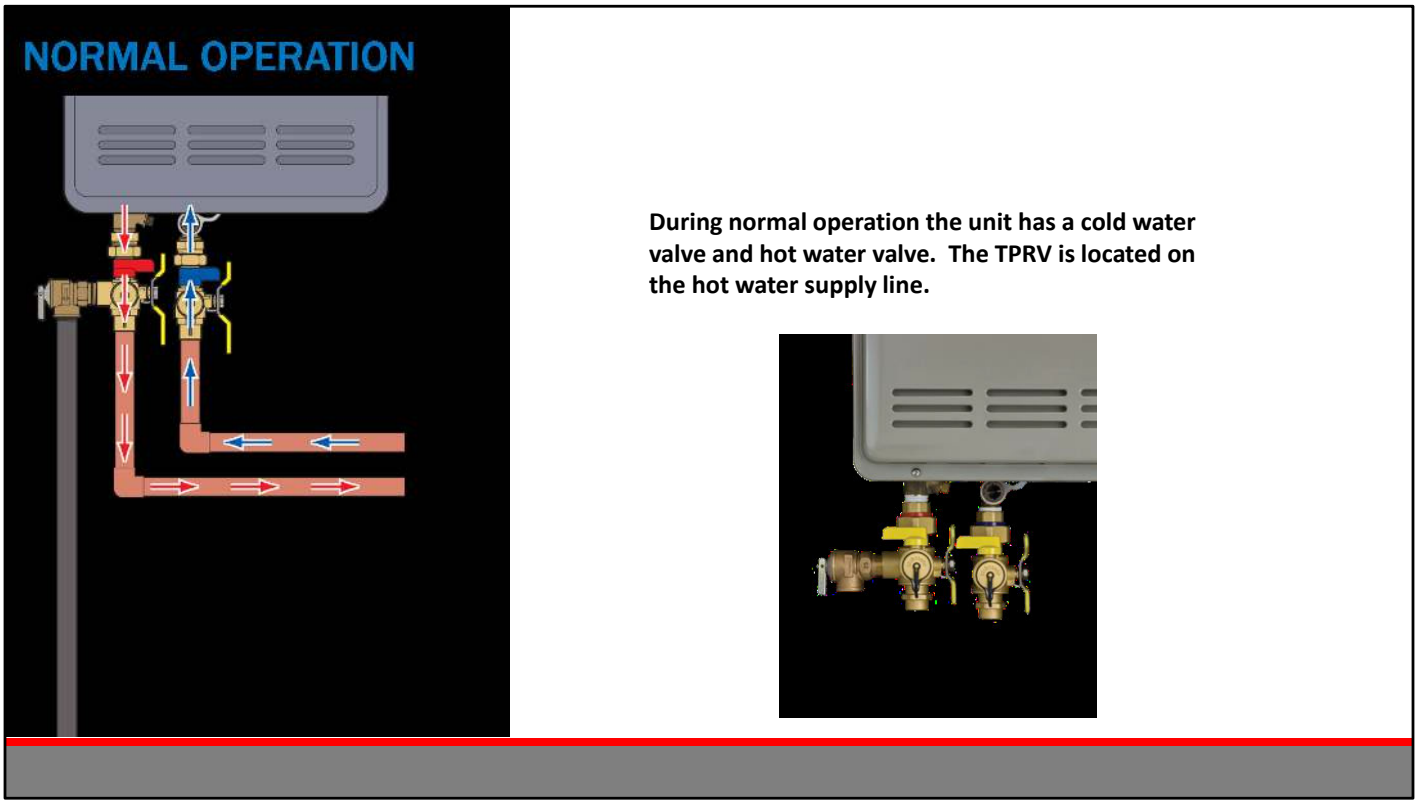


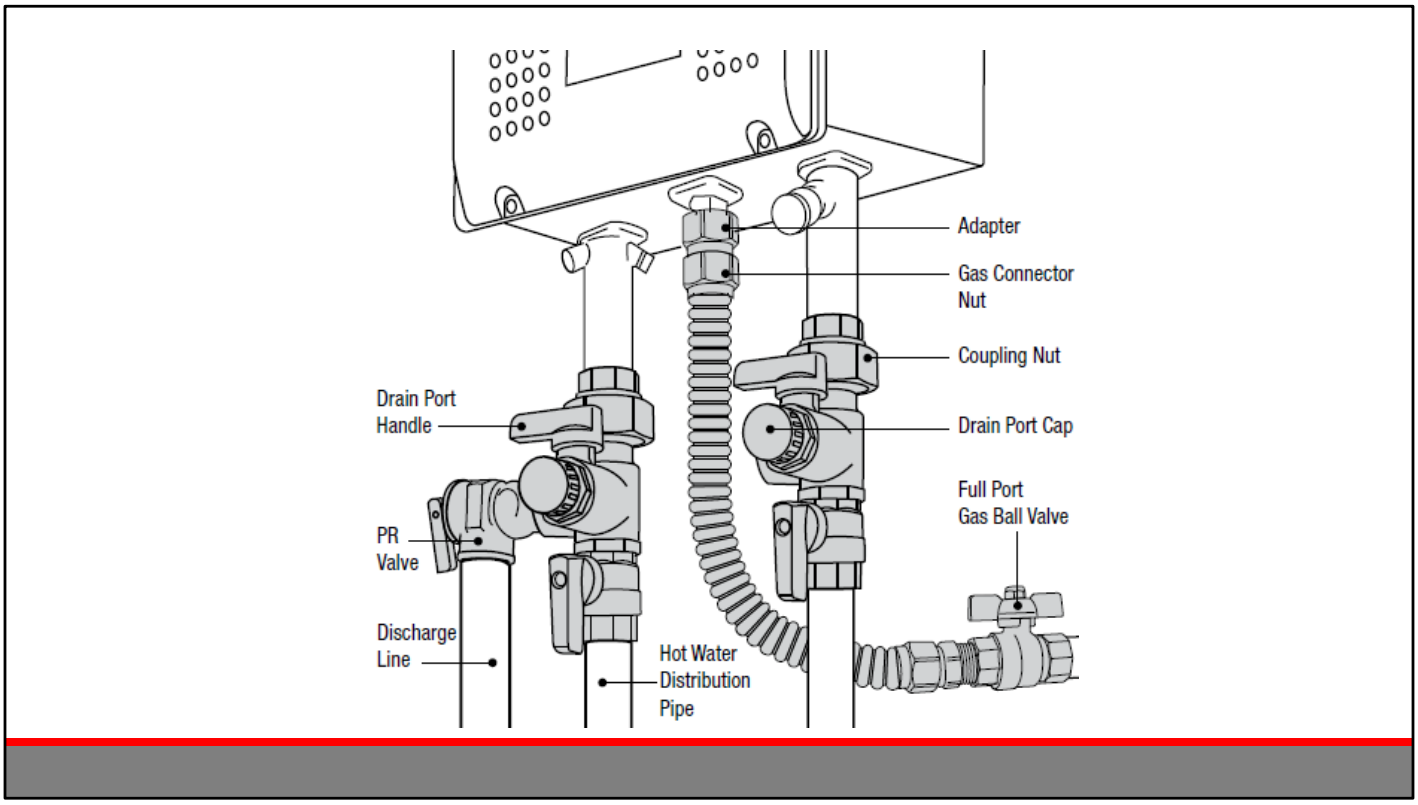



Tankless units have isolation valves on the hot and cold lines for installation, service and maintenance.




CLEANING
Tankless units require flushing for descaling.
The isolation valves allow the unit to be
cleaned without disconnection.


NORMAL OPERATION
During normal operation the unit has a cold water valve and hot water valve. The TPRV is located on the hot water supply line.


Adapter
Gas Connector Nut
Coupling Nut
Drain Port Handle
Drain Port Cap
Full Port Gas Ball Valve
PR Valve
Discharge Line
Hot Water Distribution Pipe




**Notice the valve installations, the position or order of the hot, cold and gas varies.**
**What is wrong with the TPRV discharge**




1. Improper Installation
2. Poor Functional Flow
3. Incorrect supply outside of the unit Range
4. Intermediate Hot-Cold
5. Long heat up wait
6. Low pressure



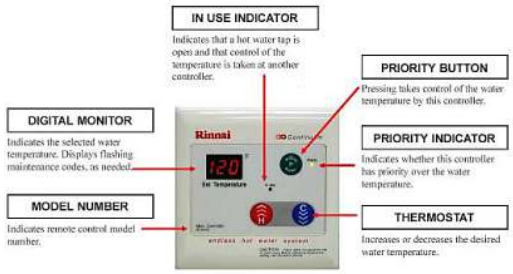
Key inspection procedures?

Cover Unit Type
Flue Configuration
Pipe Configuration

**Interior remote controls for tankless units are typically installed in the bathroom areas.**

**Error codes shown on the screen inform the owner service requirements and have saved many home inspectors for an oversite.**

**For example: The code LC indicates build ups and a need for system flush.**



# Water Heater Units



The newest system for hot water is the hybrid system. It functions as a heat pump with electric backup to provide hot water.





**How the Heat Pump Water Heater Works**

In “Energy Saver” mode, this water heater’s high efficiency heat pump operates automatically for hot water storage in this sequence:

**(1)** A fan pulls air through the top air filter.

**(2)** Heat in the air is absorbed by eco-friendly refrigerant inside the evaporator coil and cool (dehumidified) air is exhausted. **(3)** Refrigerant is pumped through a compressor, which increases the temperature. **(4)** Simultaneously the cooler water from the bottom of the tank is pumped to the top of the appliance, where it circulates through a condenser coil. **(5)** Hot refrigerant transfers its heat to the water inside the condenser coil. **(6)** Heated water is returned back to the top of the tank. **(7)** All functions are controlled simultaneously by an advanced circuit board located behind the user touch pad. In “High Demand” mode, the heat pump can run in tandem with an electric element during periods of high demand. In “Electric Heat Only” mode, the heat pump is disabled and the appliance operates like a standard electric water heater with two elements. **(8)** Condensate exits the unit.

# End of Course

End of Presentation

Thank You