

PERFORMING WATER HEATER PREVENTATIVE MAINTENANCE

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COMMUNICATING MAINTENANCE SERVICE WITH THE CUSTOMER

Checking In

1. This is ALWAYS required before starting your work.
2. Go into the office and let them know you are with Benrich and are there to perform preventative maintenance.
3. Ask if there are any keys or access codes you will need to get into the enclosures. They might ask for your license or something else temporarily while you hold those keys.
4. If you don't know the location of the enclosures, check the property maps on our website. If it is not on our website, then ask for the location of the enclosure and a property map if available so we can add it to the website.
5. Let them know there may be recommendations or issues that need to be reported once your work is completed and ask who you should review those items with such as a property manager or maintenance supervisor.

Filling out Paperwork

1. This must be completed before checking out with the property.
2. A work order form must be filled out to show your time and an overview of your work performed. In addition, an inspection sheet must be filled out for each unit you perform maintenance on. So for a property with 5 boilers or water heaters, you will have 1 work order form and 5 inspection sheets filled out.
3. If there is no one on-site to check out with, you must still complete your paperwork before moving onto your next call or ending your day.

Making Recommendations

1. Too much information is always better than too little information. Your job is to write up everything you find that is not up to the Benrich standards. Most inspections should have recommendations, if you are going through multiple water heating units with no recommendations, you are most likely not being thorough enough.
2. When parts are replaced during your PM service, the customer does not need to pay for labor. If parts are not approved while we are on-site and we have to return, our PCC (Preferred contract customer) labor rate will be charged. You must communicate this to the decision maker on-site so they understand the terms. For example: "If you are able to approve this repair while I am on-site today, we can waive the labor and truck charge, however if we have to return when it fails, we will have to charge for labor."

Getting Approval to replace parts

1. Do not replace parts unless given permission.
2. Try to speak with the decision maker (manager or maintenance supervisor) prior to starting and ask if you can have some of their time after completing your work to review parts that need to be replaced.
3. When reviewing your estimates/recommendations, show them your paperwork as well as pictures on your phone of what you are referring to (visuals help if they aren't familiar with water heaters). It also builds their trust in your recommendations.
4. When writing up a lot of recommendations, be prepared to prioritize what items are most urgent if requested.

5. Make sure the customer knows that if they approve a recommendation while on-site, they don't have to pay for labor, and only for parts while on-site during PM inspections.
6. If they give approval, ask them to check the "approved" box and sign their name
7. If there is no one on-site, call your dispatcher and see if they can call someone to get permission for replacing parts. If you get approval, get the person's name from dispatch and check the approved box and write "verbal approval given to (dispatcher's name) by (Property representative's name) at (time of day)."

Checking out

1. After your work is complete and you have performed any approved recommendations, go to the office and ask if you can check out with the decision maker (manager or maintenance supervisor).
2. If you haven't already done so, let them know if you have some recommendations you'd like to review with them and follow the steps listed above in the approval process.
3. Obtain signatures and leave the pink copy with the customer (unless on tablet)

FILLING OUT THE INSPECTION SHEET

Make Name of the manufacturer (American Standard, AO Smith, Rheem)

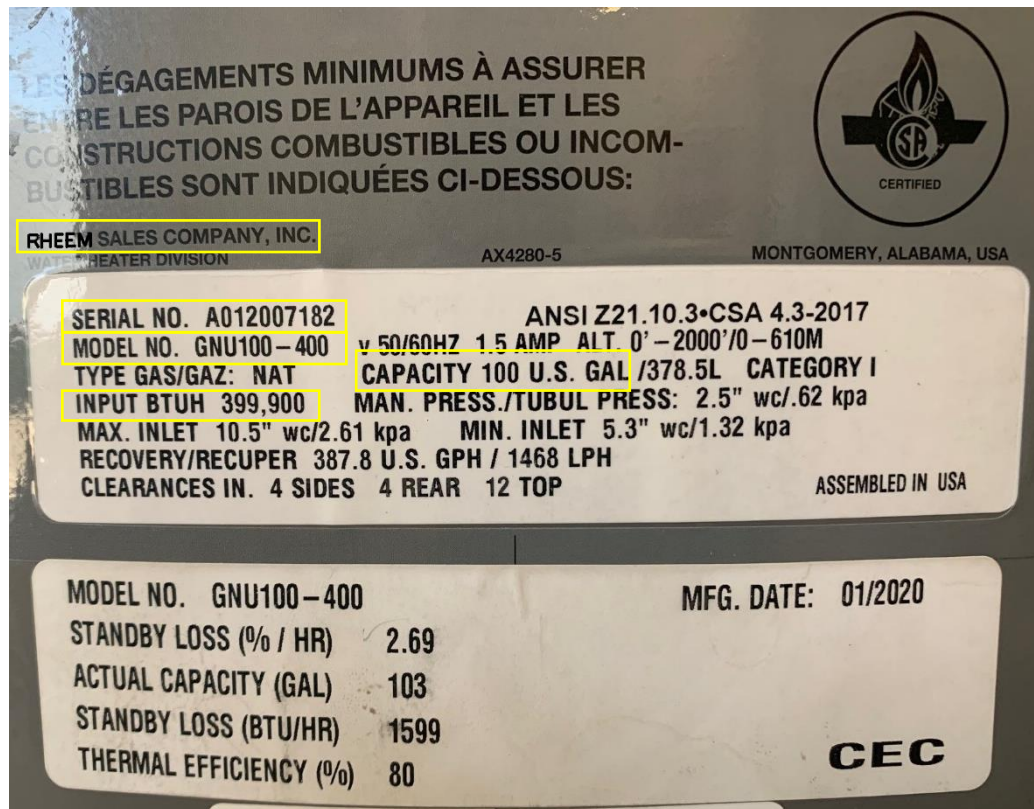
Model/Serial/BTU Found on the information plate found on the side of the water heater.

Domestic means it is hot water used for the residential units such as bathrooms, kitchens, laundry etc.

Heating means it is used for hydronic heating. The hot water from the water heater heats the hydronic coils that a blower blows air through to heat the air within the units. A key indicator on this is a larger return line (1 1/2" to 2") and a larger return pump (2B1050 or H67 size)

PSI (Pound Force per Square Inch)

is the water pressure. Thread a pressure gauge on a hose bib and then open the hose bib to get your reading and determine the PSI. 60 PSI is standard.



Discrepancy/Recommendations This section is where you annotate work performed, why parts were replaced, recommendations and other important information that needs to be communicated. In no instance should this section be left blank or with just a sentence. If there are no parts replaced, recommendations or noteworthy items, write down some details on the work you performed. (Help the customer understand how much work you did rather than leaving a blank page) - for example...

- Drained and flushed water heater, removed all scale and restored water heater. Pulled and cleaned burners, checked gas pressure and all other safeties. Piping has no signs of leaks, exercised ball valves, cleaned enclosure, water heater is fully operational at this time.

Parts Replaced During Service List all parts with the amount in front of each part. Include part numbers. For example:

- (1) Flow Switch FS43
- (1) Temp Press Gauge RA0079000

Estimate / Parts Description If you recommend any parts or piping that needs to be replaced, this area is used to write up an estimate for the customer to use. Enter all parts, part #'s and amounts.

- Always include the **labor**, however if this is a contract customer you are performing preventative maintenance for, let the customer know that if they give you approval, you can waive the labor amount since you are already on-site. If not approved while on-site, the return trip will require the labor and truck charge.
- **Truck charge.** Just like labor, this should always be added, however if your a performing preventative maintenance, you can waive the truck charge if they approve a repair while you are already on-site. If not approved while on-site, the return trip will require the labor and truck charge
- The customer needs to check either **approved or rejected and sign**. Rejected just means they are rejecting to do it at the moment. They can approve it later, however labor and a return truck charge will be charged if done later

WATER HEATER DESCALE STEPS

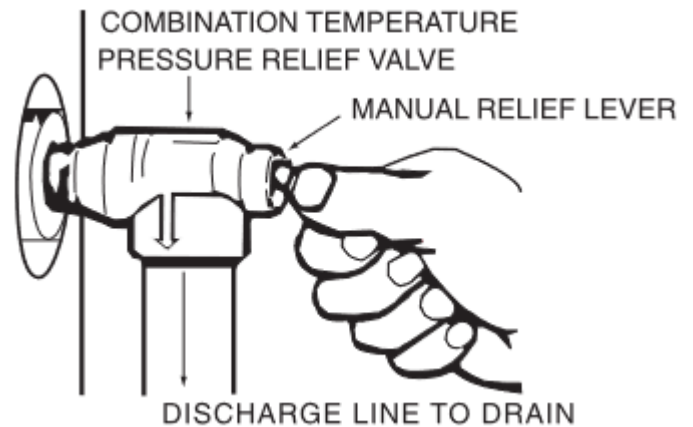
1. **ISOLATE** Turn off power to heater and disconnect return pump. Isolate the water heater by closing the valves on the incoming cold and hot outgoing. Pull the pressure relief valve to release the pressure and check that the heater is properly isolated. Water will shoot out for a second and then turn to zero pressure once the expansion tank has depleted.

2. **DRAIN** Connect a garden hose to the hose bib at the bottom of the tank. Run the hose to the nearest drain or location where a large amount of water can be released. If in question, ask the property manager or maintenance supervisor if you can drain to your selected location.

- The water usually drains slow, but that depends on the amount of scale inside the heater and if the scale is blocking the drain line. To drain water heater faster, remove the hose bib completely and thread in a $\frac{3}{4}$ " nipple into the water heater and connect your hose to the other side of the nipple. This will give a larger opening for water to pass. You can also clear the port with a screw driver if necessary to break up the scale. This may need to be performed multiple times during the draining process.
- Prop open the pressure relief valve so it stays open allowing air to enter the tank for it to drain faster. A screw driver or spare piece of cut copper can be used to keep it propped open.
- Draining can take anywhere from 20 to 40 minutes so if the property has multiple water heaters, you should start draining two at a time to speed up this process.

3. **START INSPECTION LIST** While the water heater is draining, start inspecting the water heater components and filling out your paperwork

4. **CLEANOUT PORT** After the water heater finishes draining, remove the cleanout port sheet metal cover by removing the sheet metal screws. Use 6-point sockets to unthread the cleanout port bolts and remove the cleanout port cover and gasket. If any cleanout bolts are broken off, do not remove the cleanout port as you will not be able to re-seal the port. Notify the customer that the water heater cannot be de-scaled in this condition.



5. **REMOVE SCALE** Reach in and remove all scale within the water heater by hand. Be careful as the temperature of the scale may be hot. Use a bent piece of pipe to reach the back of the water heater or a shop vacuum can be used depending on the type of scale you are removing (sand will work, but large pieces of scale may not).



6. **FLUSH** Open and close the cold feed line very quickly to flush out any scale you might not have gotten. Be careful not to get your area wet depending on where you are working as well as the pilot.
7. **RE-SEAL** Replace the gasket to ensure proper isolation. The gasket is included in most contracts – check with dispatch to be sure. Put the cleanout cover back on.
8. **RESTORE** Open the cold feed line to begin refilling the tank with water. Once water stops running, pull the pressure relief valve to remove the air in the tank. Once the tank is full, the PRV will shoot out water when you pull it. Be careful not to get pilot assembly or other electronic equipment wet. Slowly crack open the hot outgoing line. Once the noise of the water stops, you can open it fully.
- Put the sheet metal cover back on cleanout.
 - Turn power to the water heater back on.
 - Turn return pump back on. If the return line has an isolation valve and hose bib, flush return line to remove air.

WATER HEATER COMPONENT INSPECTION LIST

1. **COMPUTER CONTROLLED** Computer controlled means the water heater has a computer system controlling the heater's operation and desired temperature. This system can be monitored remotely by the property management and provide reports and alerts to the user. The most typical type we see is EDC.

- a. **How to test/inspect:** Look at the control box, usually on the water heater or wall of the room. Check the status of operation. This can be a green or red light. Green indicates the heater is being controlled by the computer and red indicates that the computer has been bypassed and the heater is running off the tank stat.
- b. **When and how to bypass:** If the heater is not providing sufficient heat, try bypassing the management system and see if it gives the heater a call for heat. To bypass, press the red button which will turn the light red. If there is still no call for heat, then the management system may be bad and will need to be disconnected. To disconnect, follow the wiring into the heater and detach where it ties in.
- c. **Tips:** The management system usually ties into the thermostat with wire nuts or on the PC board at the system enable connection or interlock. When removing the management system from the PC board, you must re-install a jumper at the connection.



2. **LOCK ON ENCLOSURE** Is the door locked, does the gate have a lock to prevent anyone from coming in to tamper with the heater?

3. **ELEMENTS (FOR ELECTRIC WATER HEATERS)**

Electric water heaters have elements rather than gas burners to heat the water. Verify that they are getting power and heating. After the tank has been drained and descaled, these rods need to be pulled and inspected. Turn off power, disconnect the wires, use a socket and breaker bar to remove elements (the socket size varies and is not always a typical size). They can accumulate scale – clean or replace if needed.



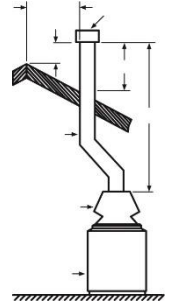
4. **BURNER ASSEMBLY:** The burner assembly holds a flame at the bottom or the top of the water heater depending on the unit.

- a. **How to test/inspect:** Burners can either be individual burner tubes, a single burner or a tray of burners. The burners should be pulled and cleaned with water or air to remove all dirt and debris. If using water, let the burners dry out as much as possible before putting them back in the water heater. Look for signs of cracked or damaged burners. To remove, you will need to first remove any items that may be in the way such as gas valves or blowers.
- b. **When it needs to be replaced:** Any damaged or cracked burners should be replaced. Damaged burners can cause a delayed ignition or soot up the water heater.



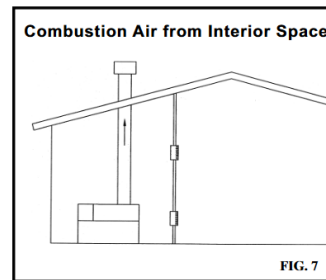
- c. **How to replace it:** There are various makes and models, refer to the manual and remove the old burners as described above and install the new burners.

5. **FLUE SYSTEM** The flue system is the boiler or water heater's venting that allows exhaust to properly exit. Make sure it is properly secured at all joints. There should be sheet metal screws at each connection holding it together as well as metal tape.



- d. **How to test/inspect:** Look at the venting and its connections to check for rust or holes.
- e. **How to replace or repair:** Secure connections or any gaps with sheet metal screws and vent tape. To replace, remove the vent tape and screws holding each piece together and then disconnect each piece. Replace with new pieces.
- f. **Tips:** Any vent longer than 20' requires a barometric damper. Vent can never be horizontal and must always be going up even if at a slight slope.

6. **COMBUSTION AIR** Combustion air is the make-up air within the water heater room. This allows air to enter the room so the water heater is able to breathe and use oxygen to produce its flame.



- g. **How to test/inspect:** Make sure there are upper and lower vents or louvers in the door or walls, sized properly for the boiler or water heater. These vents or louvers should be cleaned. If they don't exist, this must be written up and recommended.
- h. **Tips:** Make sure nothing is blocking the combustion air to the room

7. **PILOTS** There are two types of pilots: Standing and Electronic Pilots. Standing pilots is on 24/7 with a flame. The electronic pilot lights whenever there is a call for heat and will go out when the water heater shuts off.



- i. **How to test/inspect:**
 - i. Standing Pilot – requires you to time test the thermocouple – see thermocouple below. The Standing Pilot may require you to inspect or clean the orifice if the pilot flame is weak or small.
 - ii. Electronic pilot – inspect the wire going to the pilot for heat damage. Look at the size of the flame, if too small then the pilot needs to be cleaned.
- j. **When it needs to be replaced:**
 - i. Standing Pilot – Pilot assemble should be replaced if damaged but usually only the thermocouple needs to be replaced when it doesn't pass the time test and orifice may need to be cleaned.
 - ii. Electronic Pilot - It should have a strong spark when lighting, if the pilot sounds erratic or takes more than 20 seconds to light it should be replaced. If wire is melted at pilot assembly it needs to be replaced.
- k. **How to replace it:** Burner tray should be pulled to access pilots. Remove screws and pilot tubing to replace.

8. **THERMOCOUPLE** Flame sensor next to pilot on old atmospheric or water heaters.

- l. **How to test/inspect:** To test, shut off the gas and immediately perform the following time test:
 - i. If pilot safety shuts off under 1 minute – thermocouple is bad and needs to be replaced
 - ii. If pilot safety shuts off after 1 minute – thermocouple is good
 - iii. If pilot safety doesn't shut off after 2 minutes – pilot safety is bad and needs to be replaced
- m. **How to replace it:** Unscrew both ends, remove and install new one. Make sure both ends are tight.
- n. **Tips:** Make sure the thermocouple is positioned correctly so that the pilot flame hits it.

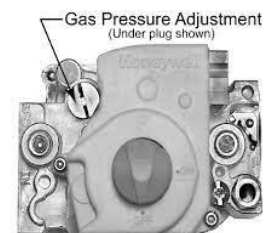


9. **GAS LEAKS** check for the smell of gas. If you suspect gas, you can spray soapy water on the gas line and look for bubbles to find a leak. If a leak is present, turn off the gas and fix the connection by taking apart the pieces and putting them back together using pipe dope. Do not use a lighter! Gas is heavier than air and falls to the ground.



10. **GAS VALVE:** Controls the gas flow to the main burners. The gas valve has a tap on the supply side and manifold side where hoses can be connected to measure the gas pressures. It also has an adjustment screw to adjust gas pressure. Clockwise increase pressure and counter-clockwise decreases gas manifold pressure. The black knob at the top is an on/off switch.

- o. **How to test/inspect:** Make sure it is opening at the time of ignition by making sure its getting 24 volts to the valve. Then make sure you are getting your manifold pressure to indicate that the gas valve is opening.
 - i. **When it needs to be replaced:** If the gas valve is getting 24 volts but is not opening – indicated by no manifold pressure upon ignition. Before replacing, double check there is supply gas pressure.
 - ii. **to replace it:** Unthread the gase valve from the gas train on both sides of the gas valve. Use pipe dope on the threading when putting on the new gas valve.
 - iii. **Tips:** Be sure to double check that the top black knob is turned on.



11. **TEMP AND PRESS RELIEF** Safety on the storage tank that releases built up water pressure.

- a. **How to test/inspect:** The lever on top should be pulled up to open the valve and make sure water shoots out and it is working. If it leaks after testing, pull the valve completely open to remove any debris that is preventing it from sealing. Open the valve 100% and let it slam shut to allow it to seal.
- b. **When it needs to be replaced:** If it is leaking and you can't get it to fully isolate; if there is corrosion buildup; if the body is cracked; if the handle is broken off.
- c. **How to replace it:** Turn off heater and return pump. Close cold, hot and return lines to isolate it. Pull the relief valve to remove the pressure. Unthread it to remove and then install the new one. Restore water slowly. Pull the new valve to release any air pressure until water comes out.
- d. **Tips:** If there is no expansion tank or a bad regular can cause the T&P Relief to leak from excess water pressure.



12. **TEMP GAUGE** Provides the water temperature reading.

- a. **How to test/inspect:** Visually check to make sure it is legible and not cracked or leaking
- b. **When it needs to be replaced:** Replace when unreadable, cracked or full of water.
- c. **How to replace it:** Shut down heater, turn off return pump, isolate heater system by shutting off ball valves on piping, pull PRV to release the pressure, unthread the gauge and install a new one using Teflon tape
- d. **Tips:** Double check the needles aren't broken on new gauges out of the box



13. **RECIRCULATING PUMP(S)** Pump attached to the end of the return line pulling hot water back to the heater. If the water is being used for hydronic heating, the property will usually have two return pumps – a summer and winter (larger) pump.

- a. **How to test/inspect:** Unscrew flat head fitting to make sure impellor is spinning. Grab ahold of the return line with your hand to make sure it is hot. The return should be within 5 degrees of the hot outgoing line. When necessary, open impellor to check for scale. Write down model on paperwork.
- b. **When it needs to be replaced:** When the pump is getting power and not spinning. Electrical plastic plate has signs of electrical damage (melted plastic, smells burnt). If the impellor is broken.
- c. **How to replace it:** Isolate water, shut off electrical power to pump, remove wiring and remember where connections go and what the pump setting is at, remove bolts to disconnect from piping and replace with new pump. Make sure it is pumping in the right direction.
- d. **Tips:** Recommend pulling pump off of the volute to check the impellor. The shaft can be spinning but the impellor could still be broken or full of scale.



14. **FANS/BLOWERS** Blows charges burner/igniter chamber with air which feeds into the burners for proper combustion.

- a. **How to test/inspect:** Use Check the blower cage to make sure it is clean from dirt and debris. Clean if necessary.
- b. **When it needs to be replaced:** When burnt out, noisy or hard starting (slow to start).



- c. **How to replace it:** Shut down heater, disconnect electrical wire harness, remove and replace.

15. **AIR FILTERS** Check any air intake for dirt and debris and clean as necessary. Filters need to also be pulled, inspected and replaced when necessary.

16. **PIPING** All copper piping in the enclosure



- a. **How to test/inspect:** check for leaks or signs of corrosion. Write up all bad piping in an estimate. Make sure water heater is piped correctly.
- b. **How to replace it:** Shut down water heater and pumps, isolate water, pull PRV to remove water pressure, cut out bad piping, solder or propress new piping, restore water and check for leaks.

17. **ISOLATION VALVES** Shuts water off at location of valve.

- a. **How to test/inspect:** Exercise all of the isolation valves by opening and closing them. Look for signs of corrosion.
- b. **When it needs to be replaced:** If any are frozen and won't move, they need to be written up with an estimate. This is very important in case any leaks occur so you can get proper isolation.
- c. **How to replace it:** Shut down heater, isolate water and pull PRV, cut out and replace with new valve by either soldering or using the propress.
- d. **Tips:** For soldering, make sure all water is stopped and the existing piping you are tying into is very clean.



18. **EXPANSION TANK** Protects against thermal expansion. Has a bladder inside that expands and contracts to absorb pressure in the system. All boiler/water heater/storage tanks require expansion tanks. They should be installed on the cold feed after the check valve.

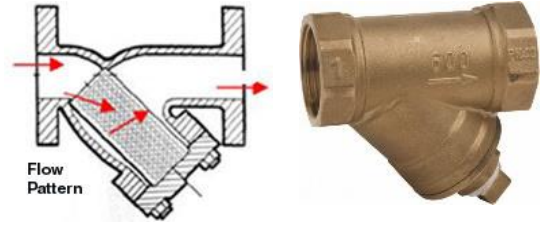
- a. **How to test/inspect:** To check the expansion tank, use a PSI gauge. Do not use your finger or a screw driver as it will reduce the PSI. The PSI on the expansion tank should match the PSI of the city water pressure. If it is lower, remove the expansion tank and pressurize to the correct setting and re-install. To pressurize, connect a pump to the Schrader valve and pump to match city pressure at system.
- b. **When it needs to be replaced:** If it is full of water or leaking, it will need to be replaced. Make sure it is mounted vertically either right-side up or upside down and not horizontal or at an angle.
- c. **How to replace it:** Isolate system, pull PRV to release pressure, unthread and replace. Use teflon tape on threading.



- d. **Tips:** Make sure you run out water pressure on PRV before removing. New expansion tanks are pressurized at 40 PSI, so be sure to pressurize it to match the city pressure before installing.

19. **WYE STRAINER** Catches debris traveling in the piping system with a screen that the water passes through.

- a. **How to test/inspect:** Isolate the wye strainer and unthread the basket to remove any debris inside. Rethread using Teflon tape. If the screen has been removed, write “no screen” on the wye strainer and write it up on your paperwork.
- b. **When it needs to be replaced:** When cracked or leaking
- c. **How to replace it:** Cut out and replace similar to a ball valve.



20. **ELECTRICAL ISOLATION** Shut off of the electrical power to the unit.

- a. **How to test/inspect:** Check any breakers and switches for proper on/off power and isolation. Cover plates are in good condition and water tight.
- b. **Tips:** Be sure power is off before working with or repairing



21. **HEATER WIRING** All wiring within the water heater system

- a. **How to test/inspect:** Make sure all water heater wiring is in good shape and that nothing is exposed improperly to the elements. All conduit on the heater, flow switch, pump, etc needs to be properly attached without any wires exposed. Look for signs of pinched, melted wires or missing/melted wire nuts.



22. **DAMPER ASSEMBLY** The damper assembly is used on water heaters to keep the heat within the water heater after it cycles off. Once the water heater gets a call for heat, the damper is the first thing that opens to allow heater to properly vent.

- a. **How to test/inspect:** Check that it opens and closes properly. Dampers are bypassed frequently due to failures. If it is bypassed, then the water heater is less efficient.
- b. **When it needs to be replaced:** If it is bypassed or not working.
- c. **How to replace it:** Remove vent and sheet metal screws. Disconnect electrical and replace.



23. **DRAFT INDUCER** A draft inducer is a blower motor on venting and is usually used for multiple heaters that are connected to the same venting or when the venting is longer than 20'. May also be used to assist with venting problems. Once there is a call for heat, the draft inducer turns on.

- a. **How to test/inspect:** Make sure motor isn't running loud or too hot. Check if it is making the air switch.
- b. **When it needs to be replaced:** If it is not turning on, is running too loud or too hot
- c. **How to replace it:** Dismantle, remove electrical and sheet metal screws and replace.
- d. **Tips:** Make sure it is turning in the correct direction when replacing.



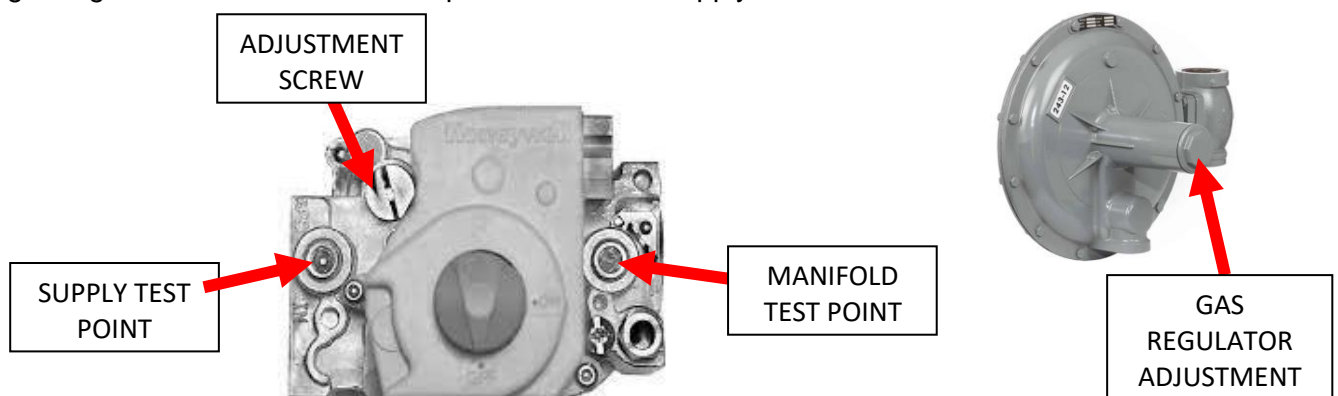
OVERALL CONDITION OF WATER HEATER ROOM Things you can note: cleanliness with trash / laundry lent, light bulbs, electrical cover plates, condition/integrity of fencing or structure protecting the heater, rodents, bees... Anything the property should know about.

BEFORE/AFTER SERVICE

- **Temperature:** The hot out line temperature – determined by the thermostat setting
- **Control Setting:** The temperature setting for the water heater
- **High Limit Setting:** The manual high limit setting

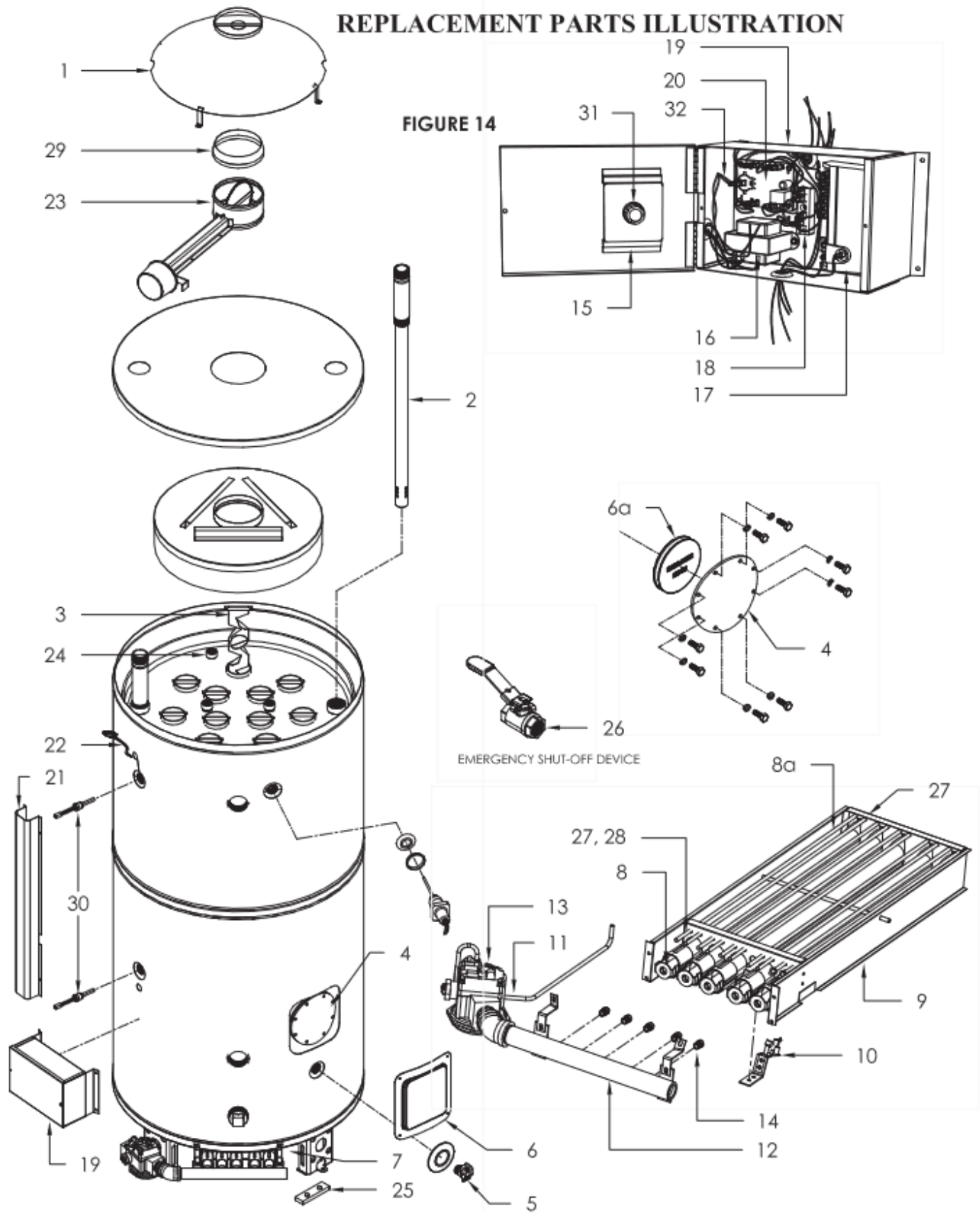
GAS PRESSURES

- **WC at Air Switch** The water column reading that you get from the hose coming out of the chamber and to the air switch. Check air switch rating for required water column. Remove hose from air switch and attach to your slack tube to read the air coming out of the combustion chamber and adjust air to the required air switch setting by adjusting the blower.
- **Manifold Full Fire** The water column reading on gas valve at manifold side. Check water heater plate for required water column. Remove gas valve outlet tap and attach hose tubing after the gas valve and check reading with all stages fired. Manifold can be adjusted by removing the cover to the adjustment screw with a flat head and then adjusting either clockwise to increase manifold gas pressure and counter-clockwise to reduce manifold gas pressure.
- **Supply Full Fire** Check water heater plate for required water column. Attach hose tubing to gas supply line before gas valve. There is usually a threaded tap on the supply line or gas valve you can remove and attach your hose to. Shut off gas supply prior to removing the test plug. Check reading with all stages fired. If adjustment is necessary, locate property gas regulator and adjust the pressure by removing the cap indicated with the red arrow and adjust clockwise to increase or counter-clockwise to decrease gas supply.
- **Supply Static** Check water heater plate for required water column. Attach hose tubing to gas supply line before gas valve. Check reading with heater off. If adjustment necessary, locate property gas regulator and follow same steps mentioned in Supply Full Fire.



WATER HEATER COMPONENT LOCATIONS

REPLACEMENT PARTS ILLUSTRATION



<u>PART NO.</u>	<u>DESCRIPTION</u>
1	DRAFTHOOD
2	DIP TUBE
3	FLUE BAFFLE
4	HAND HOLE TANK COVER
5	DRAIN VALVE
6	HAND HOLE COVER JACKET
6a	HAND HOLE COVER GASKET
7	HEAT SHIELD
8	MAIN BURNER TUBE(S) QUANTITY AND LENGHT VARY DEPENDING ON MODEL
8a	BURNER RODS, SETS OF 2 PER BURNER (SOME MODELS)
9	BURNER TRAY
10	PILOT BURNER ASSEMBLY
11	PILOT SUPPLY TUBE
12	MAIN BURNER MANIFOLD
13	GAS VALVE (<i>Emergency shut-off device</i>)
14	MAIN BURNER ORIFICE
15	BRACKET POTENTIOMETER (<i>Spark Ignition models</i>)
16	TRANSFORMER (<i>Spark Ignition models</i>)
17	IGNITION CONTROL (<i>Spark Ignition models</i>)
18	TERMINAL BLOCK (<i>Spark Ignition models</i>)
19	CONTROL BOX (<i>Spark Ignition models</i>)
20	ELECTRONIC CONTROLLER (<i>Emergency shut-off device</i>)
21	CAPILLARY TUBE COVER
22	DAMPER HARNESS (<i>Flue Damper models only</i>)
23	FLUE DAMPER (<i>Flue Damper models only</i>)
24	ANODE ROD
25	TANK LEG THERMAL BREAK (<i>Required on all combustibile floor installations</i>)
26	MANUAL SHUT-OFF VALVE IF APPLICABLE (<i>Emergency shut-off device</i>)
27	ROD CLIPS (<i>4 per burner</i>) - <i>Some Models</i>
28	ROD SPRING (<i>2 per burner</i>) - <i>Some Models</i>
29	DAMPER REDUCER (<i>Some Models</i>)
30	SENSOR
31	KNOB (<i>Spark Ignition models</i>)
32	POTENTIOMETER (<i>Spark Ignition models</i>)