PERFORMING BOILER PREVENTATIVE MAINTENANCE

Table of Contents

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 have been any issues or complaints regarding their hot water you should be aware of.
4. 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.
5. 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 so we can add it to the website.
6. 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 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 only pays for the parts and 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 along with a truck charge. 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 make a return trip for a delayed approval or 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.

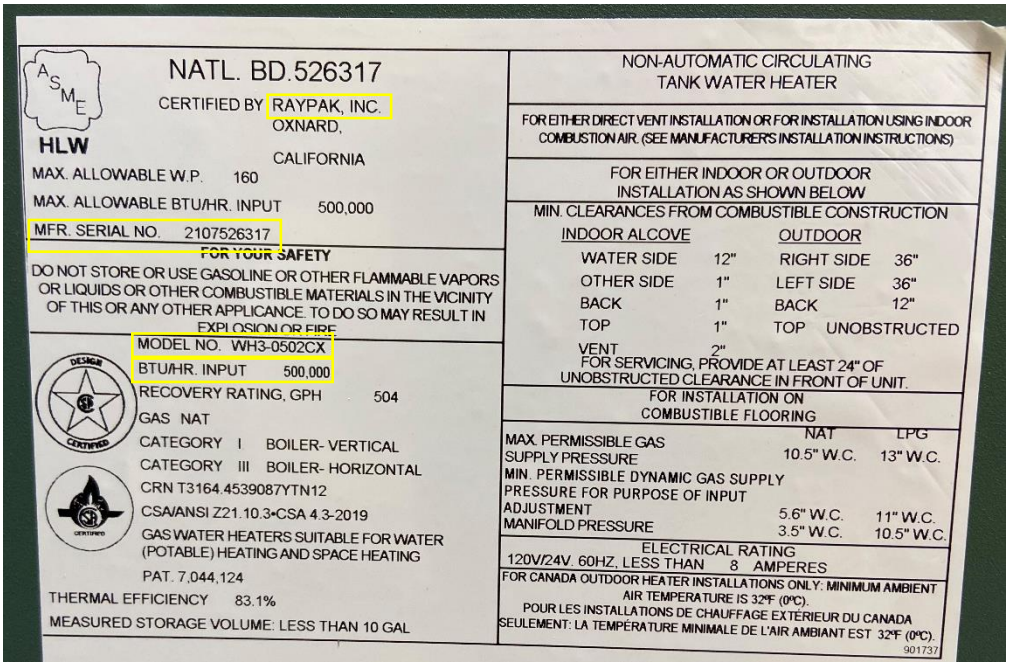
3. When reviewing your estimates/recommendations, show them your paperwork as well as pictures on your phone of what you are referring to (visuals help if they aren't familiar with boilers). It also builds their trust in your recommendations.
4. When writing up a lot of recommendations, be prepared to 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 (Raypak, Laars, Lochinvar)



Model/Serial/BTU Found on the boiler plate which is usually on the outer side of the boiler or sometimes inside the boiler.

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 boiler 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 ½" 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...

- "Checked gas and air pressures, cleaned air filter, HSI checked good at 50 ohms, pulled and checked anode rods which checked good at 90%, oiled main pump, cleaned air filter, piping has no signs of leaks, exercised ball valves, cleaned boiler enclosure, boiler is fully operational at this time."

Parts Replaced During Service

List all parts with the quantity in front of each part. Include part numbers. For example:

- (2) 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**. 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 written down 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 you're 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

BOILER COMPONENT INSPECTION LIST

1. ## COMPUTER CONTROLLED

Computer controlled means the boiler has a computer system controlling the boiler'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. **<u>How to test/inspect</u>:** Look at the control box, usually on the storage tank or the side of the boiler. Check the status of operation. This can be a green or red light. Green indicates the boiler is being controlled by the computer and red indicates that the computer has been bypassed and the boiler is running off the tank stat.
   b. **<u>When and how to bypass</u>:** If the boiler is not providing sufficient heat, try bypassing the management system and see if it gives the boiler 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 boiler and detach where it ties in.

c. **Tips:** The management system usually ties into the tank stat 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.

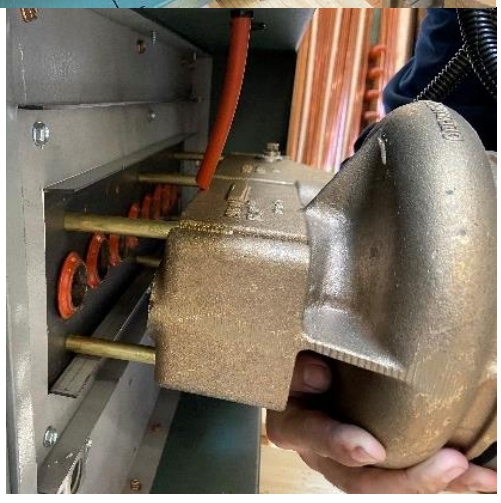
2. LOCK ON ENCLOSURE Is the door locked, does the gate have a lock to prevent anyone from coming in to tamper with the boiler?

3. HEAT EXCHANGER The heat exchanger is also called the tube bundle and is where the water passes through the boiler and is heated by the burner flames below. It is made of copper.

a. **How to test/inspect:** Inspection includes looking for visual signs of leaks or soot. Leaks will usually be seen from water coming out of the bottom of the boiler sheet metal. If there are signs of a leak, you will need to start removing panels of sheet metal to inspect the heater and confirm the leak. Also look for signs of soot which includes shorty cycling, a strong smell, black powder around the vent or built up on burners and tube bundle. Soot can be caused by combustion issues (bad venting or air and gas pressures). To fully inspect, you can either remove the vent on the top of the boiler and look down into the tube bundle or you will need to disassemble the boiler to access the tube bundle from the front.

b. **When it needs to be replaced:** When it starts to leak or when it is clogged with scale.

c. **How to replace it:** Water must be isolated first. Try isolating at the inlet and oulet piping of the boiler. If you can't get proper isolation, you'll need to isolate the cold incoming, hot outgoing and return lines. Pull the pressure relief valve (PRV) to release the pressure and confirm proper isolation of water. Disconnect headers on both ends of the heat exchanger by unscrewing the nuts holding it together. For smaller boilers, the tube bundle will come out of the top after removing the hood and top sheet metal sections. For larger boilers, the tube bundle slides out the front of the boiler above the burners. This requires you to disconnect and remove the gas line(s) manifolds inside the combustion chamber, and any sheet metal pieces in the front or sides of the boiler that are in the way.



d. **Tips:**

   i. When the heat exchanger is clogged with scale, it will create a loud banging noise. Be aware that a banging noise could also be caused by the pump being bad or filled with scale so it should be pulled and checked first.

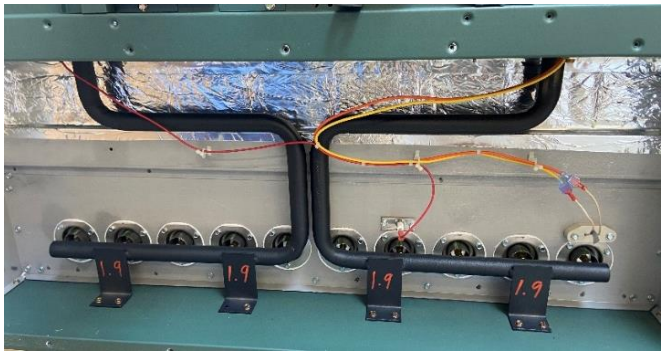
ii. Leaks must be confirmed. There have been times where techs assume the tube bundle is leaking, however the leak is coming from another source such as the flow switch conduit connected to the boiler.
iii. If in a pinch, to help keep the boiler running while you are getting a replacement heat exchanger, the following can be done: On a Low Nox boiler, remove some of the sheet metal screws at the bottom of the boiler to allow the water to escape and not fill up the chamber. Once you remove the screws you will need to reset your air settings as they may have lowered. For atmospheric boilers, you can cover the electronic pilot with a piece of metal to protect it from any dripping water.
iv. When removing a large tube bundle, the boiler sheet metal can collapse – recommend supporting it on the corners.
v. Some headers require dams and diffusers (separates or divides the inlet and outlet water). Be sure to re-install it when replacing the heat exchanger.

4. REFRACTORY The refractory is also called the Fire Box which protects the boiler and it's components from the heat of the open flame inside the combustion chamber.

a. **How to test/inspect:** You cannot access the refractory without pulling apart the boiler and removing the tube bundle or burners. So a visual inspection of the outer sheet metal behind the boiler should take place to look for signs of heat damage.
b. **When it needs to be replaced:** If there are signs of heat damage, this could indicate that the refractory is cracked, damaged or missing pieces and needs to be replaced. When replacing a tube bundle, the refractory should always be replaced as well.
c. **How to replace it:** For smaller boilers at 400k btu's or less, the refractory is removed from the top of the boiler. But you will need to remove the hood and tube bundle before you can access the refractory. For larger boilers, it is removed from the lower half of the boiler and the boiler will need to be disassembled to access it.
d. **Tips:** Refractories are very fragile and can break easily. All corners must be tight and snug to prevent heat from escaping and damaging boiler.

5. BURNER ASSEMBLY The burner assembly holds a flame at the bottom of the boiler that sits below the heat exchanger to heat the passing water. It is fed by the gas train and lit by the pilot or hot surface igniter.

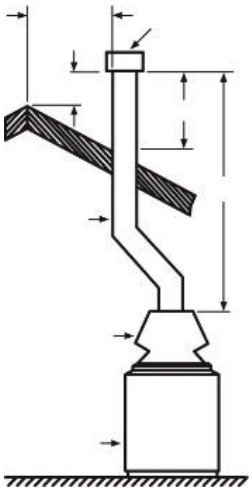
a. **How to test/inspect and replace:** Burners can either be individual burners, a set of burners or a tray of burners. You will need to first shut down the boiler, isolate gas if necessary and then remove the gas supply line(s) in front of the burners and in some cases, the blowers. There is usually a union you can disconnect on the gas line manifold. In a sealed combustion chamber, you remove the screws holding the burner(s) in place and then slide them out. Once removed, they need to be cleaned with water or compressed air to remove dirt and debris. Let them dry out as much as possible before putting them back in place (gas pressure cannot move water inside burners). When putting the burners back in, the burners in the



best condition should be placed under and close to the location of the hot surface igniter and flame sensor.

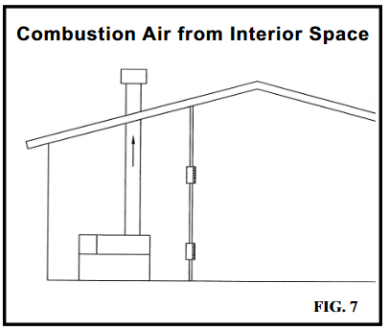
b. **When it needs to be replaced:** Any damaged or cracked burners should be replaced. Damaged burners can cause the boiler to soot up or heat damage.
c. **Tips:** If burners are melted and disformed, you will need to pull boiler apart and cut them off as they will not slide out.

6. 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.



a. **How to test/inspect:** Look at the venting and it's connections to check for rust or holes.
b. **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.
c. **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.

7. COMBUSTION AIR Combustion air is the make-up air within the boiler room. This allows air to enter the room so the boiler is able to breathe and use oxygen to produce it's flame.



a. **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.
b. **Tips:** Make sure nothing is blocking the combustion air to the room

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

a. **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.
b. **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.

c. **How to replace it:** Burner tray should be pulled to access pilots. Remove screws and pilot tubing to replace.

9. PILOT VALVE The pilot valve is on atmospheric boilers and provides gas to the pilot.

a. **How to test/inspect:** If the pilot is lit, it is working. You can test all joints with soapy water for gas leaks.
b. **When it needs to be replaced:** If the pilot does not light and you have gas and the pilot valve is getting 24 volts on the top two terminals, then it needs to be replaced.
c. **How to replace it:** Shut off gas and then disconnect the brass farrells on the inlet and outlet of the pilot valve. Disconnect mounting screw and 24 volt wires. Install new pilot valve.

10. PILOT SAFETY The pilot safety is rare and part of the standing pilot. The pilot safety along with the thermocouple controls the pilot on atmospheric boilers. It shuts off the gas to the pilot when the thermocouple doesn't sense heat.

a. **How to test/inspect:** To test the pilot safety, 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
b. **How to replace it:** Shut off gas and then disconnect the brass farrells on the inlet and outlet. Disconnect mounting screw and 24 volt wires. Install new pilot safety.
c. **Tips:** Make sure brass farrels are tight to avoid gas leaks

11. 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.

12. GAS VALVE Controls the gas flow to the main burners. There can be one or multiple stages with gas valves on a boiler. Each gas valve has two test ports – one for supply gas pressure and the other is for manifold gas pressure. It also has a regulator to adjust manifold pressure. This regulator can be adjusted – turning it clockwise will increase the manifold pressure; turning it counter-clockwise will decrease the manifold pressure. The black knob at the top is an on/off switch.

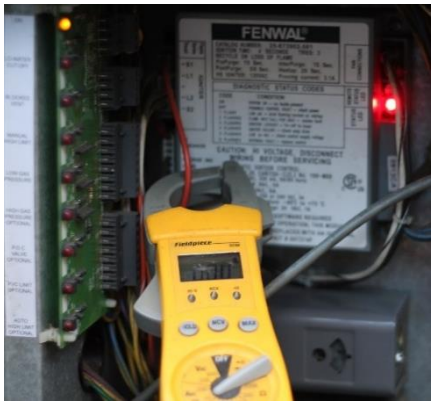
    a. **How to test/inspect:** Make sure it is opening at the time of ignition by making sure its getting 24 volts to the valve. Then make sure you are getting your manifold pressure to indicate that the gas valve is opening.
    b. **When it needs to be replaced:** If the gas valve is getting 24 volts but is not opening – indicated by no manifold pressure upon ignition. Before replacing, double check there is supply gas pressure.
    c. **How to replace it**: Unthread the gave 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.
    d. **Tips:** Be sure to double check that the top black knob is turned on.

13. ELECTRONIC IGNITION For atmospheric boilers and water heaters, the electronic ignition is an S-86 or a blue colored G67. They control lighting the pilot and opening the gas valve.

    a. **How to test/inspect:** Check for 24 volts at the ignition module to be sure it is getting power. Check that the pilot lights and that the gas valve has opened.
    b. **When it needs to be replaced:** If the module is getting 24v and the pilot continues to click with a flame but the gas valve doesn't open, the ignition module needs to be replaced.
    c. **How to replace it:** Remove by unscrewing it and then disconnect all wiring and plug wiring into new unit. Pay attention to where the wiring needs to be connected before unplugging. It helps to take a picture or label the wires before removing.
    d. **Tips:** Electronic ignitions can use flashing lights to indicate failures. Pay attention to what message they are giving before turning off power which will remove the error message.

14. FENWALL On Low NOx boilers, the FENWAL is a control module that controls the igniter, blower, gas valve. It provides fault messages through flashing lights – these faults are listed on the FENWAL. There is no true way to test a FENWAL, however if one of the components that it controls is not working, this could be an indication that the FENWAL is bad.

15. HOT SURFACE IGNITER (HSI) Once the HSI gets 120v, it will ignite the gas once it proves to the control module that it is hot enough.



a. **How to test/inspect:** Place your volt meter around one of the connecting wires and watch the amp draw when the boiler fires. It should go above 4.0 and then drop to the 3's. If it drops below 3.4 before firing, it is weak. Also check ohms which should be between 40 and 70 for a good reading. To test ohms, put each volt meter lead in each of the HSI wires. Test the ohm reading after it has cooled down to room temperature – if it is hot, the reading will be lower and incorrect.

a. **When it needs to be replaced**: When the amp draw or ohm reading is not within the parameters above. Or if there is visual buildup (glaze) on the igniter.

b. **How to replace it:** Open the combustion chamber, disconnect the two wires on the HSI, remove the screws and pull it out.

c. **Tips:** It can break very easily. Use a nut driver rather than a drill when installing a new igniter to avoid breaking the element. After installing the new igniter, check the ohm reading to make sure it didn't break.

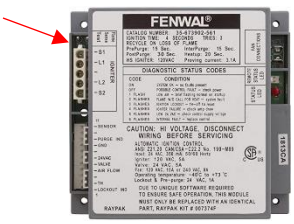
16. FLAME SENSOR Sits above the burners and senses the flame

a. **How to test/inspect:** Visibly check the condition of the sensor rod to see if it has corrosion or is bent. Minor corrosion can be removed with a soft cloth.

b. **When it needs to be replaced:** If the rod is bending or worn out. Also check flame strength at FENWALL by putting the two volt meter leads on the test point for any reading.

c. **How to replace it:** Open the combustion chamber, disconnect the flame sensor wire, remove the screws and pull out flame sensor.

d. **Tips:** When looking through the flame sensor hole, make sure it is clear (there have been situations where the fire box has fallen on the flame sensor)



17. THERMOCOUPLE Flame sensor next to pilot on old atmospherics or water heaters.

a. **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
b. **How to replace it:** Unscrew both ends, remove and install new one. Make sure both ends are tight.
c. **Tips:** Make sure the thermocouple is positioned correctly so that the pilot flame hits it.

18. MOD VALVES A modulating temperature control on atmospheric boilers that don't have a storage tank.

a. **How to test/inspect:** The red dial has listed numbers. 4 to 5 is around 120 to 125 degrees. 6 to 7 is around 130 degrees. Set it between 5 or 6, but check the temperature gauge to make sure your getting the right temperature.
b. **When it needs to be replaced:** When you turn the mod valve all the way down and it doesn't shut off the burners.
c. **How to replace it:** Unscrew and remove the top half of the unit. A new gasket will likely need to be installed with it. Then check for gas leaks.
d. **Tips:** If the tank has a tankstat, then put the mod valve maxed out at 9 and it will run off the tankstat. If the mod valve won't shut off, remove the red knob and manually turn screw clockwise till it closes.

19. TANKSTAT controls the temperature of the water in the tank and sends a "call for heat" to the boilers when there is a demand.

a. **How to test/inspect:** Turn it up and down to make sure it turns the boilers off and on. For most apartment applications, it should be set at 125. Make sure heat compound has been applied to the sensor inside the storage tank.
b. **When it needs to be replaced:** When the water is getting hotter than the setpoint. Or if it doesn't send a call for heat when there should be demand.
c. **How to replace it:** Remove mounting screws, disconnect wiring and remove prove from well.
d. **Tips:** Use the auto and manual high limits to test water temperature to compare against tankstat setting. They should all click within a few degrees of the same temperature.

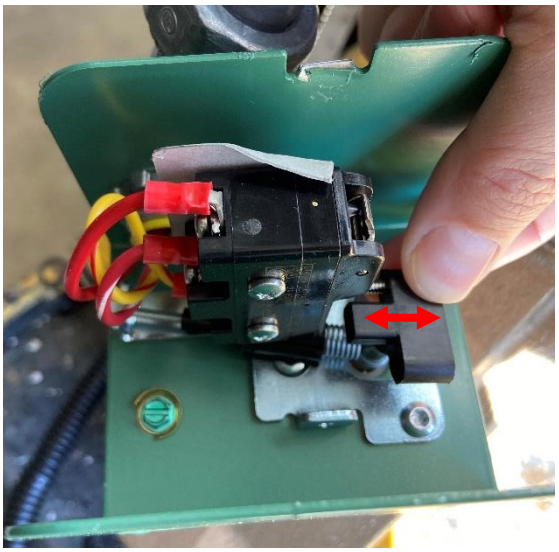
20. HIGH LIMIT The **automatic high limit** is usually set at 180 and is a safety that will shut off the boiler temporarily when it reaches the set temperature. Once the boiler temperature cools back down, the auto high limit with allow the boiler to turn back on. The **manual high limit** is set higher usually at 200 and permanently shuts off the boiler until the red button is manually pushed back in.

a. **How to test/inspect:** Lower the temperature to test whether they shut off the boiler when triggered. To do so, lower the temperature setting until you hear the boiler shut off, then put it back to its original setting to see if the boiler turns back on. Press the red button for manual high limit to allow the boiler to turn back on.
b. **When it needs to be replaced:** When the water is getting hotter than the setpoint. Or if it doesn't send a call for heat when there should be demand.
c. **How to replace it:** Remove mounting screws, disconnect wiring and remove prove from well.
d. **Tips:** Use the auto and manual high limits to test water temperature to compare against tankstat setting. They should all click within a few degrees of the same temperature.

21. 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:** 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 pressure regulator can cause the T&P Relief to leak from excess water pressure.

22. FLOW SWITCH A safety that reads water flow and is activated when the pump turns on. It is a safety that tells the boiler the pump is running. Electrical connections should be at "common" and "normally open".



a. **How to test/inspect:** Remove the top cover and feel the spring loaded bar to check for tension. Test by pushing back the paddle to make sure it shuts off the boiler. It should have good tension indicating the water flow pressure from the pump is good. If there are signs of corrosion or any other issue, isolate the water and pull the PRV. Remove the flow switch by shutting down boiler, isolating water, pulling PRV, disconnecting the wires (pay attention to where they are supposed to go) and then unthread the flow switch. Once out, check the condition of the paddle and arm and for any scale.
b. **When it needs to be replaced:** If it doesn't shut off the boiler when you push the paddle, if leaking or showing lots of corrosion.
c. **How to replace it:** Follow instructions for pulling the flow switch and then install a new one with wiring in same positions. Make sure the new paddle matches the size of the pipe and doesn't hit the bottom of the pipe. Never use the smallest paddle.
d. **Tips:** The flow switch can freeze or get stuck in a closed position and allow the boiler to continually run. The tension screw can also be adjusted for weaker or stronger flow.

23. PRESSURE SWITCH There are a few types of pressure switches which act as safeties. One type is your **air pressure switch** that makes sure the blower fan is working. Another type of is the **water pressure switch** and is attached to the boiler piping.

a. **How to test/inspect:**
   i. **Air Switch:** Connect your slack tube/manometer hose to the air switch tubing. Check rating on the air switch and while the blower is running, make sure the air is reading greater than that rating by one full number.
   ii. **Water Pressure Switch:** Remove pressure switch and inspect inlet port for debris. There is a pressure test button on top you can push down that should shut off the boiler.
b. **When it needs to be replaced:**
   i. **Air Switch:** When your getting the correct air setting and the switch does not close. Air switch can stick closed causing the boiler to not come on.

ii. **Water Pressure Switch:** When it is corroded/leaking or there is water pressure and it isn't closing.

c. **How to replace it:**
   i. **Air Switch:** Disconnect wiring, mounting screws and hoses and replace
   ii. **Water Pressure Switch:** Isolate the boiler, pull prv, remove wiring and replace

24. TEMP/PRESS GAUGE Provides the water temperature and pressure 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 boiler, isolate boiler 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

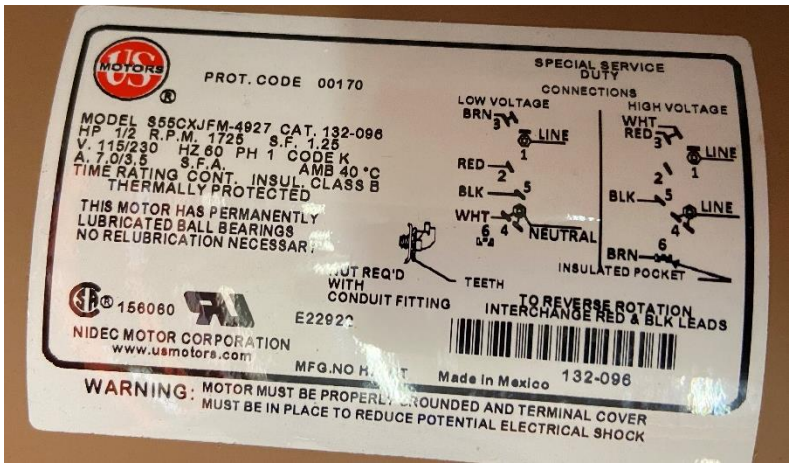
25. PRESSURE RELIEF VALVE Safety on the boiler that releases built up water pressure. This should also be used to remove pressure when isolating the boiler for a plumbing repair and it should be pulled to make sure it is working.

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:** 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 pressure regulator can cause the T&P Relief to leak from excess water pressure. If the handle is broken and you need to relieve the pressure, do so at the temp and pressure relief valve on the storage tank.

26. MAIN PUMP/MOTOR Pump that circulates the water between the boiler and the storage tank which activates the flow switch. The pump is made up of the motor, bearing assembly and impellor.

a. **How to test/inspect:** Check amp draw which is always on the FLA rating plate and anything 1 amp over the rating plate is too high which means the motor is weak. If it has a rubber coupler, look for black shavings which would indicate that it is not aligned correctly around the coupler. If there is a spring coupler, you will hear a loud grinding noise if it is broken. If there is poor flow, check the impellor for scale by pulling the pump.
b. **When it needs to be replaced:** If the motor is overamping, the motor needs to be replaced and also check the impellor because of possible restrictions/damage. If making a loud grinding

noise when turning on, turn it off and back on while testing the start-up amp draw. If the amp draw is too high, it could trip the breaker depending on breaker rating. If the noise continues, it should be replaced.



c. **How to replace it:** Turn off boiler, isolate water to boiler, pull PRV to check pressure is removed, disconnect the wiring and remember where each wire connects (On Armstrong, Line 1 and 2 connect with #1 and #4, then connect ground to green screw), remove bolts connecting it to the header, replace gasket and put in new pump with bolts, restore water and check for leaks, attach wiring, fire boiler to make sure it works.

d. **Tips:** Always check incoming voltage to pump to determine whether it is high or low voltage. Then wire motor according to the data plate. Check pump rotation to make sure it is running the correct way.

27. RECIRCULATING PUMP(S)

Pump attached to the end of the return line pulling hot water back to the boiler. 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 and remove flat head fitting on the side 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, 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.

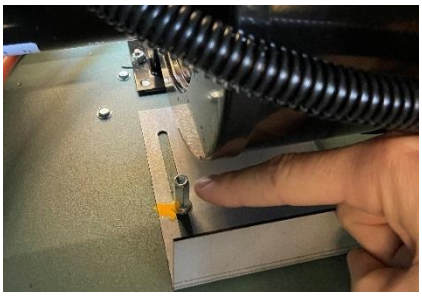
28. FANS/BLOWERS

Blows air that charges burner/igniter chamber with air which feeds into the burners for proper combustion. Also makes the air switch close.

a. **How to test/inspect:** Use your slack tube and connect hose to the tee on air switch hose to test air pressure at air switch. Air should be at least one full number greater than the air switch rating depending on CO2 (rating is located on the air switch). The blower is adjusted by the

shutter on the bottom of the blower. Opening increases and closing decreases air. If the blower is dusty, clean off the fan blades.

b. **When it needs to be replaced:** When burnt out, noisy or hard starting (slow to start).
c. **How to replace it:** Shut down boiler, disconnect electrical wire harness, remove 4 3/8" bolts, then remove and replace.



29. AIR FILTERS Filters out debris from entering the boiler cabinet. First defense in keeping the burners clean. Dirty filters will cause boiler to fail on low air.
    a. **How to test/inspect:** Pull and check the air filter for tears and holes. Clean the filter by rinsing it with water. Before putting it back, get the air filter as dry as possible after washing it.
    b. **When it needs to be replaced:** If damaged or falling apart
    c. **How to replace it:** Pull out old one and replace with new one
    d. **Tips:** Don't put them back in wet, moisture from the filter could find its way back to the igniter.

30. PIPING Inspect all copper piping in the boiler enclosure

    a. **How to test/inspect:** check for leaks or signs of corrosion. Write up all bad piping in an estimate. Make sure boiler/tank are piped correctly. Pipe sizes should be as follows:
        i. 1 ½" for 0 - 400,000 BTU
        ii. 2" for 500,000 – 900,000 BTU
        iii. 2 ½" for 1 million and up BTU
    b. **How to replace it:** Shut down boiler 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.

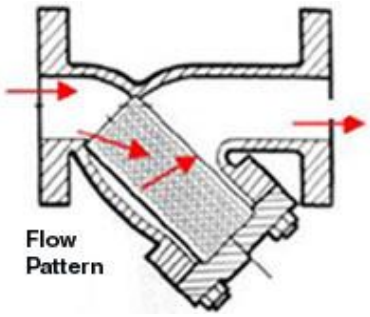
31. ISOLATION VALVES Shuts water off at location of valve.

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 boiler, 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.

32. 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 tephlon 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.

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

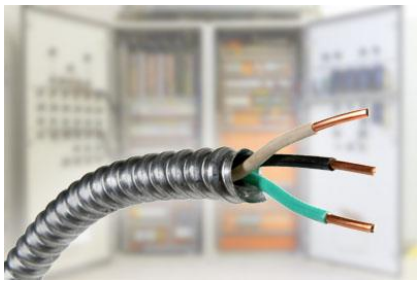


a. **How to test/inspect:** Isolate the wye strainer and unthread the basket to remove any debris inside. Rethread using Teflon tape. If the screen has been removed, write "no screen" on the wye strainer and write it up on your paperwork.
b. **When it needs to be replaced:** When cracked or leaking
c.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

34. ELECTRICAL ISOALTION 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

35. BOILER WIRING All wiring within the boiler system



a. **How to test/inspect:** Make sure all boiler wiring is in good shape and that nothing is exposed improperly to the elements. All conduit on the boiler, 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.

36. 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.

37. 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.

38. STORAGE TANK Holds and stores the hot water that is fed from the boiler and then feeds the hot water to the property when there is a demand out of the top port.

a. **How to test/inspect:** Look for signs of leaking such as pooling water at the base or rusty drips on the side. Make sure it has earthquake straps.
b. **When it needs to be replaced:** When it is leaking
c. **How to replace it:** Remove/disconnect tankstat wiring, Isolate the water at all connections, pull the PRV to remove pressure, disconnect the dialectic unions at the ports or cut the copper if there are no unions present. Remove tanks and install new one.
d. **Tips:** Never plug the PRV

39. TANK ANODE Protects the lining of the tank by acting as a sacrificial rode. The water is attracted to the anode and will attack it before attacking the lining of the tank. If the tank anode is gone, the lining of the tank will be at risk which could lead to it leaking. If the tank glass lining is cracked, the tank anode rods will dissolve faster.

    a. **How to test/inspect:** Isolate the tank and pull the PRV to release any pressure, unthread both anode rods using a 1 1/16" size bit with a breaker bar. A "cheater pipe" is commonly used to extend the length of your handle for extra leverage. Once removed, inspect their condition. Must be very careful not to harm the threading when putting back into the tank otherwise it will not seal and will have to be re-threaded (Don't let this happen!). Use Teflon tape when putting back in.
    b. **When it needs to be replaced:** They should be replaced when 50% or more is gone.
    c. **Tips:** Write on the tank the date the anodes were checked or replaced.

OVERALL CONDITION OF ENCLOSURE

Things you can note: cleanliness with trash / laundry lent / plant growth, light bulbs, electrical cover plates, condition/integrity of fencing or structure protecting the boiler, rodents, bees… Anything the property should know about.

BEFORE/AFTER SERVICE

- **Temperature**: The hot out line temperature – determined by the tankstat setting
- **Control Setting:** The tankstat, header stat or mod valve setting
- **High Limit Setting:** The Manual high limit setting

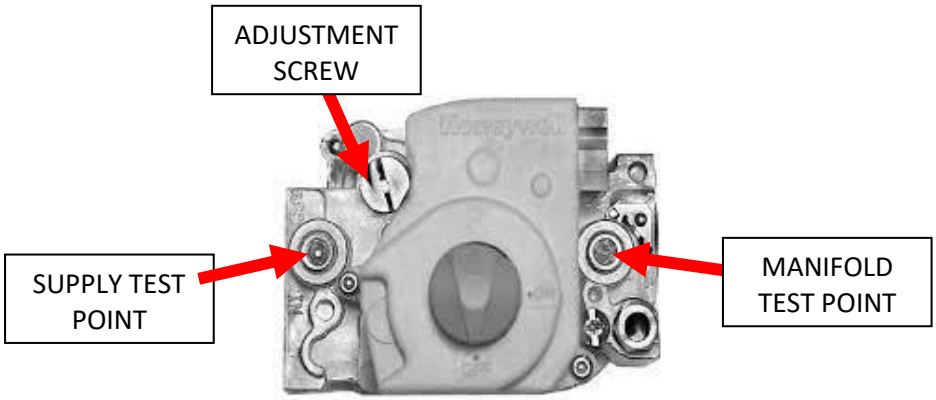
GAS PRESSURES

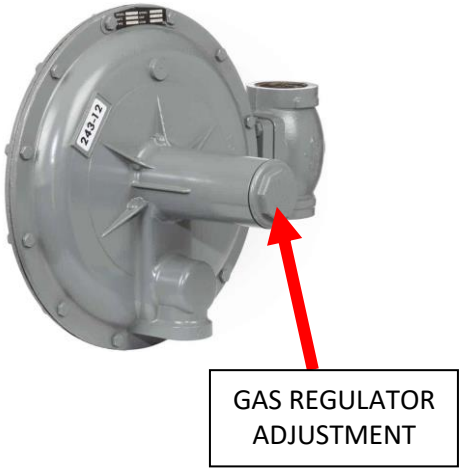
- WC at Air Switch The water column reading that you get from the hose coming out of the chamber and to the air switch. Check air switch rating for required water column. Remove hose from air switch and attach to your slack tube to read the air coming out of the combustion chamber and adjust air to the required air switch setting by adjusting the blower.

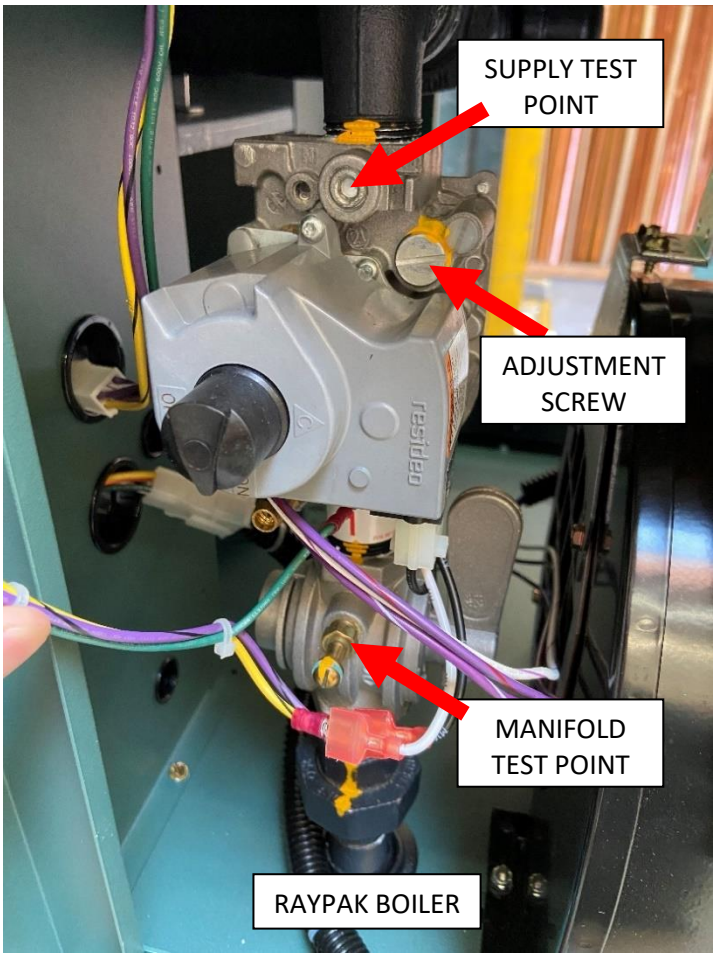
- Manifold Full Fire The water column reading on gas valve at manifold side. Check boiler plate for required water column. Remove gas valve outlet tap and attach hose tubing after the gas valve and check reading with all stages fired. Manifold can be adjusted by removing the cover to the adjustment screw with a flat head and then adjusting either clockwise to increase manifold gas pressure and counter-clockwise to reduce manifold gas pressure.

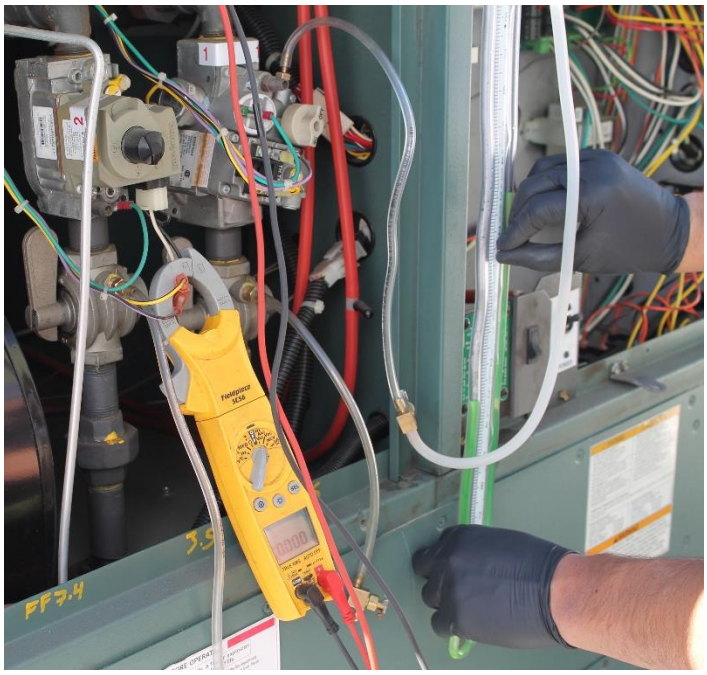
- **Supply Full Fire** Check boiler plate for required water column. Attach hose tubing to gas supply line before gas valve. There is usually a threaded tap on the supply line or gas valve you can remove and attach your hose to. Shut off gas supply prior to removing the test plug. Check reading with 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.

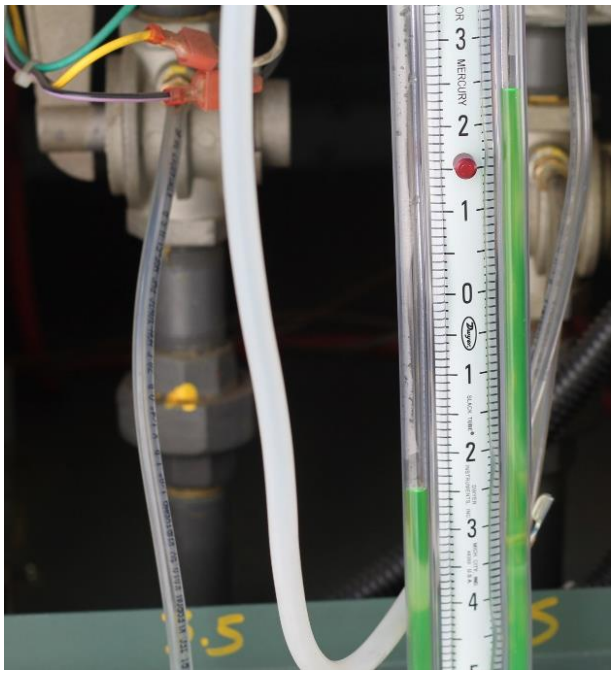
- **Supply Static** Check boiler plate for required water column. Attach hose tubing to gas supply line before gas valve. Check reading with boiler off. If adjustment necessary, locate property gas regulator and follow same steps mentioned in Supply Full Fire.











- CO2% The reading from the analyzer. To test, place probe 50% of the way into the boiler vent. Then full fire boiler on all stages and check CO2. The desired range is 7.8 – 8.2%. Lowering the air will increase the CO2 and increasing the air will lower the CO2. To lower the air, close the blower shutter and to increase the air, open the blower shutter.

Hi Delta Component Locations: