TriangleTube
Hot Water Specialists

SERVICE TECHNICIAN'S

TROUBLE SHOOTING GUIDE

FOR ALL PHASE III

INDIRECT FIRED WATER HEATER

Phase III Service Technician's Trouble Shooting Guide

This guide is to be used in conjunction with all Phase III Indirect Fired Water Heaters (TR Series, SMART Series & HL Series) Technical Specifications Installation and Maintenance Guide.

Good Trouble Shooting Practices

Before leaving for the job site:

- Check your parts and tools.
  - Test equipment and tools that you will need:
    Electrical meter that can measure voltage and continuity.
    Pressure gauge, Watts #276H300 Test Gauge.
    Temperature gauge
    Bucket, 1 gallon or larger with volume markings.
    Stopwatch
  - Parts to solve most problems:
    Thermostat (Aquastat) P/N P3KITTH01
    O-Ring Kit P/N P3KITOR01
- Know the water heater model number.
- Know boiler manufacturer and model number.
- Review all appropriate manuals before leaving for the job site.

At the job site:

- Clarify the problem.
- Have the Phase III manual and any boiler manuals and/or wiring and piping schematic readily available
- Turn to page 2 -- read carefully and follow instructions step by step.

Remember !!

Follow the Troubleshooting Guide step by step, always double checking your results. Skipping steps or not completing steps can lead to wrong conclusions, repeated visits to the job site, unhappy customers and unnecessary warranty claims.

Situation		Corrective Action Section
Insufficient Hot Water	Yes →	*Insufficient Hot Water* - page 3 - Undersized water heater - Boiler system improperly sized - Check component parts - Boiler operating temperature - Location of flow control devices - Air in system - Clean boiler system
↓ No		

Excessive Domestic Water Temperature	Yes →	*Excessive Water Temperature* - page 6
		- Reduce Staking
		    - Lowering boiler operating temperature
		    - Relocating T-stat bulb
		    - Reverse boiler piping
		- Install thermostatic mixing valve
		- Recirculation loop

↓ No		
Boiler Relief Valve Lifting or Weeping	Yes →	*Boiler Relief Valve Lifting or Weeping* - page 7 - Undersized boiler expansion tank - Faulty boiler expansion tank - Simulate maximum expansion - Faulty boiler relief valve - Faulty boiler fill valve - Inner tank leak
↓ No		
Temperature/Pressure Relief Valve Lifting or Weeping	Yes →	*T&P Relief Valve Lifting or Weeping* - page 8 - Undersized or missing domestic side expansion tank - Faulty domestic expansion tank - Faulty T&P relief valve - High domestic supply pressure - Possible water hammering or pressure spikes - Boiler operating temperature
↓		
Water Found on the Floor Near the Tank	Yes →	*Water on the Floor* - page 9 - From sources other than the water heater - T&P valve lifting and discharging - Loose piping connections
↓ No		
Top of Tank/ Insulation Wet	Yes →	*Top of Tank / Insulation Wet* - page 10 - From sources other than the water heater - Loose piping connections - Leakage from the drywell
↓ No		
Water Quality Problems	Yes →	*Water Smells / Taste Bad* - page 11 - Water smells like "rotten eggs" - Milky water - Rusty discolored water

Is the water heater undersized for the application

- There are many methods of sizing various applications, i.e. ASHRAE sizing tables, or ASPE domestic water heating design manual, re-confirm the water demand required for the application.
- Re-confirm the flow rates of the fixtures. Was the tank sized for shower heads at 2.0 gpm, when the actual heads are 5.0 gpm? Use a bucket and a stopwatch to determine fixture flow rates.
- Evaluate the hot water usage pattern for a day. Is the peak demand unusually high for the application?
- Has the demand for domestic hot water changed since the system was installed? A bathroom remodeling project with a newly installed whirlpool tub will drastically change the domestic water demand.

Is the boiler system properly sized

- Is the boiler providing the required output of BTU's to meet the domestic water load?

$$\text{Domestic Demand gph} = \frac{\text{Blr Output BTU's}}{(\text{Temp. Rise °F} \times 8.33)}$$

Temp Rise ºF = Desired Temp.ºF - Incoming Temp.ºF

8.33 = Density of Water lbs/gal. x 1 Btu/lbs ºF

Example: A single family home with a 3.0 gpm shower fixture and a 150,000 Btu/hr output boiler capacity. Is the boiler capacity adequate to deliver 115ºF water for an extended period?

$$\text{Domestic Demand gph} = \frac{150{,}000 \text{ Btu/hr}}{[(115°\text{F} - 50°\text{F}) \times 8.33]} = 277 \text{ gph}$$

The boiler capacity is capable of delivering 4.6 gpm continuously which is adequate for this application.

Action Item:

- Measure the BTU input to the boiler by clocking the gas meter or finding the oil flow rate based on nozzle size and pump pressure.

- Does the hot water system need to be wired for domestic priority? For systems in which either the storage or BTU's available are marginal it is recommended to wire the domestic water heater in a priority manner.
- Is the boiler piping to the water heater properly sized to allow the required flow rate for maximum BTU transfer? The temperature differential of the boiler supply and return water should be 20ºF to 30ºF.

- Is the circulator between the boiler and the water heater properly sized to provide adequate flow for maximum BTU transfer?

Pipe Size	Flow Rate	BTU's Transfer
3/4"	3 to 7 gpm	50 to 100 MBH
1"	8 to 15 gpm	100 to 180 MBH
1 1/4"	12 to 25 gpm	160 to 300 MBH
1 1/2"	18 to 35 gpm	200 to 450 MBH
2"	30 to 55 gpm	300 to 650 MBH

Check component parts

- Is the domestic water thermostat functioning properly? With a electrical voltmeter check for continuity between terminals C and 1 on the snap-set connection.

  Action Item:

  1. Disconnect the snap-set connector on the Phase III water heater.
  2. Turn the thermostat knob to the highest setting - clockwise to initiate a call for heat.
  3. Check for continuity between terminals C and 1 (end connectors on the snap-set). On a call for heat, these contacts should be in the close position.
  4. Continue checking for continuity while turning the thermostat knob to the lowest setting - counter clockwise to satisfy the call for heat. The contacts should open, breaking the continuity.
  5. If any of these steps fail, replace the thermostat.
  6. Reconnect the snap-set.

- Is the thermostat setting too low? If the thermostat setting is too low the boiler may not have the opportunity to deliver the maximum BTU's required to completely heat the entire volume of water stored in the tank.

- During a call for heat by the water heater, does the boiler circulator begin pumping, does the zone valve open, does the boiler fire? Check every component in the system to ensure they are properly functioning.

- Check the thermostat sensing bulb size and fit into the drywell. Some older units have a sensing bulb that is thinner and fits loose inside the drywell. The newer thermostats have a larger bulb which fits tighter in the drywell allowing better heat transfer for more accurate water temperature sensing.

Action Item:

- If the sensing bulb does not slide into the drywell; remove burrs from top 1 1/2" inside the drywell with a 3/8" drill.

- What is the location of the thermostat bulb? A bulb inserted completely at the bottom of the drywell will initiate a quicker response for a call for heat. This is typically the position of the bulb required for applications in which there are large draws of domestic water.

- Remove and examine the dip tube located in the cold water inlet. Replace if damaged. A broken or melted dip tube will cause the cold water to discharge across the top of the tank, thus short cycling the water heater.

Check the operating temperature of the boiler

- If possible increase the boiler operating temperature to 180ºF or 200ºF.

- Maintain a minimal temperature in the boiler during non-heating seasons. A boiler typically has a higher standby loss than the indirect water heater. After a long standby period the colder boiler may absorb the stored energy within the water heater during the initial call for heat.

Check location of flow control devices

- Lab tests have shown that during long standby periods the boiler piping can act as a thermal siphon and draw stored heat from the domestic water. Locate flow control devices (zone valve, spring check valves...) or heat trap loops in the boiler piping close to the water heater. Insulate all boiler piping to and from the water heater.

Check for air in the system

- An air bound water heater or boiler will not circulate system water properly, resulting in a lack of heat transfer.

Clean the boiler system

- A dirty boiler system can cause deposits to form on the outer wall of the inner tank, which insulates the tank, affecting the heat transfer. Clean the boiler system per the boiler's manufacturer's instructions.

  Action Item:

  - Install a strainer in the boiler piping on older installations or for systems prone to becoming dirty.

Excessive water temperature is usually the result of stacking within the water heater. Stacking is the occurrence of various water temperatures layering within the water heater with the hottest water in the uppermost layer. This layering or stacking effect typically occurs during small draws of hot water (typically less than 25% of the storage capacity) which are long enough to create a call for heat on the thermostat, but are short enough not to deplete the stored energy within the tank. Excessive stacking can occur when frequent short to moderate draws are taken in quick succession. During this type of situation, the temperature of the domestic water can approach the temperature of the boiler water.

REMEMBER: All water heaters (direct and indirect) will stack.

Reducing stacking within the tank

- Reduce the boiler operating temperature to 160ºF - 170ºF. This will limit the maximum domestic outlet water temperature during high stacking water usage.
- Raise the thermostat sensing bulb higher in the drywell. This will reduce the frequency of thermostat calls for heat during small draws of hot water. However, it will reduce the quantity of available hot water during a deep draw by delaying the call for heat to the boiler.
- Reverse the boiler side piping. The older installations have the boiler supply at the top of the water heater and return at the bottom. Reversing the piping, supply at the bottom and return at the top will:
  a) Result in lower tank stacking by having the hottest boiler water closer to the cooler incoming domestic water.
  b) Reduce the effect of "thermal overshoot" after the thermostat call for heat has been satisfied.
  c) Provide a more uniform hot water delivery temperature during moderate to deep draws (25% to 100% of the tank's storage capacity).

  Reversing the boiler piping will not affect the performance of the water heater.

Install thermostatic mixing valve

- Installation of a thermostatic mixing valve will provide an uniform delivery temperature with minimal regard to water usage.

Recirculation Loop

- Installation of a properly sized recirculation loop not only provides prompt delivery of hot water, but it provides circulation and mixing of the water within the tank.

Is the expansion tank on the boiler side properly sized?

- The additional quantity of boiler water contained in the outer tank must be considered when sizing the boiler side expansion tank.

Phase III Model	Boiler Side Capacity Gal.
TR-20	8
TR-30	9
TR-36	12
TR-45	8
TR-60	8
TR-80	15
TR-120	30
SMART 20 / HL-20	5
SMART 30 / HL-30	5
SMART 40 / HL-36	6
SMART 50 / HL-45	8
SMART 60 / HL-60	8
SMART 80	14
SMART 100	25

- Insufficient allowance for expansion on the boiler side can cause the boiler pressure relief valve to lift.

Is the expansion tank defective, water logged or improperly charged?

- Check for failed gaskets or bladders, or a faulty Schraeder valve.
- Use a tire gauge to check the charged pressure of the tank

  Action Item:

  - Increase the boiler operating temperature and let the system run at the higher temperature. This will simulate maximum expansion in the boiler system.
  - If the boiler relief valve lifts and/or there is a significant increase in the boiler system pressure, the expansion tank is flooded or undersized.

Is the boiler pressure relief valve functioning properly?

- Dirt and water deposits can accumulate under the valve seat.

Check the boiler automatic fill valve for defects.

- Is the valve filling to the correct pressure?

Check for possible inner tank leak

- If possible, isolate the Phase III tank from the boiler system for an extended period of time. Observe the boiler system pressure during that time.

Is there a thermal expansion tank installed on the domestic supply piping and is it properly sized?

- A thermal expansion tank is required if the domestic supply piping includes a backflow preventer or pressure reducing valve.
- Ensure the potable water expansion tank is properly sized according to the water heater volume and supply pressure.
- During long periods when there is no draws from the tank (i.e. overnight), the T&P relief valve may lift or weep due to thermal expansion, but may function properly during normal periods of tank draws.

Is the expansion tank defective, water logged or improperly charged?

- Check for failed gaskets or bladders, or a faulty Schraeder valve.
- Use a tire gauge to check the charged pressure of the tank

Is the temperature/pressure relief valve functioning properly?

- Dirt and water deposits can accumulate under the valve seat.

Check the domestic supply pressure entering the water heater.

- If the pressure is over 70 psi it is recommended to install a pressure reducing valve. This will prevent any pressure spikes or increases in pressure due to thermal expansion which may cause the T&P valve to lift or weep.

Check the domestic system for possible sources of water hammering or pressure spikes.

- Some appliances such as clothes washers and dishwashers utilize fast acting valves which may cause water hammering or pressure spikes through the domestic water system.

  Action Item:

  - Install water hammer arrestors as required per the manufacturer's instructions, or install flexible connectors to isolate the tank from the domestic system

Check the operating temperature of the boiler

- If the boiler operating temperature is excessive, 200ºF or higher, stacking can occur in the inner tank raising the domestic water temperature close to the boiler operating temperature.

  Action Item:

  - Reduce the boiler operating temperature to 180ºF.

Is the source of the water from the tank?

- Check for possible water seepage through foundation cracks. Did the water appear after a heavy rain?

Is the source of water from the T&P relief valve?

- Place a bucket under the discharge piping of the T&P relief valve and monitor it for a day or two. This is a procedure that can be done by the homeowner.
- If the T&P relief valve is the source, refer to the T&P Relief Valve section of this guide.

Check all connections - boiler connections, domestic connections....

- Check all the boiler connections to the water heater. A build-up of corrosion is a sure sign of a leak.
- Check the domestic connections. Look at the welds where the spuds enter into the outer tank. Excessive water hammering in the domestic system may crack these welds.
- Check the seal around the air vent and drywell for leaks. Remove the drywell and check the O-ring gasket (if applicable) beneath it.

  Action Item:

  - To replace the drywell O-ring (if applicable) use the O-Ring Replacement Kit (P/N P3KITOR01). When re-installing the drywell with a rubber O-Ring gasket do not over tighten and crush or tear the O-ring.
  - Apply sealant (i.e. Leaklok or Loctite) completely around threads in all applications.

Is the source of the water from the tank?

- Check for possible overhead pipes leaking onto the tank

Check all connections - domestic connections, air vent....

- Check the connections to the water heater. Are they loose? A build-up of corrosion around joints is a sure sign of a leak.
- Check the domestic connections. Look at the welds where the spuds enter into the outer tank. Excessive water hammering in the domestic system may crack these welds.
- Check the seal around the air vent and drywell for leaks. Remove the drywell and check the O-ring gasket (if applicable) beneath it.
- Remove the thermostat sensing bulb from the drywell. Is the bulb wet or is water visible at the top of the drywell? If so, replace the entire drywell.

  Action Item:

  - To replace the drywell O-ring (if applicable) use the O-Ring Replacement Kit (P/N P3KITOR01). When re-installing the drywell with a rubber O-Ring gasket do not over tighten and crush or tear the O-ring.
  - Apply sealant (i.e. Leaklok or Loctite) completely around threads in all applications.

The hot water smells like "rotten eggs"

The most common cause of water to smell like "rotten eggs" is a non-toxic sulfate reducing bacteria. The bacteria usually enters into the water system through a break in the supply piping or during construction/maintenance of the supply piping. The bacteria survives in the water system by converting sulfate (SO_4) in the water to hydrogen sulfide (H_2S) gas. It is this gas that creates the "rotten egg" smell. The presence of hydrogen sulfide can also affect the taste of the water as well. Along with the stench caused by this bacteria, black deposit which typically indicate pipe and/or fitting corrosion may also appear in the water.

WARNING

In extremely high concentrations, hydrogen sulfide gas can be toxic. However, the gas is detectable prior to reaching harmful levels.

The bacteria will thrive in any water system under the following conditions:

- High levels of sulfur in the water
- Activated hydrogen in the water from cathodic reactions within the tank
- Water with little or no dissolved oxygen
- Storing the domestic water below 140ºF

Other causes of smelly water:

- Chlorides of magnesium and calcium gives water a bitter taste
- Chloride of sodium will produce a salty tasting water
- Sulfates above 50 ppm in the water gives the water a medicinal taste.
- Carbon dioxide in water with a low pH results in water that is fizzy.
- Iron and tannic waters will produce water with a bad taste and odor.

Action Item:

- The treatment of this situation requires the water system to be shock-chlorinated. Depending on the severity of the bacteria within the water system, several treatments may be needed.

Hot water from the faucet appears milky

When water is initially drawn from the faucet it appears to be milky or cloudy, but it becomes clear after the water is allow to stand for several minutes. This is usually an indication that the water contains high levels of soluble gases such as oxygen, chlorine, carbon dioxide, hydrogen sulfide or others.

As the water system pressure increases, the amount of gas that water can hold in a solution decreases. When air and gases are forced out of the heated water, the problem may be evident in one or both of the following conditions:

- Gases, in the form of small bubbles, may make the water appear milky from the tap, but clear after several minutes when those bubbles will separate. Similar to the reaction that occurs as air bubbles form on the walls of a pan shortly before the water begins to boil.
- The release of dissolved gas can also create air pockets and air locks in the water system piping. This can cause spurts of air or gases when opening the hot water faucet.

There is generally no cure for milky water cause by dissolve gases, although it can be reduced with aerated faucets. In some applications the amount of air and gases precipitating out of the water will reduced in time. It should be noted that these gases are not harmful to the end user.

Discolored water from the hot water faucet

The water from the hot water faucet appears discolored, either rusty, brown, black or yellow. Because the inner tank is stainless steel, which by its nature is resistant to corrosion, the problem is not tank related. The problem is usually a non-toxic iron reducing bacteria that is commonly found in soil, well water, water treatment plants and piping systems. The bacteria usually thrives in those systems in which the soluble iron exceeds 0.2 ppm. The bacteria will feed on the soluble iron in the water producing "rusty" color water as a by-product of the feeding process.

Variables in which the bacteria can thrive in:

- Elevated levels of iron and manganese in the water
- Water with little or no dissolved oxygen
- Water storage temperatures below 140ºF

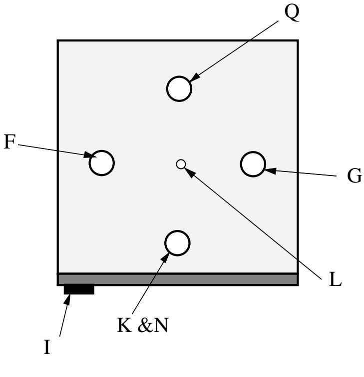
Items that can potentially increase the presence of the bacteria:

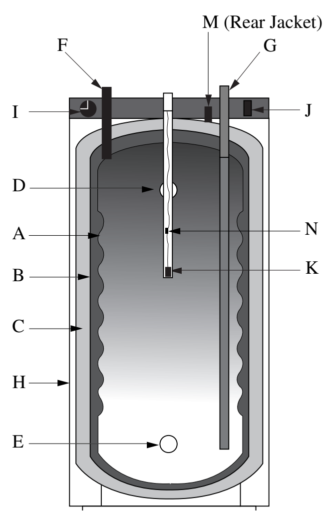
- Water softeners
- Well water
- Long periods of no water movement

Action Item:

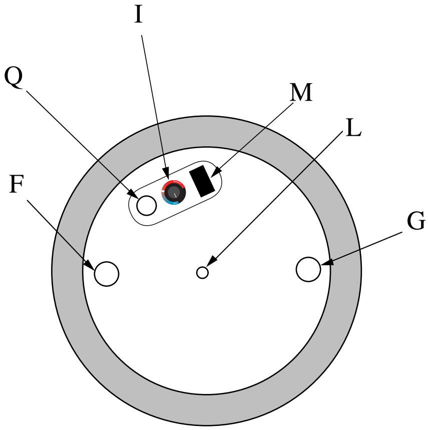
- The treatment of this situation requires the water system to be shock-chlorinated. Depending on the severity of the bacteria within the water system, several treatments may be needed.

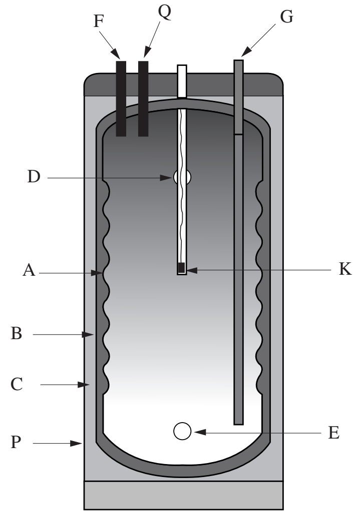
TR Series



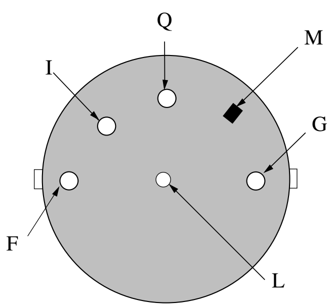


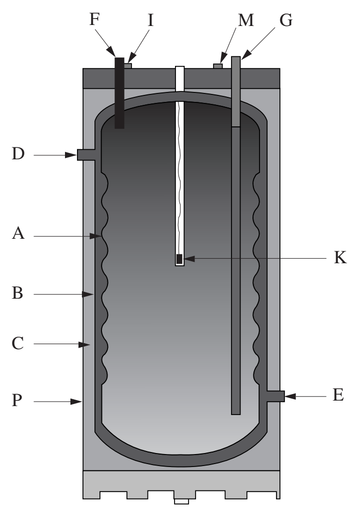
SMART Series





HL Series





A. Inner stainless steel tank
B. Outer steel tank
C. Polyurethane insulation
D. Boiler water supply
E. Boiler water return
F. Hot water outlet
G. Cold water inlet
H. Enameled steel jacket (TR Series)
I. Thermostat control
J. Temperature gauge (TR Series)
K. Thermostat remote sensing bulb
L. Air vent
M. Snap-set connector
N. Thermometer remote sensing bulb (TR Series)
P. Vinyl jacket (Smart & HL Series)
Q. Auxiliary connection

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