BRADFORD WHITE®
WATER HEATERS

Solar Water Heater With Electric Backup

Solar Saver® Heaters

SERVICE MANUAL

Troubleshooting Guide
and Instructions for Service

(To be performed ONLY by
qualified service providers)

Models Covered by This Manual:

S-SW2-60R6DS
S-SW2-75R6DS
S-SW2-115R6DS

Save this manual for future reference

Table of Contents

Introduction

This service manual is designed to aid service and maintenance professionals on the function, proper diagnosis and repair of Bradford White solar water heaters with electric backup. Required service for system components beyond the solar water heater should be directed to the system installer or directly to the system component manufacturer. System components include such items as the solar controller, solar collector and circulator.

The text and illustrations in this manual provide step by step instructions to facilitate proper operation and troubleshooting procedures. Contact the Bradford White Technical Support Group immediately for Bradford White supplied equipment if diagnosis can not be made using the methods described in this service manual. Contact the solar component manufacturer for assistance regarding other equipment.

Tools

- Multi Meter.
- 1-½ Deep Well Socket (element removal).
- ¼" Nut Driver.
- Phillips Head Screwdriver.
- Thermometer.
- Drain Hose.
- Various Hand Tools: Pipe Wrench, Channel Locks, Pliers (common & needle nose), Wire Cutters, Wire Strippers, Flashlight.

Commonly Used Formulas

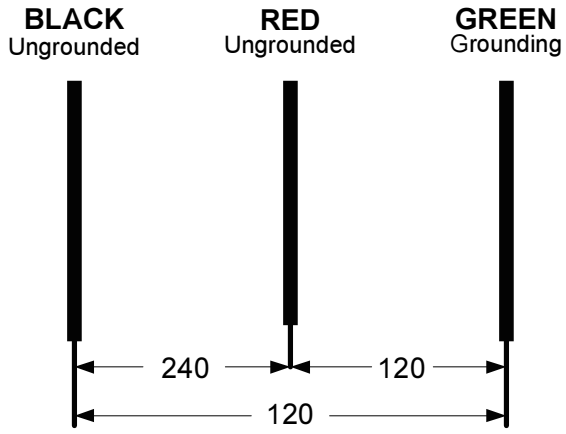
Single Phase Amps = $\frac{\text{Watts}}{\text{Volts}}$ Example 4500W/240V = 18.75A

Watts = Amps x Volts Example 18.75A x 240V = 4500W

Ohms = $\frac{\text{Volts}^2}{\text{Watts}}$ Example $(240\text{V})^2$ / 4500W = 12.8 Ohms

Service Wire Configuration

240 VOLT



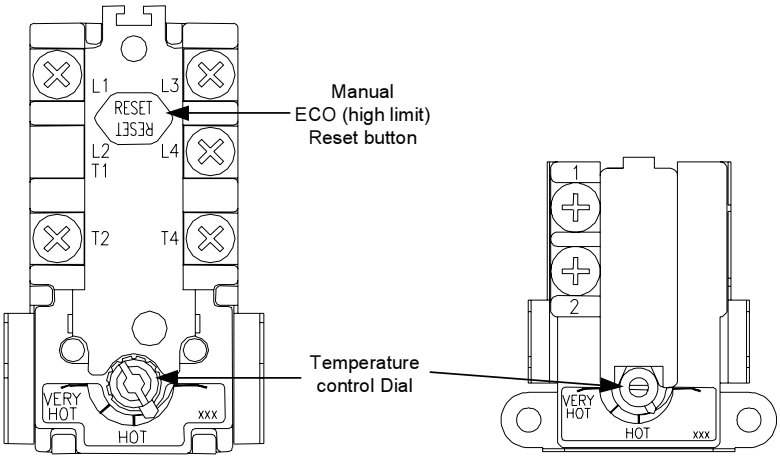
Wattage Limitation at 240 Volts

Solar Water Heater with Double Electric Element Backup Series (Non-Simultaneous operation)

Maximum Wattage	Element Upper/Lower
5,500	5,500/5,500

Surface Mounted Thermostats

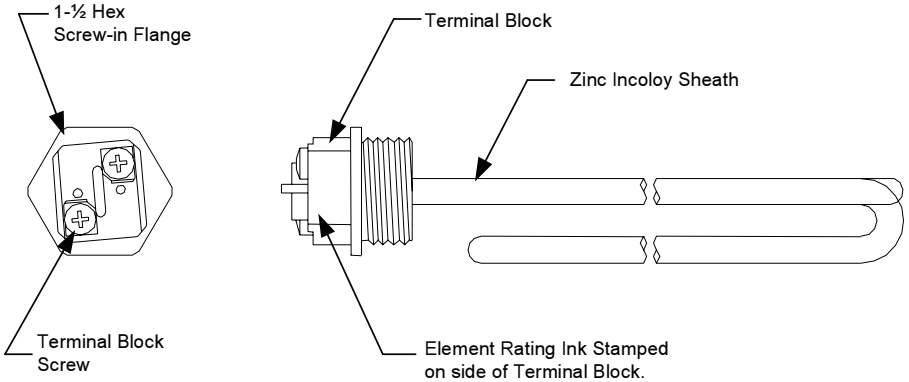
Surface mounted thermostats are mounted into a bracket which holds the thermostat against the side of the tank. Surface mounted thermostats respond to tank surface temperatures to sense a call for heat, set point temperature settings and high limit (ECO) activation. It is important that the entire back surface of the thermostat is in full contact or flush with the tank. Improperly mounted thermostat will lead to improper heater operation.



Upper thermostat
Surface Mount
With
ECO (high limit)
89T Series

Lower thermostat
Surface Mount
59T Series

Direct Immersion "Screw-in" Type Heating Element



Non-Simultaneous Operation

Non-Simultaneous Mode: Allows only one heating element to operate at a time. For example, when the tank is cold, the upper element is energized first, heating the top of the tank. Only when the upper thermostat is satisfied, the upper element is de-energized and power is directed to the lower thermostat, energizing the lower element and heating the bottom portion of the tank until the lower thermostat is satisfied. As hot water is drawn off the tank, it is replaced with cold water delivered through the dip tube to the bottom of the tank. When the tank cools at the lower thermostat level, the thermostat will call for heat energizing the lower element. If enough hot water is drawn from the tank, the top portion of the tank cools and the upper thermostat will call for heat, de-energizing the lower element and allowing only the top element to energize until the upper thermostat is satisfied.

The lower thermostat in the solar water heater is located above the internal heat exchanger. This design allows the heat exchanger to be in cooler water during short draws, providing more heat transfer from the solar heating system.

Solar water heaters with double electric element backup are designed to operate using a single operating mode detailed as follows:

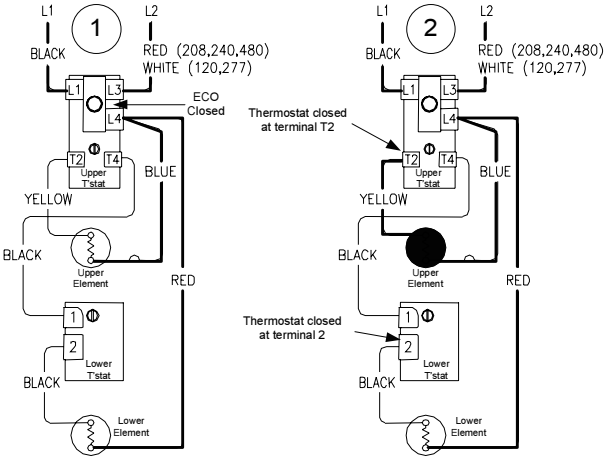
Sequence of Operation- Double Element, Non-Simultaneous Operation, Single Phase.

1. Line voltage is applied across terminals L1 & L3 of the upper thermostat. ECO is closed, so there is voltage at terminal L4 and to one side of the upper and lower elements.

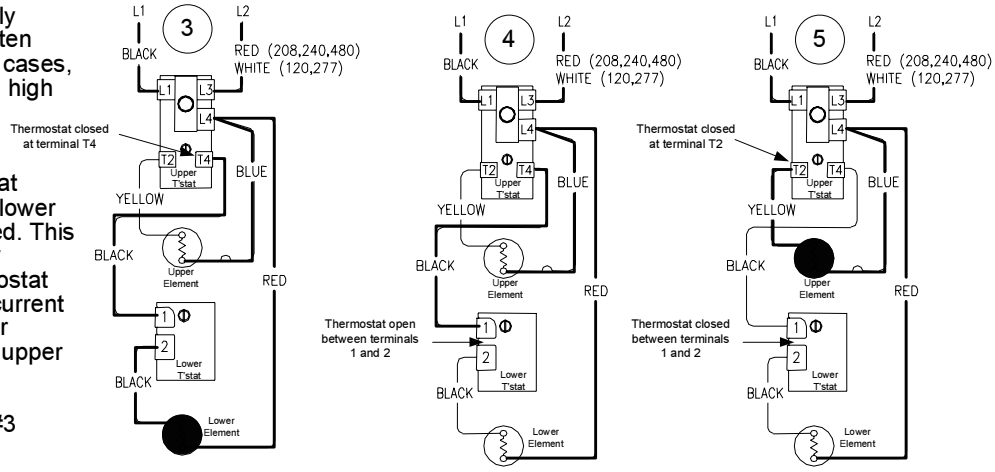
2. Tank is cold. Therefore, the thermostats are closed at terminals T2 & 2 (calling for heat). The circuit is complete through the upper thermostat only, allowing current to flow through the upper element.

3. When the upper thermostat is satisfied, it opens at terminal T2, interrupting current flow through the upper element. Terminal T4 closes, allowing voltage to pass to terminal 1 of the lower thermostat. This completes the circuit through the lower thermostat and allows current flow through the lower element.

4. When the lower thermostat is satisfied, it opens at terminal 2, interrupting current flow through the lower element. The system is now in stand-by mode waiting for the next call for heat



5. The lower thermostat/element combination will generally cycle on and off more often then the upper. In some cases, such as a cold tank or in high demand periods, the upper thermostat will call for heat (opening at terminal T4 and closing at terminal T2) prior to the lower thermostat being satisfied. This will interrupt current flow through the lower thermostat and element and allow current to flow through the upper element only. When the upper thermostat is satisfied, it resumes operation as described in sequence #3 above.



NOTICE

This Service Manual is for servicing the solar water heater. If other components of an installed system requires service, those questions should be directed to the installer or the specific component manufacturer.

Most common cause for improper electric backup operation can be linked to heating element failure.

When troubleshooting an electric backup solar water heater with the incidence of “No Hot Water” or “Insufficient Amount of Hot Water”, it’s always a good idea to check the heating elements first following the procedure on page 9.

Common Heating Element Failures Are:

1. **Dry Firing.** Element may be partially submerged in water or most likely, completely exposed with no water in the tank. In some cases sediment or lime build up around an element can eventually cause an air pocket, and within seconds, result in a dry-fired element. At this point the element becomes inoperative. When element replacement is required, be sure the tank is full of water prior to energizing the water heater.

2. **Grounded Element.** An element with a short circuit to ground will in most cases cause the circuit breaker in the service panel to open or shut off. In some cases there may not be enough current draw for the circuit breaker to open. This will allow the heating element to be in continuous operation resulting in over-heated water, limited only by the ECO (Energy Cut Off) located in the thermostat. Repeated actuation of the ECO reset button on the thermostat usually is the result of a grounded element.

3. **Sediment build up.** Slow hot water recovery can usually be traced back to sediment or lime build up around the heating element. Sediment build up can also over time cause a dry-fired element.

Illustration 1, below shows a common “Screw-In” type heating element identifying certain features commonly referred to throughout this manual.

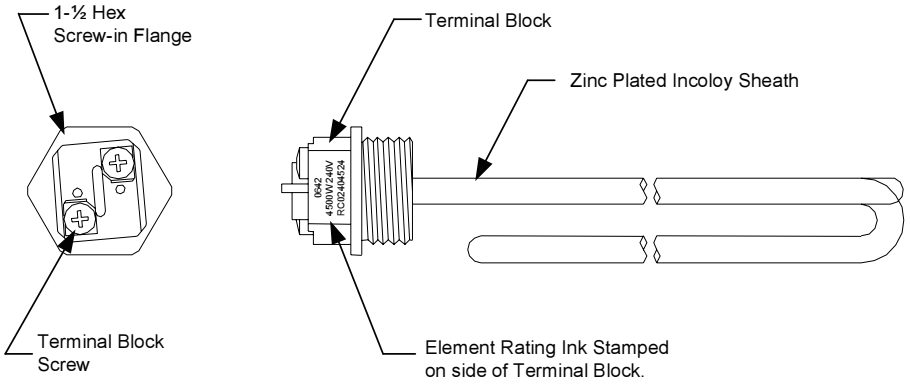


Illustration 1
Typical Direct Immersion “Screw-In”
Type Heating Element

Quick Step Plan to Hot Water

1. TURN OFF power to water heater and solar controller. Check all wire connections to insure they are tight and corrosion free.

2. Turn power "ON" and determine that service voltage is present and the high limit (ECO) has not actuated (see procedure on page 8).

⚠ WARNING
High voltage exposure. Use caution when making voltage checks to avoid personal injury.

NOTICE
This Service Manual is for servicing the solar water heater. If other components of an installed system requires service, those questions should be directed to the installer or the specific component manufacturer.

3. Check for inoperative heating element (see procedure on page 9).

4. Check for proper thermostat operation (see procedures beginning on page 10). NOTE: Thermostat testing procedures assume items 2 and 3 above are in working order.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION	SERVICE PROCEDURE
No Hot Water	1. No Power to heater. 2. Loose wire connections. 3. Inoperative upper heating element. 4. Inoperative upper thermostat. 5. Open ECO. 6. Inoperative solar controller or connection. 7. Inoperative circulator in solar heating system.	1. Check fuses or circuit breakers in service panel. 2. Check all wire connections. 3. Check heating elements. Replace as needed. 4. Check thermostats operation. Replace as needed. 5. Check ECO. Reset or replace thermostats as needed. 6. Check for proper solar controller operation. 7. Check for proper circulator operation.	3. See Service Procedure RE-II, Page 9. 4. See Service Procedure RE-III, Page 10. 5. See Service Procedure RE-I, Page 8. 6. Refer to Controller manufacturer 7. Refer to circulator manufacturer
Not Enough Hot Water	1. Inoperative lower heating element. 2. Thermostats set to low. 3. Inoperative thermostats. 4. Loose wire connection. 5. Sediment or lime build up on elements. 6. High demand period. 7. Undersized heater. 8. Very cold inlet water to heater. 9. Plumbing connections reversed. 10. Damaged dip tube. 11. Improper solar collector application.	1. Check heating elements, replace as needed. 2. Increase thermostat setting. 3. Check thermostats, replace as needed. 4. Check all wire connection. 5. Remove heating elements and check for lime build up. 6. Reduce demand. 7. Replace with larger heater. 8. Temper water to heater. 9. Correct plumbing connections. 10. Check dip tube, replace as needed. 11. Review solar collector calculations and orientation.	1. See Service Procedure RE-II, Page 9. 3. See Service Procedure RE-III, Page 10. 5. See Service Procedure RE-V, Page 13. 10. See Service Procedure RE-VI, Page 14. 11. Refer to solar collector manufacturer.
Slow Hot Water Recovery	1. Sediment or lime build up on elements. 2. Loose wire connections. 3. Inoperative thermostats. 4. Derated heating element installed.	1. Remove heating elements and check for lime build up. 2. Check all wire connections. 3. Check thermostats, replace as needed. 4. Check terminal block of element for proper voltage and wattage rating.	1. See Service Procedure RE-V, Page 13. 3. See Service Procedure RE-III, Page 10.
Over Heated Water or Continues Operation	1. Thermostat not in contact with tank. 2. Grounded heating elements. 3. Thermostat set to high. 4. Inoperative thermostats. 5. Inoperative ECO. 6. Undersized water heater. 7. Incorrectly adjusted mixing device. 8. Improperly programmed solar controller.	1. Position thermostat flush with tank surface. 2. Check heating elements. Replace as needed. 3. Adjust thermostats to desired setting. 4. Check thermostats, replace as needed. 5. Check ECO, replace thermostat as needed. 6. Replace with larger heater. 7. Adjust mixing device. 8. Refer to solar controller instructions.	1. See Service Procedure RE-IV, Page 12. 2. See Service Procedure RE-II, Page 9. 4. See Service Procedure RE-III, Page 10. 5. See Service Procedure RE-I, Page 8. 7. Refer to included mixing device instructions.
Noisy (singing or hissing) Elements	1. Lime formation on elements.	1. Remove and clean heating elements. Replace as needed.	1. See Service Procedure RE-V, Page 13.

Line Voltage Testing

⚠ WARNING
High voltage exposure. Use caution when making voltage checks to avoid personal injury.

1. Turn "OFF" power to water heater.

2. Remove access cover(s) from front of water heater. Remove insulation and plastic cover from thermostat.

3. Set multi-meter to volts AC.

4. Turn power "ON" to water heater.

5. Check voltage across terminals L1 & L3 of upper thermostat (see illustration 2).

   A) Rated voltage IS present, power to the water heater is okay.

   B) Rated voltage NOT present, Check circuit breaker at service panel.

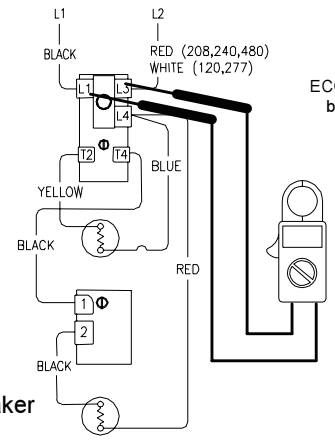


Illustration 2

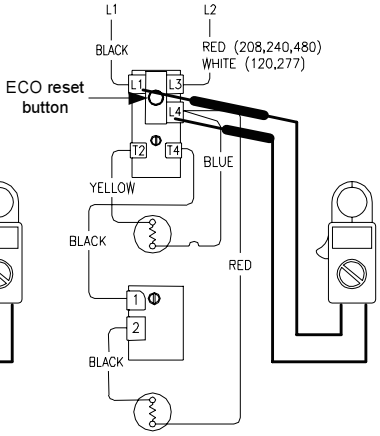


Illustration 3

High Limit (ECO) Testing

1. Check voltage across terminals L1 & L4 upper thermostat (see illustration 3).

   A) Rated Voltage IS present, ECO is okay.

   B) Rated voltage NOT present, proceed to step 2.

2. Turn power "OFF" to water heater and firmly press ECO reset button on thermostat. Turn power "ON" and recheck voltage across terminals L1 & L4 of upper thermostat (see illustration 3).

   A) Rated voltage IS present, the ECO has previously opened indicating the water in the tank, at some point did overheat, check the following:
      1. Thermostat must be in full contact with tank.
      2. Be sure heating elements are not shorted to ground (see page 9).
      3. Proper thermostat operation (see procedures beginning on page 10).

   B) Rated voltage NOT present, water in tank may be over heated.
      1. If water is hot, turn "OFF" power to water heater and flow water through tank to cool below set point of upper thermostat. Recheck voltage per step 1.

      2. If water is cool, Replace upper thermostat.

Testing For Open Or Burned Out Element.

⚠ WARNING
High voltage exposure. Be sure power is turned OFF to water heater prior to performing this procedure.

Step 1. **TURN OFF POWER TO WATER HEATER.**

Step 2. Remove access covers from front of water heater. Remove insulation and plastic cover from thermostat.

Step 3. Disconnect wires from heating element.

Step 4. Set multi-meter to “ohms” setting.

Step 5. Touch probes of multi-meter to screw terminals of heating element (see illustration 4).

Step 6. Reading should be 12.8 ohms (±6%) for a 240 volt, 4500 watt element:

$$\text{Ohms} = \frac{\text{Volts}^2}{\text{Watts}}$$

A reading outside the range using the formula above (±6%), indicates a bad element and the element must be replaced.

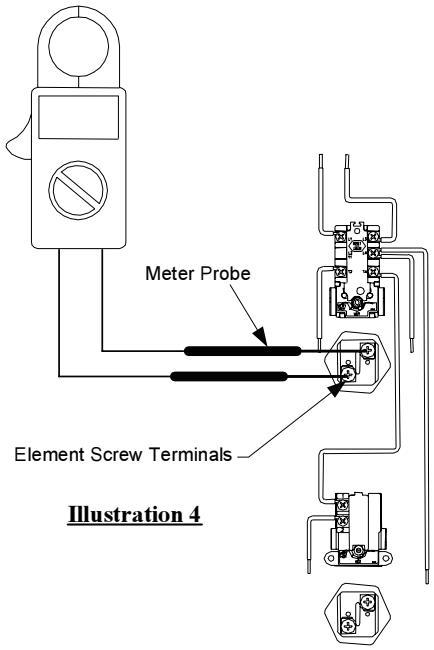


Illustration 4

Testing For Heating Element Short Circuit To Ground.

Step 1. **TURN OFF POWER TO WATER HEATER.**

Step 2. Remove access covers from front of water heater. Remove insulation and plastic cover from thermostat.

Step 3. Disconnect wires from heating element.

Step 4. Set multi-meter to “ohms” setting.

Step 5. Touch one probe of multi-meter to either screw terminal of heating element and the other on the element flange (see illustration 5). There should be no reading on the ohm meter. Any reading indicates a grounded element and the element must be replaced. Repeat this step for the other screw terminal.

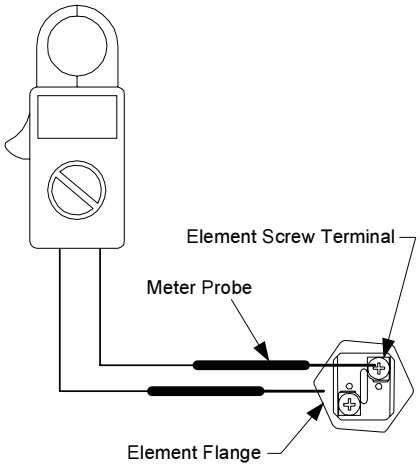


Illustration 5

⚠ WARNING
High voltage exposure. Use caution to avoid personal injury during this procedure.

Double Element, Non-Simultaneous, Single Phase Operation.

Water In Tank Is Cold With Power ON.

1. This procedure assumes line voltage, ECO and elements are in working order.
2. Turn power "ON" to water heater.
3. Set multi-meter to "Volts AC".
4. Check across terminals L4 and T2 of upper thermostat (see illustration 6).
   - A) Rated voltage NOT present, Recheck ECO. If ECO is okay, replace thermostat.
   - B) Rated voltage IS present, proceed to next step.
5. Check across element terminals (see illustration 7).
   - A) Rated voltage NOT present, check wire connections from thermostat to element.
   - B) Rated voltage IS present, Repeat element testing see page 9.

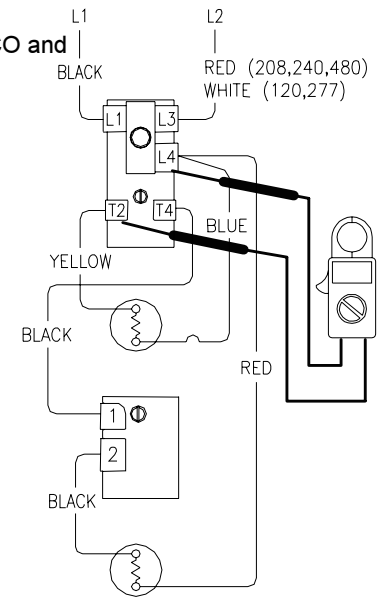


Illustration 6

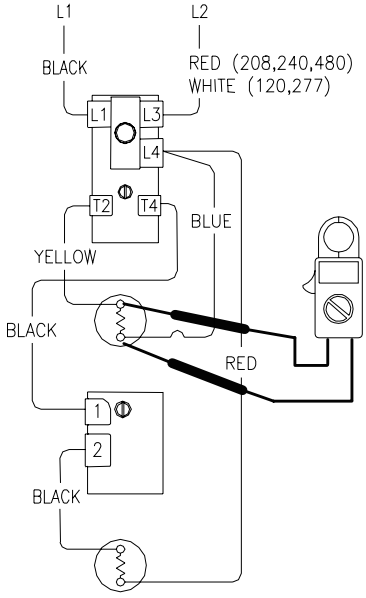


Illustration 7

Tank Does Not Deliver Enough Hot Water.

1. This procedure assumes line voltage, ECO and elements are in working order.
2. Turn power "ON" to water heater and set multi-meter to "Volts AC".
3. Adjust temperature setting of upper thermostat to the highest setting. Water temperature in tank must be below thermostat setting for this test.
4. See illustration 6 above, check voltage across terminals L4 and T2 of upper thermostat.
   - A) Rated voltage IS present, okay, upper thermostat is calling for heat. Go to step 5 below.
   - B) Rated voltage NOT present, replace upper thermostat.
5. Adjust temperature setting of <u>upper</u> thermostat to the minimum setting. Water temperature in tank must be above thermostat setting for this test.
6. Check voltage across terminals L4 and T4 of upper thermostat (see illustration 8).
   - A) Rated voltage NOT present, replace upper thermostat.
   - B) Rated voltage IS present, thermostat is okay. Go to step 7 on next page.

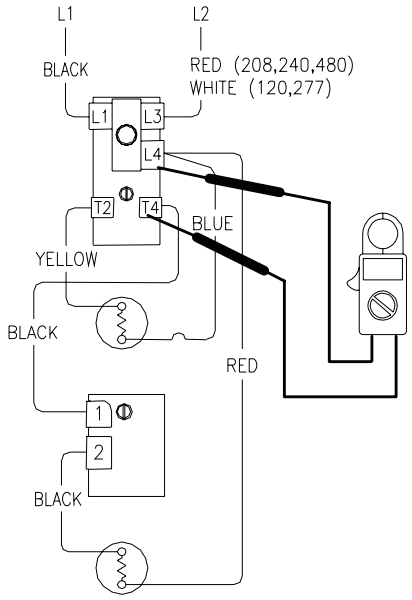


Illustration 8

Double Element, Non-Simultaneous, Single Phase Operation (continued).

⚠ WARNING
High voltage exposure. Use caution to avoid personal injury during this procedure.

Not Enough Hot Water (continued).

7. Check voltage across terminal L4 of upper thermostat and terminal 1 of lower thermostat (see illustration 9).

   A) Rated voltage NOT present,
   - check wire connection between thermostats.

   B) Rated voltage IS present, okay, go to step 8.

8. Adjust lower thermostat to highest setting. Water temperature in tank must be below the lower thermostat setting for this test.

9. Check voltage across terminal L4 of upper thermostat and terminal 2 of lower thermostat (see illustration 10).

   A) Rated voltage NOT present, replace lower thermostat.

   B) Rated voltage IS present, thermostat is ok.

⚠ WARNING
Be sure thermostats are reset to their original temperature settings as found prior to thermostat testing

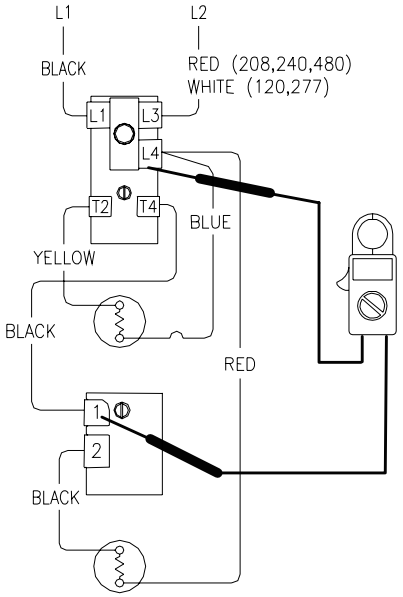


Illustration 9

Water Temperature In Tank Is Above Thermostat Setting.

1. This procedure assumes line voltage, ECO and elements are in working order.

2. Adjust upper and lower thermostats to the lowest setting.

3. Turn power “ON” to water heater and set multi-meter to “Volts AC”.

4. Check across terminals L4 and T2 of upper thermostat (see illustration 6 on page 10).

   A) Rated voltage IS present, replace upper thermostat.

   B) Rated voltage NOT present, upper thermostat is okay. Go to step 5 below.

   C) Lower than rated voltage IS present, recheck for grounded upper element (see page 9).

5. Check across terminals L4 and 2 of lower thermostat (see illustration 10).

   A) Rated voltage IS present, replace lower thermostat.

   B) Rated voltage NOT present, lower thermostat is okay.

   C) Lower than rated voltage IS present, recheck for grounded lower element (see page 9).

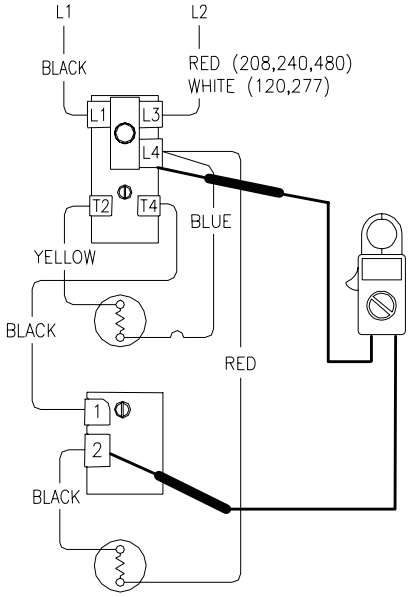


Illustration 10

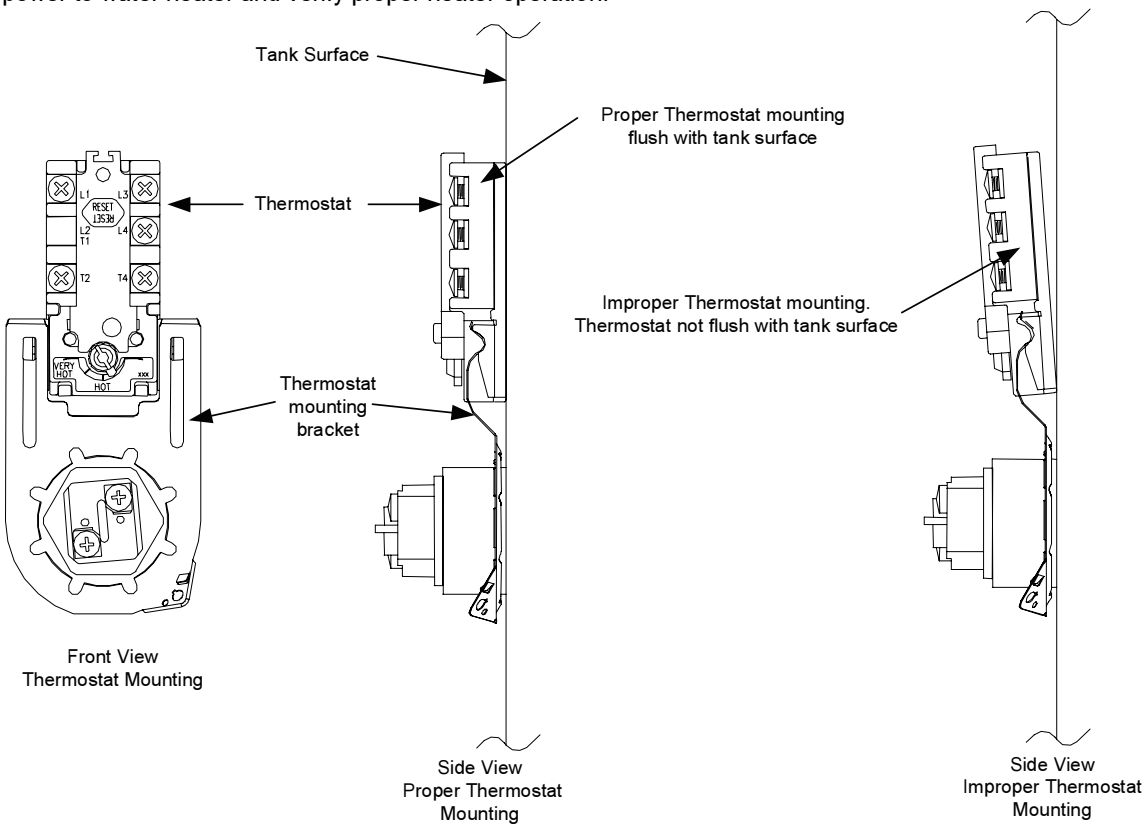
Thermostat Removal

⚠ WARNING
High voltage exposure. Be sure power is "OFF" when performing this procedure.

1. Turn power "OFF" To water heater.
2. Remove access cover and insulation.
3. Remove plastic thermostat protector from thermostat.
4. Disconnect wires from thermostat terminals. It may be necessary to label wires for proper re-connection to new thermostat.
5. Note thermostat temperature setting for proper setting of new thermostat.
6. Slide thermostat upwards and out of mounting bracket.

Thermostat Replacement

1. Use a stiff brush to remove any debris or loose scale from tank surface where new thermostat will be installed.
2. Slide new thermostat down into thermostat bracket until it snaps into place. IMPORTANT! Thermostat must set completely flat or flush to tank surface. An improperly installed thermostat will cause improper water heater operation.
3. Refer to the wire diagram located on the inside of the access cover and re-connect wires to the thermostat. Be sure wire connections are snug and corrosion free. Do not over tighten, doing so may damage thermostat.
4. Set thermostat to the original thermostat setting found on the old thermostat.
5. Re-install plastic thermostat protector.
6. Re-install insulation and access cover.
7. Restore power to water heater and verify proper heater operation.



⚠ WARNING
High voltage exposure. Be sure power is "OFF" when performing this procedure.

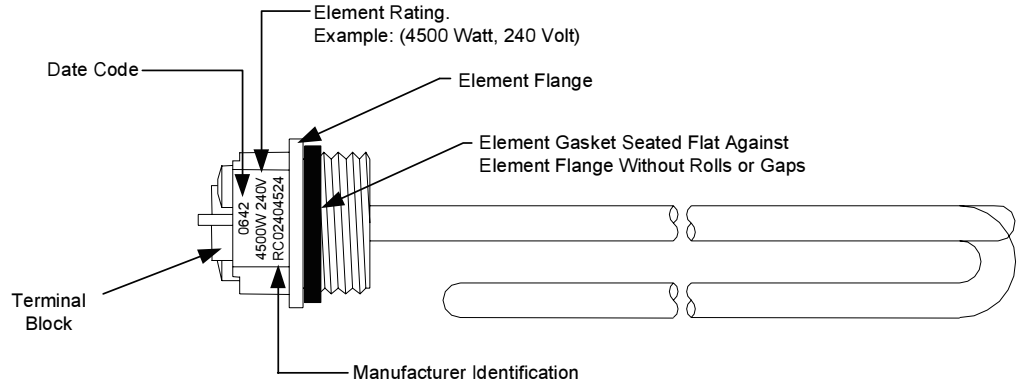
⚠ WARNING
Heater components and stored water may be HOT when performing the following steps in this procedure. Take necessary precaution to prevent personal injury.

Heating Element Removal

1. Turn power "OFF" To water heater.
2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow heater to drain to a point below the elements.
3. Close drain spigot and remove hose.
4. Remove access cover and insulation.
5. Remove plastic thermostat protector from thermostat.
6. Disconnect wires from element terminals.
7. Remove element from tank using 1-½ deep well socket or appropriate wrench. Unscrew element counter-clockwise to remove from tank.
8. Be sure to remove old element gasket from the tank. It is not recommended to be re-used.

Heating Element Replacement

1. Check element terminal block for proper electrical rating. NOTE: Some elements have dual ratings, be sure to check all surfaces of the element terminal block (see illustration below).
2. Apply new element gasket to the new element. Be sure gasket is seated flat against element flange without rolls or gaps (see illustration below).
3. Clean any debris from element fitting on tank. Lubricate element threads as needed with thread lubricant.
4. Thread new element clockwise into tank. Tighten element using 1-½ deep well socket or appropriate wrench. Do not over tighten, over tightening may damage element gasket.
5. Reconnect wires to element, be sure wires are snug and corrosion free. Do not over tighten, doing so may damage terminal block.
6. Resume water supply to heater, be sure tank is full of water and check for leaks.
7. Re-install plastic thermostat protector.
8. Re-install insulation and access cover.
9. To resume operation, **BE SURE TANK IS FULL OF WATER** and restore power to water heater. Verify proper heater operation.



Dip Tube Inspection and Replacement

⚠ WARNING
Heater components and stored water may be HOT when performing the following steps in this procedure. Take necessary precaution to prevent personal injury.

Step 1. Turn power "OFF" to water heater.

Step 2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow heater to drain to a point below the inlet connection nipple.

Step 3. Close drain spigot and remove hose.

Step 4. Disconnect inlet nipple from plumbing system.

Step 5. With an appropriate wrench, remove inlet nipple/dip tube from the water heater. Use caution not to damage nipple threads.

Step 6. Visually inspect inlet nipple/dip tube. Inlet nipple/dip tube should be free of cracks and any blockage. Hydro-jets located near the bottom of the dip tube should be open and free of any blockage. Anti-siphon hole located approximately 6" from the bottom of nipple, should be free of any blockage.

Any damage such as cracks, restriction due to deformation or unintentional holes are not field repairable and the inlet nipple/dip tube must be replaced.

Step 7. Upon completion of inspection or subsequent replacement, reinstall inlet nipple/dip tube into heater. Connect nipple to plumbing system, close spigot and remove drain hose, resume water supply and refill heater with water.

Step 8. To resume operation, **BE SURE TANK IS FULL OF WATER** and turn power "ON" to water heater.

Anode Inspection and Replacement

Step 1. Turn power "OFF" to water heater.

Step 2. Turn off cold water supply to heater. Connect hose to drain spigot of water heater and route to an open drain. Open a nearby hot water faucet to vent heater for draining. Open drain spigot of water heater and allow heater to drain to a point below the outlet connection nipple.

Step 3. Close drain spigot and remove hose.

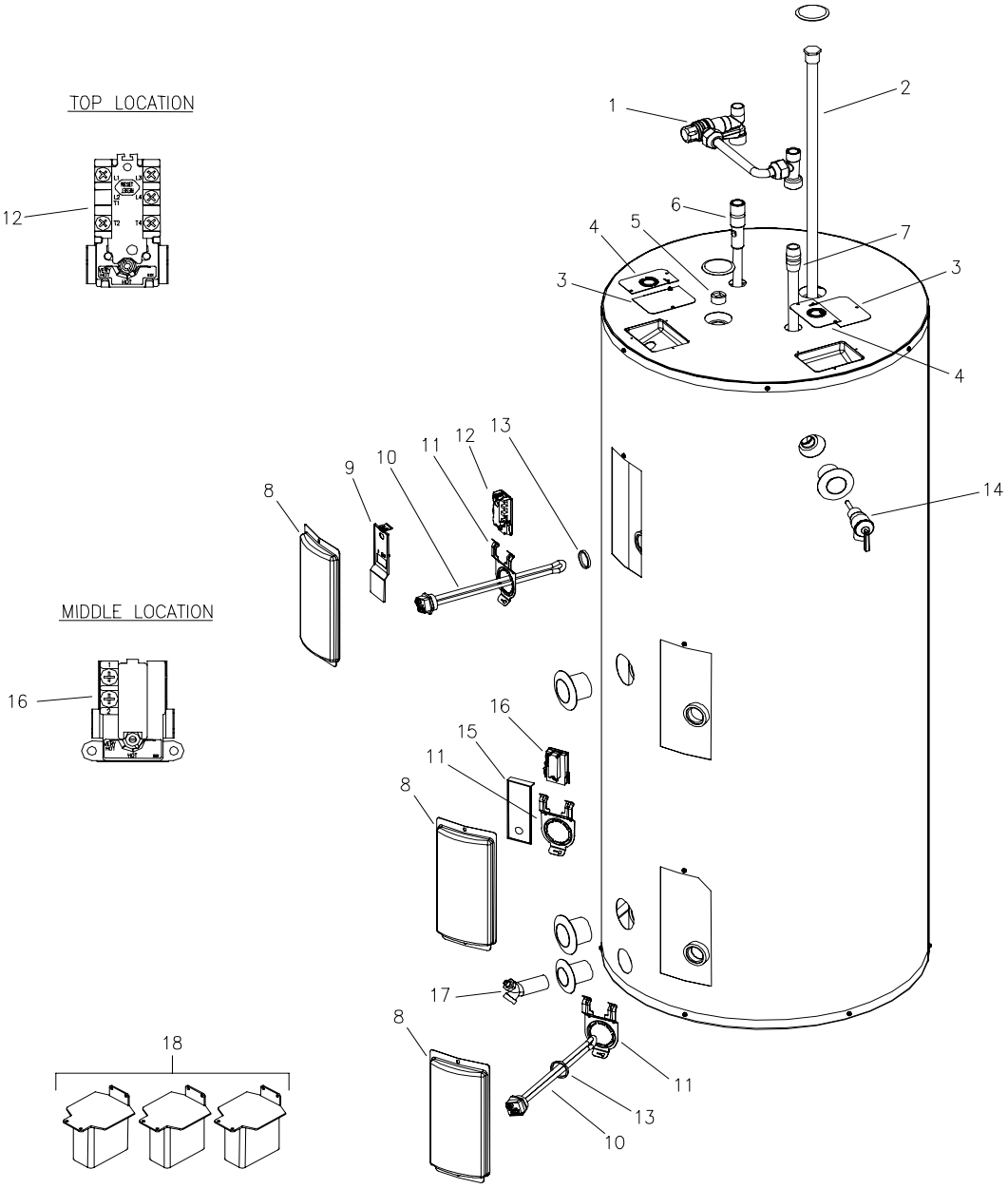
Step 4. Disconnect outlet nipple from plumbing system.

Step 5. With an appropriate wrench, remove outlet nipple/anode from the water heater. Use caution not to damage nipple threads.

Step 6. Visually inspect outlet nipple/anode. Outlet nipple/anode should show signs of depletion, this is normal. If depletion is ½ of the original anode diameter (original diameter approximately ¾"), replacement is recommended. If any of the steel core of the anode is exposed, replacement is recommended.

Step 7. Upon completion of inspection or subsequent replacement, reinstall outlet nipple/anode into heater. Connect nipple to plumbing system, close spigot and remove drain hose, resume water supply and refill heater with water.

Step 8. To resume operation, **BE SURE HEATER IS FULL OF WATER** and turn power "ON" to water heater.



1. Integrated Mixing Device
2. Hex Head Anode
3. Junction Box Cover
4. Cover Conduit/Ground
5. ¾" Plug
6. Hot Water Outlet/Anode
7. Cold Water Inlet Dip Tube
8. Access Cover
9. Thermostat Protector (Large)
10. Heating Element
11. Thermostat Mounting Bracket
12. Thermostat w/High Limit (89T33)
13. Element Gasket
14. T&P Relief Valve
15. Lower Thermostat Protector (Small)
16. Thermostat (59T)
17. Brass Drain Valve
18. Kit Dairy Barn Leg

BRADFORD WHITE®
WATER HEATERS
Ambler, PA

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