BRADFORD WHITE®
WATER HEATERS

Programmable Efficiency

Gas Water Heaters

SERVICE MANUAL SUPPLEMENT

Troubleshooting Guide
and Instructions for Service

(To be performed ONLY by
qualified service providers)

Models Covered by This Manual:

PE4403S*F(BN,SX)
PE440T*F(BN,SX)
PE4503*F(BN,SX)
PE2XR504T*F(BN,SX)

(*) Denotes Warranty Years

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⚠ WARNING

If the information in these instructions is not followed exactly, a fire or explosion may result causing property damage, personal injury, or death.

What to do if you smell gas:

- Do not try to light any appliance
- Do not touch any electrical switch; do not use any phone in your building
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

Installation and service must be performed by a qualified installer, service agency, or the gas supplier.

FAILURE TO INSTALL AND MAINTAIN A NEW, LISTED 3/4" X 3/4" TEMPERATURE AND PRESSURE RELIEF VALVE WILL RELEASE THE MANUFACTURER FROM ANY CLAIM THAT MIGHT RESULT FROM EXCESSIVE TEMPERATURE AND PRESSURES.

⚠ CAUTION

Incorrect operation of this water heater may create a hazard to life and property and will nullify the warranty.

If sweat fittings are to be used, DO NOT apply heat to the nipples on top of the water heater. Sweat the tubing to the adapter before fitting the adapter to the water connections. It is imperative that heat is not applied to the nipples containing a plastic liner.

Turn off or disconnect the electrical power supply to the water heater before servicing. Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

NOTICE

Before proceeding, please inspect the water heater and its components for possible damage. DO NOT install any water heater with damaged components. If damage is evident, then please contact the supplier where the water heater was purchased or the manufacturer listed on the rating plate for replacement parts.

⚠ DANGER

Do not store or use gasoline or other flammable, combustible, or corrosive vapors and liquids in the vicinity of this or any other appliance.

⚠ WARNING

Water heaters are heat producing appliances. To avoid damage or injury, do not store materials against the water heater or any of its components. Use proper care to avoid unnecessary contact, especially by children, with the water heater and its components. Under no circumstances must flammable materials, such as gasoline or paint thinner be used or stored in the vicinity of this water heater or in any location in which the fumes could reach the water heater.

Hydrogen gas can be produced in an operating water heater that has not had water drawn from the tank for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To prevent the possibility of injury under these conditions, we recommend a hot water faucet to be open for several minutes at the kitchen sink before you use any electrical appliance which is connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipes as hot water begins to flow. Do not smoke or have open flame near the faucet at the time it is open.

DO NOT ATTEMPT TO LIGHT ANY GAS APPLIANCE IF YOU ARE NOT CERTAIN OF THE FOLLOWING:

Liquefied petroleum gases/propane gas and natural gas have an odorant added by the gas supplier that aids in the detection of the gas. Most people recognize this odor as a "sulfur" or "rotten egg" smell. Other conditions, such as "odorant fade" can cause the odorant to diminish in intensity, or "fade," and not be as readily detectable. If you have a diminished sense of smell, or are in any way unsure of the presence of gas, immediately contact your gas supplier from a neighbor's telephone. Gas detectors are available. Contact your gas supplier, or plumbing professional for more information.

Do not operate the water heater or its accessories without the Accessory Module cover in place. Do not operate the water heater or Setback Control without the Setback Control Junction Box Assembly cover in place.

Do not operate the water heater, Accessory Module, and Setback Control with jumpered or absent controls or safety devices.

Turn off or disconnect the electrical power supply to the water heater and its accessories before servicing. Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

All electrical wiring must be installed and grounded in accordance with local codes, or in the absence of local codes, the National Electrical Code, ANSI/NFPA 70 and/or CSA C22 Electrical Code.

The Bradford White DEFENDER Safety System®

The Bradford White DEFENDER Safety System was designed to resist the ignition of flammable vapors that can occur outside of the water heater. Use and installation are nearly identical to previous versions of atmospherically fired and vented water heaters. A number of exclusive design features are incorporated in the system that will require additional knowledge on the part of the qualified service provider. The following information will instruct service professionals on the function, proper diagnosis, and repair of water heaters employing the Bradford White DEFENDER Safety System.

Introduction

The new Bradford White Programmable Efficiency water heaters are designed to provide reliable performance with enhanced standard features. New design features include reliable spark-to-pilot ignition system, enhanced diagnostics, simplified servicing, and the Bradford White Defender Safety System.

Spark-to-Pilot Ignition System - employing the spark-to-pilot ignition system promotes reliable and consistent pilot and main burner ignitions to provide hot water on demand.

Integrated Immersion Thermal Well/Gas Control with LED - was developed for ease of troubleshooting by providing simple diagnostic codes to pinpoint an installation or component performance issue.

Rugged Wiring Connections - receptacle type connections promote error free wiring.

The gas control maintains water temperature, ignition sequence, and regulates gas flow. If a situation outside of normal operating parameters exists, the gas control diagnostic LED will flash a code to positively identify an operational issue.

This service manual is designed to facilitate problem diagnosis and enhance service efficiency. To further promote quicker service times, the gas control can be removed and replaced without draining the water heater. A special tool is required and will be provided with each gas control kit shipped from your Bradford White wholesale distributor.

Please read the service manual completely before attempting service on this new series of models.

How the DEFENDER Safety System Works

During normal operation, air for combustion is drawn into the water heater through the openings in the jacket. This air travels down and around the combustion chamber and enters through holes in the very bottom of the corrosion resistant combustion chamber. The air then travels up through the flame arrestor louvers, where the velocity of the air is increased and its direction altered. The air then mixes in a normal manner with supplied gas and is efficiently combusted, producing very low NO_x emissions.

In the unlikely event trace amounts of flammable vapors are present in the air flowing into the combustion chamber, the vapors are harmlessly ignited by the burner. If flammable vapors are in sufficient quantity to prevent normal combustion, the flammable vapor sensor recognizes this and shuts down the pilot and main burner. Should the flammable vapors continue to burn, the flame arrestor prevents the flames from traveling backwards and igniting vapors outside of the combustion chamber. In addition, the resettable thermal switch will open and shut down the pilot and main burner.

How to Use this Manual

This manual serves as a supplement to the Defender Atmospheric service manual, p/n 238-44943-00. Please refer to the Defender Atmospheric service manual for all features on this water heater that are consistent with a Defender (standard) Atmospheric water heater.

It is intended for this manual to be used by qualified service personnel for the primary purpose of troubleshooting and repair of the Bradford White Programmable Efficiency water heaters. Understanding the sequence of operation section of this manual will contribute greatly to troubleshooting the water heater.

The Honeywell WV4460E Electronic Gas Control will display error codes in the event of abnormal operation. Diagnostic codes are listed in the troubleshooting chart beginning on page 13 of this service manual. The troubleshooting chart will also indicate the probable cause for the diagnostic code and direct the service professional to a service procedure to properly diagnose the abnormal operation.

Contact the Bradford White technical support group immediately if diagnosis cannot be made using the methods described in this service manual.

Tools Required for Service

Manometer: A liquid “U” tube type or a digital (magna-helic) type can be used. This device is used to measure gas and/or air pressure and vacuum.

Multi-Meter: A digital type is strongly recommended. This device is used to measure electrical values. The meter you select must have the capability to measure volts AC, volts DC, amps, micro-amps and ohms.

Electronic Probes: In some cases, standard multi-meter probes will damage or simply not be effective to obtain certain voltage and ohm reading. It will be necessary to have special electronic “pin” type multi-meter probes. These probes are available at most electronic wholesale outlets.

Thermometer: Used to measure water temperature. An accurate thermometer is recommended.

Water Pressure Gage: Used to measure water supply pressure. Also used to determine tank pressure by adapting to the drain valve of the heater.

Gas Control Service Tool: BWC p/n 239-45991-00. A specialized tool designed to remove the gas control from the thermal well. Available from your Bradford White parts supplier and is supplied with replacement gas controls.

Various Hand Tools: Pipe wrench, channel locks, open end wrenches (3/8", 7/16", 1/2"), 12" crescent wrench, Allen wrench set, screw drivers (common & Phillips), 1/4" nut driver, pliers (common & needle nose), socket set, side cutters, wire cutters, wire strippers, wire crimpers, torpedo level, small shop vac, step ladder, flashlight, and 5 gallon pail.

Specifications

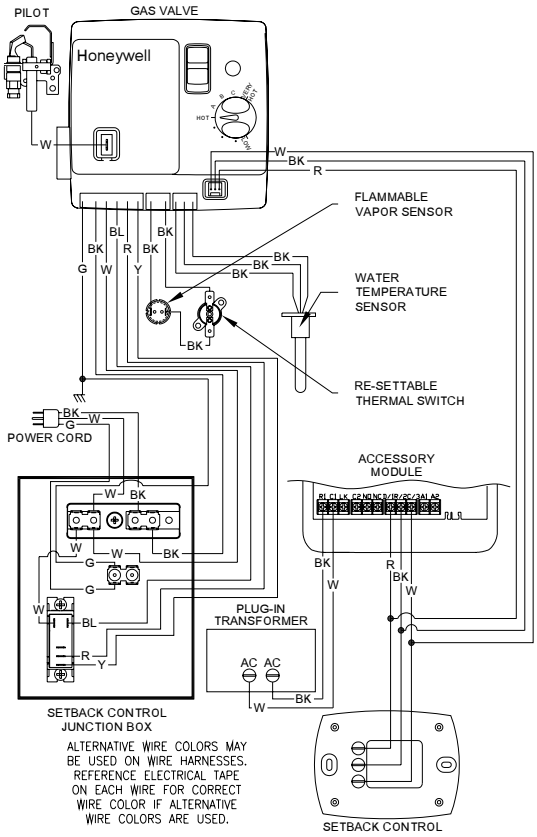
Power Supply	Dedicated 120VAC, 60 Hz, 15A
Gas Supply Pipe	Minimum 1/2” NPT (Schedule 40 black iron pipe recommended)
Approved Gas Type	Natural or Propane; unit must match gas type supplied
Gas Pressure	5” w.c. minimum for Natural Gas; 11” w.c. for Propane; 14” w.c. maximum for Natural Gas / Propane
Approved Vent Materials	Single or Double Wall Metal Vent Pipe
Minimum Clearance for Servicing	18” from top; 24” from front; 4” from sides and rear
Water Supply Pressure	150 psi maximum allowable working pressure; check local codes for supply pressure
ECO Limit	188°F (87°C)
Temperature Setpoint Range	60°F (16°C) to 160°F (71°C); approximate temperatures

Specifications

Control Timings

Ignition State	Timing
Energize Relay and Verify (Closed Circuit)	15 seconds
Trial for Ignition	90 seconds
Flame Stabilization Period	3 seconds
Re-energize Relay and Verify	15 seconds
Flame Failure Response Time	1.5 seconds (2 second maximum; 1 second minimum)
De-energize Relay and Verify (Open Circuit)	15 seconds
Relay Fault (failed open/close)	Retry after 2 minutes
Soft Lockout	Retry after 5 minutes
ECO Limit Lockout	Indefinite (See page 11 to reset)
Verify Resistive Delay	Retry after 2 minutes (repeats 5 times)
Simulated Resistive Load Lockout	Indefinite (cycle power to reset)
Hardware Error Lockout	Indefinite (self clears if fault clears for at least 15 seconds)

Wiring Diagram



BRADFORD WHITE WATER HEATERS

Note: The Sequence of Operation section is in addition to the Defender Atmospheric Service Manual, p/n 238-44943-00.

Power Up Sequence

1. **Start-up:** Upon power up, the gas control runs a safe start check with a typical delay of 5 seconds.
2. **Flammable Vapor Verification:** The gas control verifies that the Flammable Vapor Sensor is in the proper operating range prior to energizing any components. If the sensor is within the proper range, the gas control resumes normal operation. If the Flammable Vapor Sensor is out of range, the gas control LED immediately flashes 7 times with a 3 second pause.

Normal Heating Sequence

1. **Thermostat Calls for Heat:** Prior to energizing the relay, the gas control verifies the safety circuit to see if it is in the correct state. If the safety circuit is closed, the gas control LED flashes 2 times with a 3 second pause. The gas control waits 2 minutes. Then, the control cuts power to the relay. This cycle repeats until the safety circuit opens.
2. **Relay Energized**
3. **Safety Circuit Check:** If the safety circuit does not close within 30 seconds, the gas control LED flashes 3 times with a 3 second pause. The relay is powered for a maximum of 30 seconds every 2 minutes trying to close the safety circuit. This cycle repeats as long as there is a call for heat.
4. **Hold Period** (15 seconds)
5. **Trial for Pilot Ignition** (90 seconds): The gas control lights the pilot by activating the spark igniter and gas flow to the pilot burner. If flame is not sensed within 90 seconds, the spark igniter and gas flow are deactivated. The relay will remain powered, and the gas control LED flashes 6 times with a 3 second pause.
6. **Main Burner Ignition:** After pilot flame is sensed, the gas control activates the main valve for main burner ignition. The gas control will ignore flame signals for 3 seconds to allow for the main burner to stabilize.

Normal Heating Sequence (cont'd)

7. **Steady State Operation:** During steady state operation, the gas control monitors:

   Thermostat Temperature Sensor: When the setpoint temperature is satisfied, the gas control is shutdown, and power is removed from the relay. The gas control LED flashes a short flash once every 4 seconds (Idle status code).

   Relay Status: If the relay is altered during a call for heat, the pilot and main valves are shutdown. The relay is powered attempting to close the safety circuit. The gas control LED flashes 3 times with a 3 second pause.

   Flame Sensor: If flame is lost, the pilot and main valves are shutdown. The relay is powered. The gas control attempts to re-light the pilot 4 times. If unsuccessful, power is removed from the relay, and the gas control proceeds to a 5 minute lockout. The gas control re-attempts to light the pilot starting at Normal Heating Sequence #2.

8. **Thermostat Satisfies:** Gas control LED flashes once every 4 seconds.
9. **Burner Off**
10. **Relay De-energized** (15 seconds)

Abnormal Operation

1. **Flammable Vapor Sensor Fault:**

   A) If the resistance is greater than 70,000 ohms: The gas control immediately turns off all outputs. The gas control waits and monitors resistance for 30 seconds. If the resistance is greater than 65,000 ohms after 30 seconds, the gas control proceeds to verify resistive delay for 2 minutes and flashes 7 times then 1 time with a three second pause. This process is repeated 5 times until the control either returns to normal operation or proceeds to flammable vapor lockout.

   B) If the resistance is below 3000 ohms: The gas control immediately turns off all outputs and proceeds to flash 8 times then 1 time with a three second pause. The error self clears if the resistance returns to normal range for at least 15 seconds.

Abnormal Operation (cont'd)

2. **Temperature Sensor Fault:**

A) Temperature Sensor Open Circuit: The gas control immediately turns off all outputs and proceeds to flash 8 times then 3 times with a three second pause. The error self clears if the fault clears for at least 15 seconds.

B) Thermal well sensors not reading the same temperature within ±5.5°F: The gas control immediately turns off all outputs and proceeds to flash 8 times then 3 times with three second pause. The error self clears if the fault clears for at least 15 seconds.

C) Water Temperature in excess of ECO (Energy Cut Off) Limit: The gas control immediately turns off the pilot and main valves. The gas control LED proceeds to flash 4 times with a 3 second pause.

To reset the gas control, rotate the setpoint knob to the minimum setting for at least 6 seconds before returning to desired temperature setting.

3. **Safety Circuit Fault:**

A) Safety Circuit Failed to Close: The gas control proceeds to flash 3 times with a 3 second pause. The gas control waits 5 minutes, and then tries to energize the relay again.

B) Safety Circuit Failed to Open: The gas control proceeds to flash 2 times with a 3 second pause. The gas control waits 5 minutes, and then tries to de-energize the relay.

4. **Trial for Ignition Fault:**

A) Relay Fault During Trial: The gas control stops the trial for ignition. The gas control proceeds to flash 3 times with a 3 second pause. The gas control waits 5 minutes, and then tries to energize the relay again.

B) Flame Not Sensed: The gas control energizes the spark igniter attempting to light the pilot and prove flame. If flame is not sensed within 90 seconds, the spark igniter turns off, the pilot valve is closed. The gas control LED flashes 6 times then 1 time with 3 second pause. The control waits 5 minutes before repeating the ignition sequence.

Abnormal Operation (cont'd)

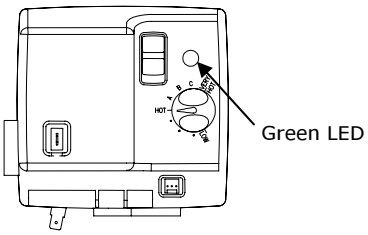
5. **Flame Sensing Fault:**

A) Flame Lost During Run: The gas control turns off pilot and main valves. The gas control increments the recycle count, if the recycle count has not reached its limit (4), another trial for ignition begins. If the recycle count has been reached, the gas control LED flashes 6 times then 3 times with a 3 second pause. The gas control waits 5 minutes before repeating the ignition sequence.

B) Flame Sensed Out of Sequence: The gas control only looks for pilot flame when the relay is energized. If flame is present when the pilot valve is not open, the gas control proceeds to wait for flame loss and flashes 5 times with 3 second pause. This continues until flame is lost. Once the flame signal is lost, the control flashes 6 times then 4 times with a 3 second pause. The control waits 5 minutes before repeating the ignition sequence.

Note: The Troubleshooting section replaces pages 4-6 in the Defender Atmospheric service manual, p/n 238-44943-00.

Observe the green LED on the water heater gas control. Diagnostic codes are displayed with a 3 second pause before repeating. Once the diagnostic code is known, check and repair the water heater, as recommended in the table below.



LED Status	Control Status	Probable Cause	Service Procedure
None (LED not on or flashing)	Electrical power not present	Control power switch in "OFF" position. Supply voltage interrupted.	Turn Power On
One short flash every four seconds	Stand-by mode, Thermostat is satisfied (no faults)	Temperature demand is satisfied (no call for heat)	Normal operation
Alternates bright and dim (heartbeat)	Thermostat calling for heat (no fault)	Tank temperature below setpoint of thermostat	Normal operation
Short flash once every second	Weak pilot signal on last call for heat	1. Unstable pilot 2. Pilot tube blocked or restricted 3. Oxidation build-up on pilot electrode 4. Wire damage to pilot assembly or bad connection at gas control	1. See Burner Inspection on page 17 2-4. See Pilot Inspection, Testing and Replacement on page 19
Two flashes, three second pause	Relay not working	Faulty relay	1. Verify cord sets are fully plugged in 2. See Relay Replacement on page 28
Three flashes, three second pause	Relay not working	Faulty relay	1. Verify cord sets are fully plugged in 2. See Relay Replacement on page 28
Four flashes, three second pause	Excessive tank temperature, system must be reset	1. Thermal well sensor out of calibration 2. Faulty gas control	1. Test Gas Control & Thermal Well 2. Replace gas control if necessary
Five flashes, three second pause	False pilot flame present	Pilot valve stuck in open position	Replace gas control
Six flashes, one flash, three second pause (Soft Lockout)	Failed to light pilot, system resets after (5) minutes	1. Unstable pilot 2. Pilot tube block or restricted 3. Oxidation build-up on pilot electrode 4. Wire damage to pilot assembly or bad connection at gas valve	1. See Burner Inspection on page 17 2-4. See Pilot Inspection, Testing and Replacement on page 19

LED Status	Control Status	Probable Cause	Service Procedure
Six flashes, two flashes, three second pause (Soft Lockout)	Relay not working properly during burner operation, system auto resets after (5) minutes	Faulty relay	See Relay Replacement on page 28
Six flashes, three flashes, three second pause (Soft Lockout)	Pilot flame extinguished, system auto resets after (5) minutes	1. Unstable pilot 2. Pilot tube block or restricted 3. Oxidation build-up on pilot electrode 4. Wire damage to pilot assembly or bad connection at gas control 5. Insufficient combustion air 6. Insufficient gas pressure	1. See Burner Inspection on page 17 2-4. See Pilot Inspection, Testing and Replacement on page 19 5. Refer to Installation & Operation Manual
Six flashes, four flashes, three second pause	Undesired false pilot flame sensed, system auto resets	Pilot valve stuck in open position	Replace gas control
Seven flashes, three second pause	Flammable vapor sensor or resettable thermal switch fault detected, see warning label	1. Flammable vapor present 2. Flammable vapor sensor exposed to excessive moisture 3. Flammable vapor sensor exposed to extreme ambient temperature 4. Resettable thermal switch open	See Flammable Vapor Sensor Testing on page 27
Eight flashes, one flash, three second pause	Flammable vapor sensor out of specification, possible short	1. Flammable vapor sensor out of specification; verify Flammable Vapor Sensor (FVS) resistance is not below 25 kΩ. 2. Possible short in flammable vapor sensor or resettable thermal switch wiring	See Flammable Vapor Sensor Testing on page 27
Eight flashes, three flashes, three second pause	Thermal well sensor damaged or unplugged or gas control electronics fault detected	1. Damage to thermal well wires 2. Thermal well sensor resistance out of range 3. Replace thermal well 4. Verify control is not wet or physically damaged 5. Reset control on/off switch 6. Replace gas control if 8-3 error persists	See Thermal Well Testing on page 21
Eight flashes, four flashes, three second pause	Gas control fault detected	1. Verify control is not wet or physically damaged 2. Reset control on/off switch 3. Replace gas control if 8-4 error persists	1. Replace gas control if wet or physically damaged 2. Cycle power 3. Replace gas control

The table, below, details the diagnostic codes that can be seen on the Setback Control. Reference the Setback Control manual, p/n 238-47808-00, for more details on this control.

		Gas Valve / Control Model	
Diagnostic Code #	**Description**	**Accessory Module**	**WV4460E (intermittent pilot gas control)**
Conn	Setback Control not connected to gas valve / control or improperly wired together.	x	x
2	Relay remains energized		x
4	Weak pilot signal detected.		x
6	Pilot signal detected out of sequence.		x
18	Internal gas valve fault detected.	x	
20	Failed to light pilot.		x
23	Pilot signal detected out of sequence (before it should).		x
24	Pilot signal detected out of sequence (after it should).		x
29	Relay failed to energize		x
31	Upper tank sensor out of specification.		
32	Lower tank sensor out of specification.		x
63	Ignition successful, but flame lost during run cycle. Soft lockout.		x
64	Internal gas valve fault detected.		x
85	Soft Lockout due to maximum number of recycles exceeded, last recycle was from pressure switch open		x
87	A manual reset is required due to Rollout Limit		x
89	Equipment missing or improperly wired together.	x	
93	Internal gas valve fault detected.		x
95	Flammable vapor sensor fault detected, see warning label.		x
96	Flammable vapor sensor out of specification, possible short.		x
143	Water heater tank leak detected.	x	
145	Leak sensor improperly installed or leak sensor resistor missing.	x	

The table, below, details the diagnostic codes that can be seen on the Accessory Module. Reference the Accessory Module manual, p/n 238-47878-00, for more details on this control.

LED Status		Accessory Module Status	Probable Cause
Green	LED on continuously.	Power on (no fault).	n/a
Red	One flash and three second pause.	Leak alarm fault. Inlet Shut-off valve open.	Water heater tank leak.
Red	Two flashes and three second pause.	Leak alarm fault. Inlet Shut-off valve closed.	Water heater tank leak.
Amber	Four flashes and three second pause.	Leak sensor malfunction.	1. Leak Sensor resistor removed. 2. Leak Sensor improperly connected to Accessory Module.
Amber	Five flashes and three second pause.	Gas control missing / not connected.	1. Wrong gas control wire harness was used. 2. Accessory Module was not connected to gas valve.
Red	LED strobe (quick flashes).	Hardware error.	Internal electronics failure, replace Accessory Module.

Note: The Burner Maintenance section replaces pages 31-33 in the Defender Atmospheric service manual, p/n 238-44943-00.

Burner Inspection

At periodic intervals (every 6 months), a visual inspection should be made of the pilot and main burner for proper operation and to assure no debris is accumulating. The pilot flame should be stable. Some causes for an unstable pilot flame are:

a) Gas pressure is out of specification.

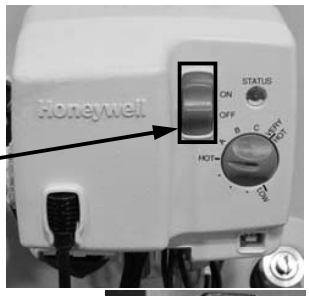
b) Pilot flame not fully engulfing spark/flame sensor.

The main burner should light smoothly from the pilot and burn with a blue flame with a minimum of yellow tips.

Steel burner models self adjust air to gas ratio mixture and do not have an adjustable air shutter. The main burner must be free from any debris accumulation that may effect burner operation (See Burner Cleaning Procedure on page 17).

Burner Cleaning Procedure

Step 1. Move the gas control power switch to the "OFF" position.



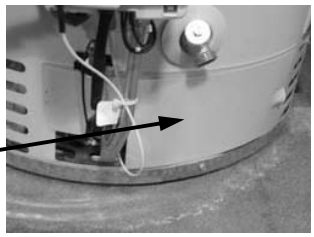
Gas control power switch

Step 2. Unplug the water heater and Accessory Module from the wall outlet.

Water heater power cord and Accessory Module transformer

Step 3. Turn off the gas supply to the water heater.

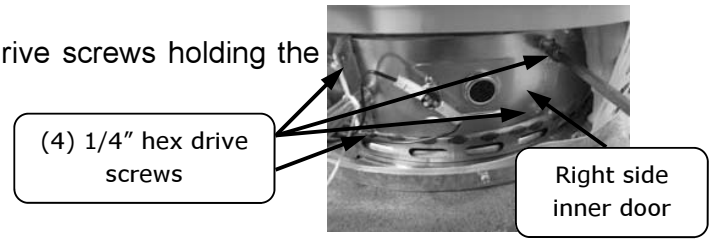
Step 4. Remove the outer door.



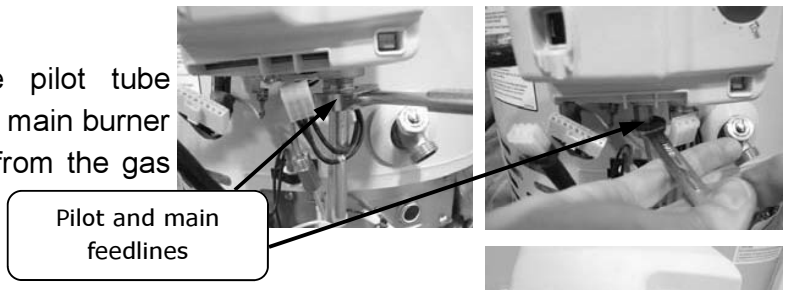
Outer door

Burner Cleaning Procedure (cont'd)

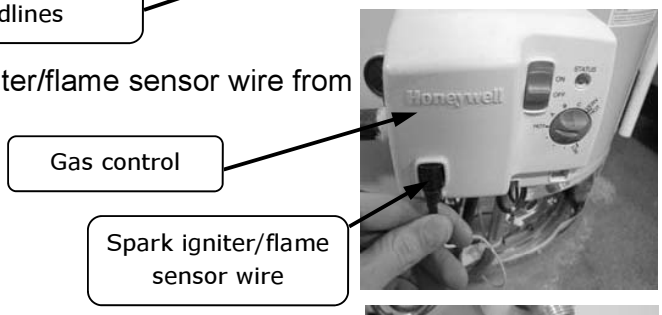
Step 5. Remove the (4) 1/4" hex drive screws holding the right side inner door in place.



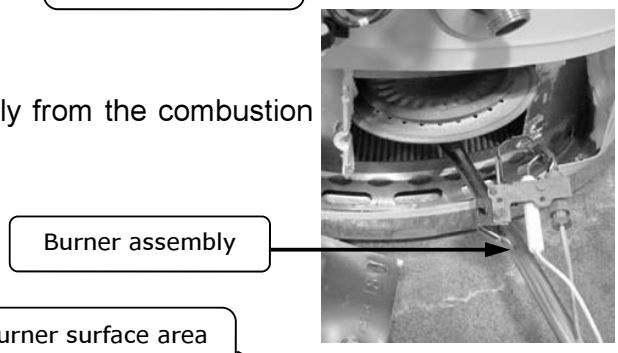
Step 6. Disconnect the pilot tube using a 7/16" wrench and the main burner feedline with a 3/4" wrench from the gas control.



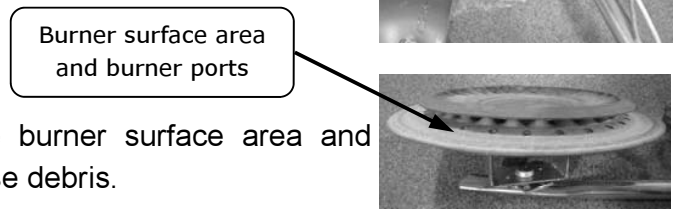
Step 7. Disconnect the spark igniter/flame sensor wire from gas control.



Step 8. Remove the burner assembly from the combustion chamber.

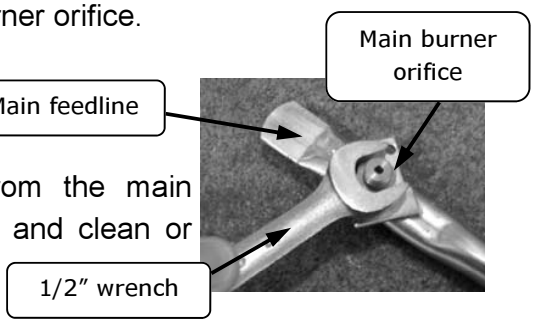


Step 9. Thoroughly inspect the burner surface area and burner port area and remove any loose debris.



Step 10. Unscrew the burner from the main burner orifice.

Step 11. Remove the main burner orifice from the main feedline using a 1/2" wrench. Inspect the orifice and clean or replace, if necessary.



Burner Cleaning Procedure (cont'd)

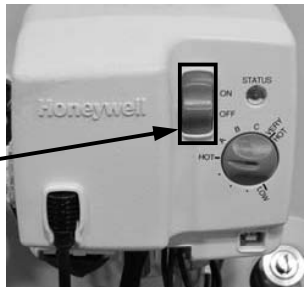
Step 12. Re-assemble the burner assembly and re-install into the water heater. Restore gas supply and check for gas leaks.

Step 13. To resume operation, follow the instructions located on the water heater lighting instruction label. Or, use the lighting instructions located in the water heater Installation and Operation manual.

Pilot Inspection, Testing, and Replacement

Note: The Pilot Maintenance section replaces page 13 in the Defender Atmospheric service manual, p/n 238-44943-00.

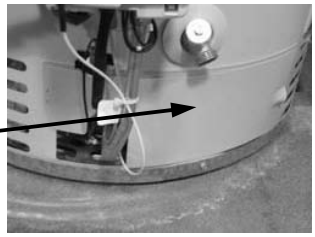
Step 1. Move the gas control power switch to the "OFF" position



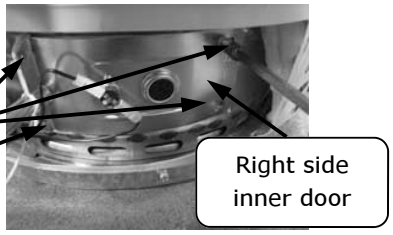
Step 2. Unplug the water heater and Accessory Module from the wall outlet.

Step 3. Turn off the gas supply to the water heater.

Step 4. Remove the outer door.

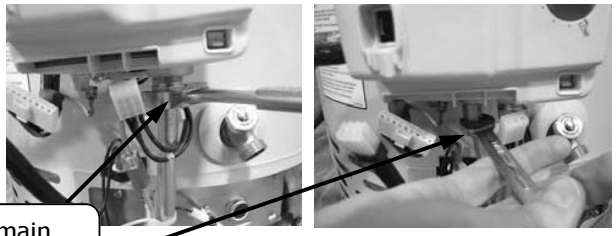


Step 5. Remove the (4) 1/4" hex drive screws holding the right side inner door in place.



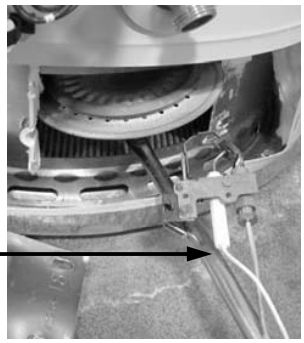
Pilot Inspection, Testing, and Replacement (cont'd)

Step 6. Disconnect the pilot tube using a 7/16" wrench and the main burner feedline with a 3/4" wrench from the gas control.

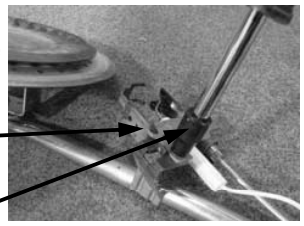


Step 7. Disconnect the spark igniter/flame sensor wire from gas control.

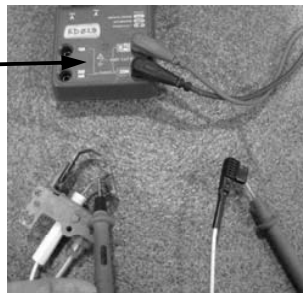
Step 8. Remove the burner assembly from the combustion chamber.



Step 9. Remove the pilot assembly from the main feedline using a 1/4'' nut driver.



Step 10. Visually inspect the spark igniter/flame sense wire for damage. Replace the pilot assembly, if damage is found.



Step 11. With a multi-meter set to the ohms setting, check continuity through the spark igniter/flame sense wire. Replace the pilot, if there is no continuity.

Pilot Inspection, Testing, and Replacement (cont'd)

Step 12. Visually inspect the spark igniter/flame sense electrode for deterioration. Replace the pilot assembly, if necessary. The electrode should not be in contact with pilot hood. If it is in contact with the pilot hood, carefully adjust electrode to a gap distance of 3/32" from the pilot hood.

Step 13. Visually inspect the spark igniter/flame sense electrode for oxidation build-up. Carefully clean any oxidation using very fine emery cloth.

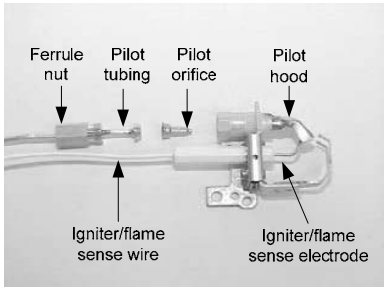
Step 14. Visually inspect the pilot tubing for kinks or cracks. If damage is found, replace the pilot assembly.

Step 15. Inspect the pilot tubing and pilot orifice for blockages:

a) Remove ferrule nut from the bottom of the pilot assembly using a 7/16" wrench.

b) Remove the pilot tube and pilot orifice.

c) Inspect the pilot tubing and pilot orifice for blockages. Clean or replace, as necessary.



Step 16. Re-assemble the pilot assembly and install it on the main feedline. Re-install the burner assembly into the combustion chamber. Restore the gas supply and check for gas leaks.

Step 17. To resume operation, follow the instructions located on the water heater lighting instruction label. Or, use the lighting instructions located in the water heater Installation and Operation manual.

Thermal Well Testing

Note: The Thermal Well Testing section replaces page 22 in the Defender Atmospheric Service Manual, p/n 238-44943-00.

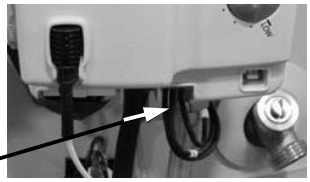
⚠ CAUTION

Do not use standard multi-meter probes for this testing. Doing so will damage the connector. Use special pin type electronic probes or small diameter wire pins inserted into connector.

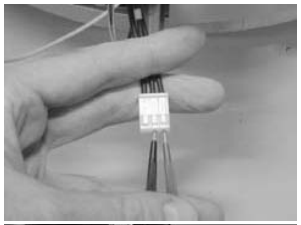
Thermal Well Testing (cont'd)

Follow the procedure, below, if the water heater gas control has gone into a ECO lockout (4 flash, 3 second pause). Reset the gas control by rotating the setpoint knob to the minimum setting for at least 6 seconds before returning to the desired water temperature setting.

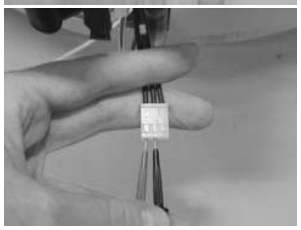
Step 1. Unplug the thermal well connector from the gas control.



Step 2. With a multi-meter set to the ohms setting, measure the resistance between the middle and right side wires.



Step 3. With a multi-meter set to the ohms setting, measure the resistance between the middle and left side wires.



Determine the correct resistance values using the Determine the Water Temperature Inside the Tank procedure. If the values are correct, replace the gas control, otherwise replace the thermal well.

Determine Water Temperature Inside Tank

Note: The Determine Tank Temperature section replaces page 23 in the Defender Atmospheric Service Manual, p/n 238-44943-00.

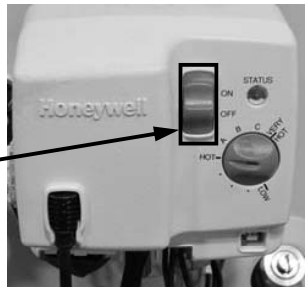
⚠ WARNING

Stored water may be HOT when performing the following steps in this procedure. Take necessary precaution to prevent personal injury.

Note: It is important to understand once the resistance for the thermal well is determined using the Thermal Well Testing Procedure on page 21, water flow through the water heater should not occur. Prior to performing the following steps, turn off the cold water supply to the water heater. This will prevent cold water flow into the tank affecting the resistance value of thermal well.

Determine Water Temperature Inside Tank (cont'd)

Step 1. Move the gas control power switch to the "OFF" position.



Step 2. Draw approximately 4 gallons of water from the drain valve into a container and discard. Draw an additional gallon and immediately measure the water temperature using an accurate thermometer. It may be necessary to open a hot water faucet to allow the water heater to drain.

Step 3. Using the chart below, determine the correct resistance value for the water temperature from Step 2.

Example: If the water temperature is 84°F, then the resistance through the sensor would be 8449 (see shaded area). NOTE: Sensor resistance increases as the temperature falls.

Sensor Resistance at Various Temperatures

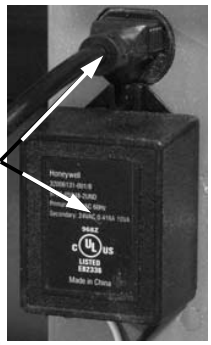
In Degrees F										
°F	0	1	2	3	4	5	6	7	8	9
40	26109	25400	24712	24045	23399	22771	22163	21573	21000	20445
50	19906	19383	18876	18383	17905	17440	16990	16553	16128	15715
60	15314	14925	14548	14180	13823	13477	13140	12812	12494	12185
70	11884	11592	11308	11032	10763	10502	10248	10000	9760	9526
80	9299	9078	8862	8653	8449	8250	8057	7869	7685	7507
90	7333	7165	7000	6839	6683	6531	6383	6238	6098	5961
100	5827	5697	5570	5446	5326	5208	5094	4982	4873	4767
110	4663	4562	4464	4368	4274	4183	4094	4006	3922	3839
120	3758	3679	3602	3527	3453	3382	3312	3244	3177	3112
130	3048	2986	2925	2866	2808	2752	2697	2643	2590	2538
140	2488	2439	2391	2344	2298	2253	2209	2166	2124	2083
150	2043	2004	1966	1928	1891	1856	1820	1786	1753	1720
160	1688	1656	1625	1595	1566	1537	1509	1481	1454	1427
170	1402	1376	1351	1327	1303	1280	1257	1235	1213	1191
180	1170	1150	1129	1110	1090	1071	1053	1035	1017	999
190	982	965	949	933	917	901	886	871	857	842
200	828	814	801	788	775	762	749	737	725	713

Gas Control & Thermal Well Removal From Water Heater

Note: The Component Disassembly, Gas Control Removal, and Gas Control Assembly sections replace pages 24-30 in the Defender Atmospheric service manual, p/n 238-44943-00.

Step 1. Move the gas control power switch to the "OFF" position.

Step 2. Unplug the water heater and Accessory Module from the wall outlet.

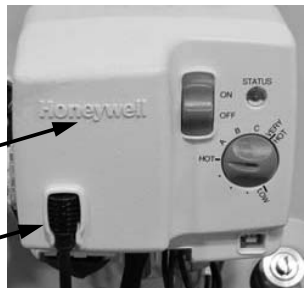


Step 3. Drain the water heater to a point below the gas control level.

Step 4. Turn off the gas supply to the water heater and disconnect the gas piping from the gas control.

Step 4. Disconnect the pilot tube using a 7/16" wrench and the main burner feedline with a 3/4" wrench from the gas control.

Step 5. Disconnect the wire harnesses and spark igniter/ flame sense wire from the gas control.

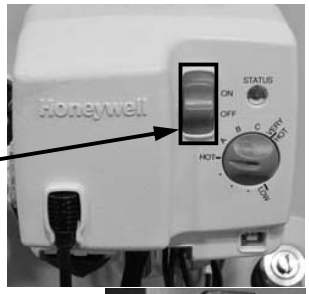


Step 6. Remove the gas control & thermal well by rotating the flats of the Thermal Well counter clockwise using a 1-5/16" wrench.

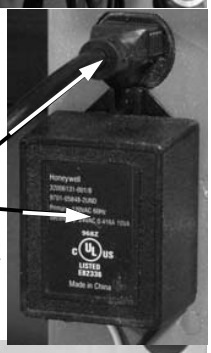
Gas Control Removal From Thermal Well

Following the steps below allow for the removal of the gas control from the thermal well without removing the thermal well from the tank.

Step 1. Move the gas control power switch to the “OFF” position.

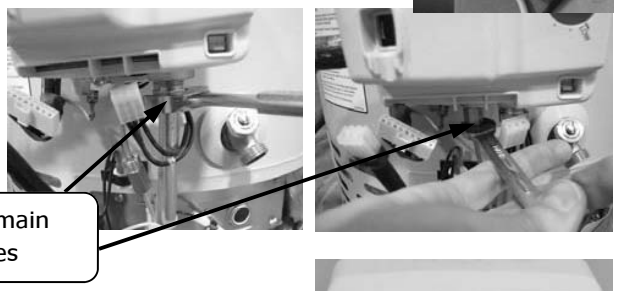


Step 2. Unplug the water heater and Accessory Module from the wall outlet.

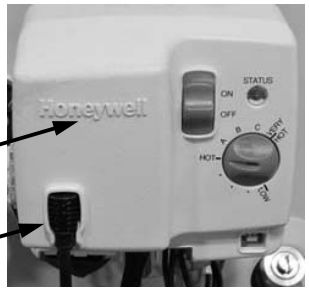


Step 3. Turn off the gas supply to the water heater and disconnect the gas piping from the gas control.

Step 4. Disconnect the pilot tube using a 7/16” wrench and the main burner feedline with a 3/4” wrench from the gas control.



Step 5. Disconnect the wire harnesses and spark igniter/ flame sense wire from the gas control.



Step 6. Using the gas control service tool, p/n 239-45991-00, available from your BWC parts supplier, insert the tool into the back of the gas control.

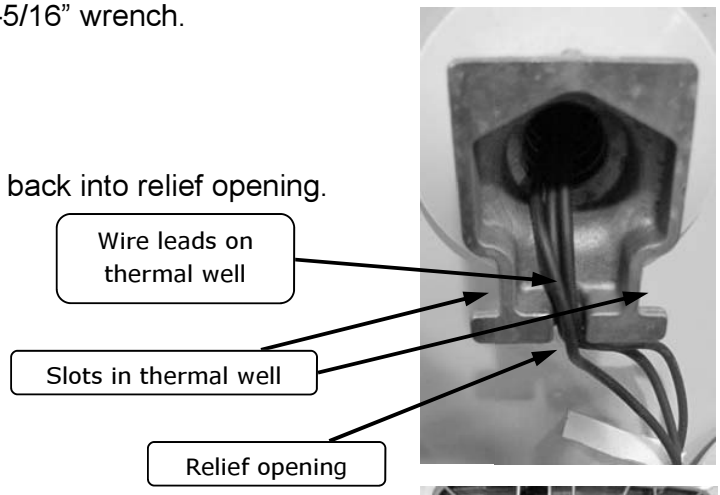
Gas Control Removal From Thermal Well (cont'd)

Step 7. Pivot the tool towards the water heater, as far as possible. Lift straight up on the gas control. The gas control should move about 1/8''. Hold the gas control in position and remove the tool. Lift straight up on the gas control to remove it completely from the thermal well.

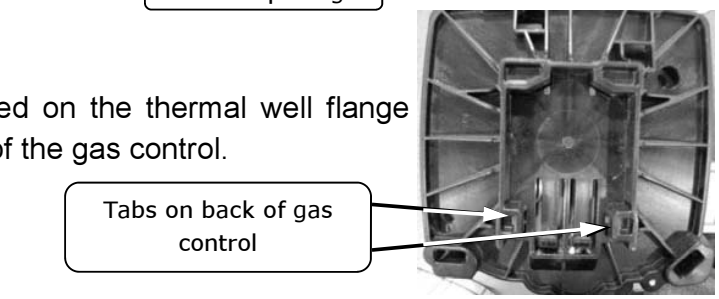
Gas Control Assembly to the Thermal Well

Step 1. Install the threaded end of the thermal well into the tank. Be sure the thermal well flange is positioned properly to allow for proper gas control installation. Tighten the thermal well using a 1-5/16" wrench.

Step 2. Route the wire leads back into relief opening.

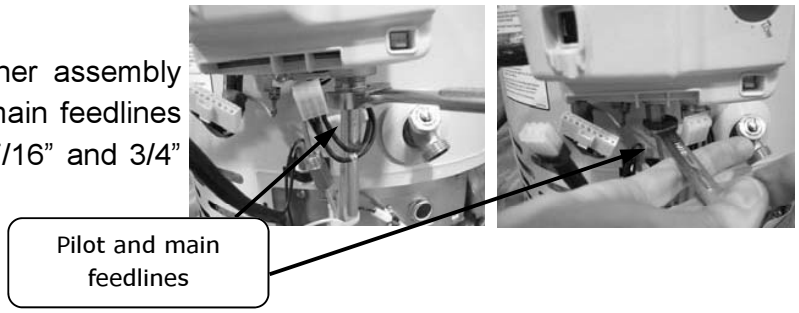


Step 3. Align the slots located on the thermal well flange with the tabs located on the back of the gas control.



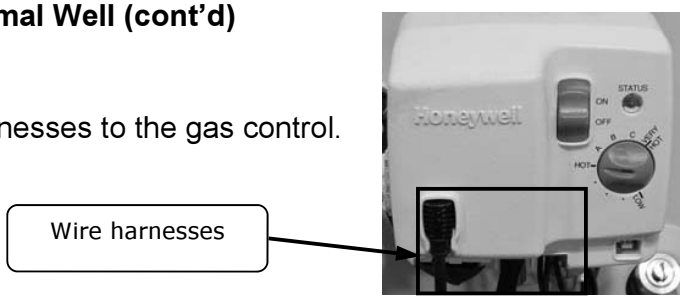
Step 4. Carefully push the gas control back onto the thermal well flange as far as possible towards the water heater. Then, slide the gas control down to lock into position.

Step 5. Install the burner assembly and connect the pilot and main feedlines to the gas control using a 7/16" and 3/4" wrench, respectively.



Gas Control Assembly to the Thermal Well (cont'd)

Step 6. Reconnect the wire harnesses to the gas control.



Step 7. Reconnect the gas piping to the gas control. Restore the gas supply and check for gas leaks.

Step 8. To resume operation, follow the instructions located on the water heater lighting instruction label. Or, use the lighting instructions located in the water heater Installation and Operation manual.

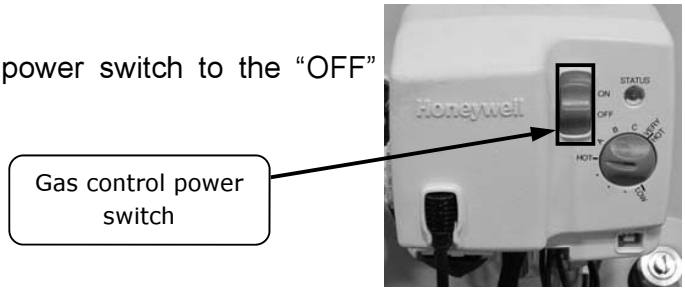
Flammable Vapor Sensor Testing

Note: The Flammable Vapor Sensor Testing section is in addition to the Defender Atmospheric service manual, p/n 238-44943-00.

⚠ CAUTION

Do not use standard multi-meter probes for this testing. Doing so will damage the connector. Use special pin type electronic probes or small diameter wire pins inserted into connector.

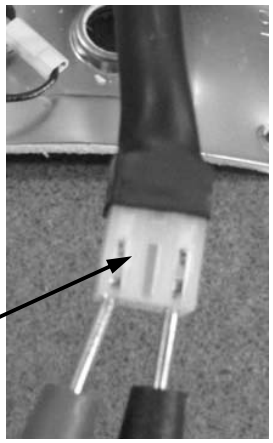
Step 1. Move the gas control power switch to the "OFF" position.



Step 2. Disconnect the flammable vapor sensor harness from the gas control.

Flammable Vapor Sensor Testing (cont'd)

Step 3. Using a multi-meter set to the ohms setting, measure the resistance of the flammable vapor sensor and resettable thermal switch. The resistance must be between 3,000 and 48,000 ohms. If the resistance is out of this range, verify that the resettable thermal switch has not been tripped. If it hasn't, replace the flammable vapor sensor.



120 VAC Circuit Trace

Note: The 120 VAC Circuit Trace section is in addition to the Defender Atmospheric service manual, p/n 238-44943-00.

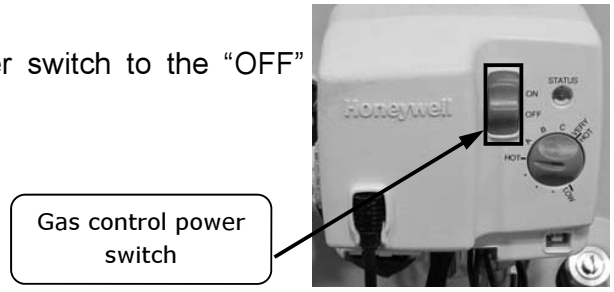
Step 1. Verify 120VAC and proper polarity are at the wall outlet.

Step 2. With the water heater plugged in and the gas control power switch in the "ON" position, verify LED status.

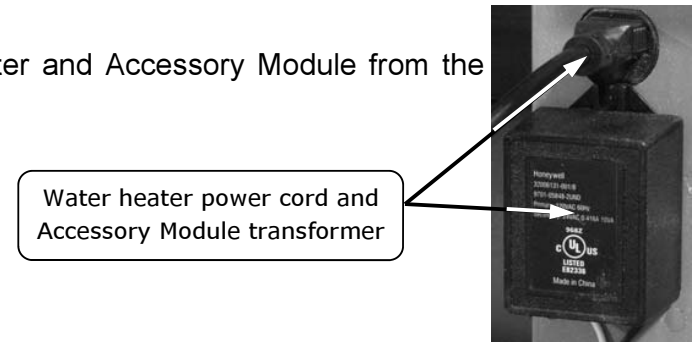
Relay Replacement

Note: The Relay Replacement section is in addition to the Defender Atmospheric service manual, p/n 238-44943-00.

Step 1. Move the gas control power switch to the "OFF" position.

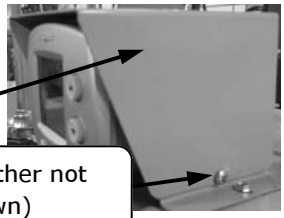


Step 2. Unplug the water heater and Accessory Module from the wall outlet.



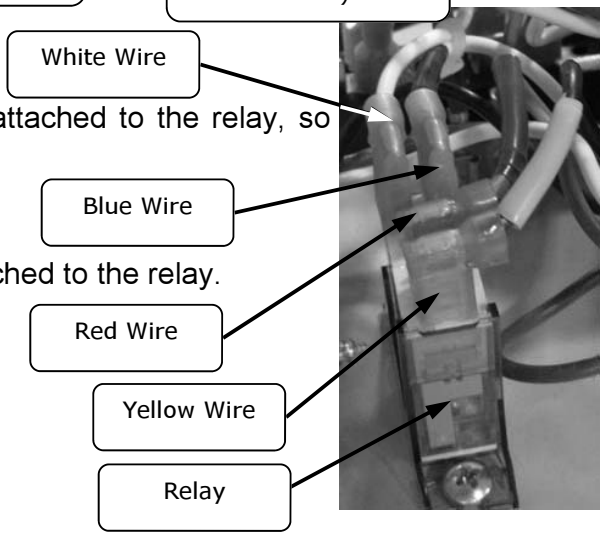
Relay Replacement (cont'd)

Step 3. Remove the (2) screws holding the Setback Control Junction Box Assembly cover on and retain for later use.



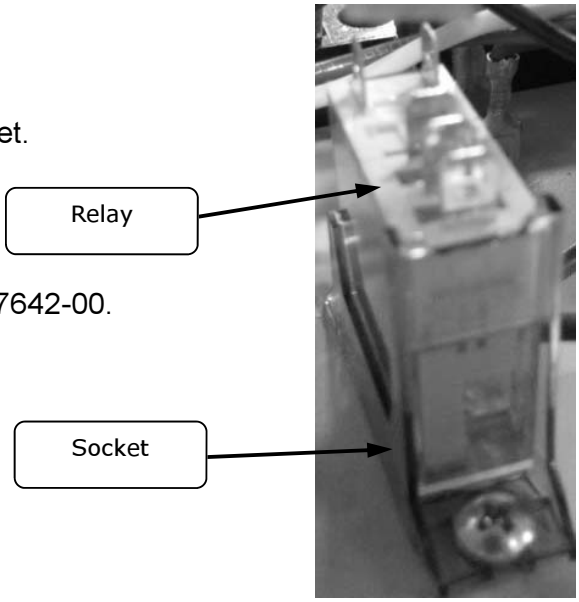
Step 4. Mark the (4) wires that are attached to the relay, so their proper location is known.

Step 5. Disconnect the (4) wires attached to the relay.



Step 6. Remove the relay from its socket.

Step 7. Install the new relay, p/n 233-47642-00.



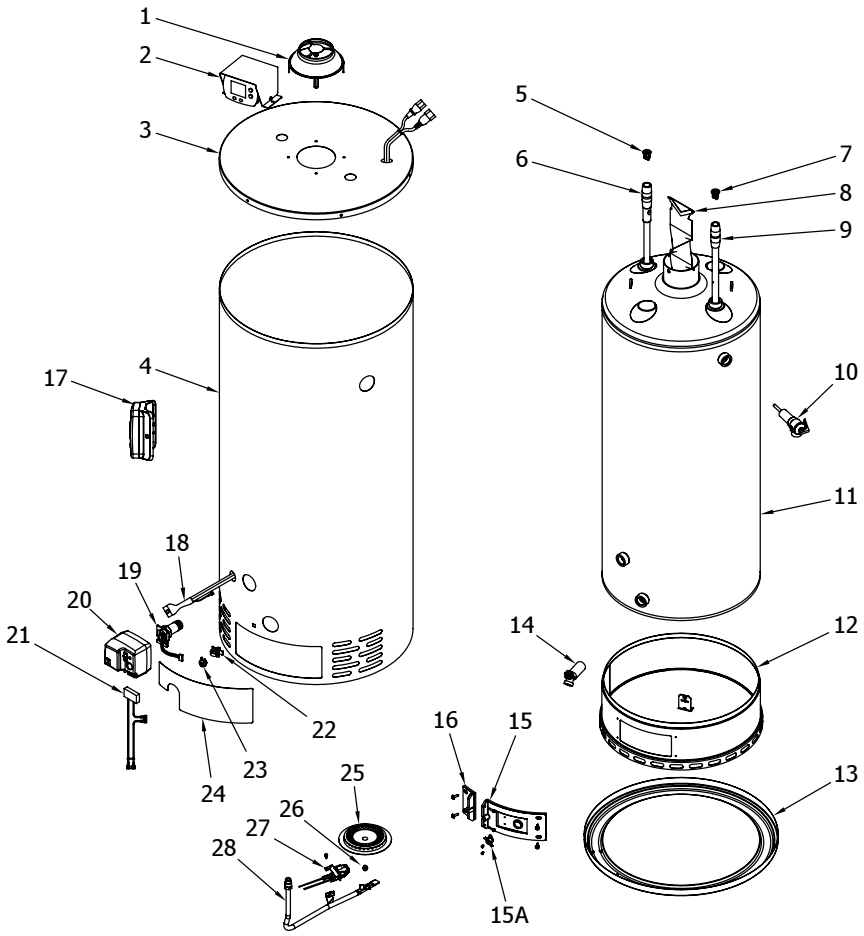
Step 8. Re-connect the wires removed in Step 5 to their proper locations.

Step 9. Re-install the Setback Control Junction Box Assembly cover and the (2) screws removed in Step 3.

Common Terms

BTU	British Thermal Units
ECO	Energy Cut Off
GPM	Gallons per Minute
Hz	Hertz
KWh	Kilowatts per hour
LED	Light Emitting Diode
NPT	National Pipe Thread
Ohms	Ohms of resistance
PSI	Pounds per Square Inch
RPM	Revolutions per Minute
VAC	Volts Alternating Current
W.C.	Inches of Water Column
°C	Degrees Centigrade
°F	Degrees Fahrenheit

NOTES



PART NAME AND DESCRIPTION	
1. Draft hood	15A. Resettable Thermal Switch
2. Setback Control Junction Box Assembly	16. Left side inner door
3. Jacket head	17. Accessory Module
4. Jacket	18. Junction box wire harness
5. Heat trap (outlet)	19. Thermal well
6. Anode Outlet Device	20. Gas control
7. Heat trap (inlet)	21. FV sensor / RTS wire harness
8. Baffle	22. FV sensor clip
9. Diptube	23. FV sensor
10. T&P valve	24. Outer door
11. Tank	25. Burner
12. Combustion chamber	26. Orifice
13. Pedestal base	27. Pilot assembly
14. Drain valve	28. Main burner feedline
15. Right side inner door	

BRADFORD WHITE®
WATER HEATERS
Ambler, PA

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BRADFORD WHITE-CANADA® INC.
Mississauga, ON

Sales/**866-690-0961**
905-238-0100

*Fax/**905-238-0105***

Technical Support/**800-334-3393**

Email
parts@bradfordwhite.com
techserv@bradfordwhite.com

www.bradfordwhite.com