

A.O. Smith
Water Heaters

SERVICE HANDBOOK

Master-Fit®

**Self Cleaning
Super-Small
Easy to Install**



MODELS COVERED

BTR Models 120 through 500

Series 100 through 111

Part No. 317917-000 • \$20.00 • Printed in the U.S.A. • 0305

BTR TANK TYPE HEATERS SERVICE HANDBOOK

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BTR SERVICE HANDBOOK INTRODUCTION

This service handbook is designed to aid in servicing and troubleshooting AOS BTR water heaters in the field. No duplication or reproduction of this book may be made without the express written authorization of the AOS Water Heater Company.

The following text and illustrations will provide you with a step by step procedure to verify proper installation, operation, and troubleshooting procedures. Additional quick reference data is included to assist you in servicing this product.

The information contained in this handbook is designed to answer common questions encountered in the operation of the BTR product line and is not meant to be all inclusive. If you are experiencing a problem not covered in this handbook, please contact the Technical Information Department at 1-800-527-1953 or your Local AOS Water Heater Sales Representative for further assistance. This handbook is intended for use by licensed plumbing professionals and reference should be made to the installation manual accompanying the product. This handbook contains supplemental information to the BTR installation and operation manual.

Rev. 4 – deleted redundant tests, corrected part numbers, new cover

BTR TANK TYPE HEATERS SERVICE HANDBOOK

Qualifications: Installation or service of this water heater requires ability equivalent to that of a licensed tradesman in the field involved. Plumbing, air supply, venting, gas supply and electrical testing skills are required.

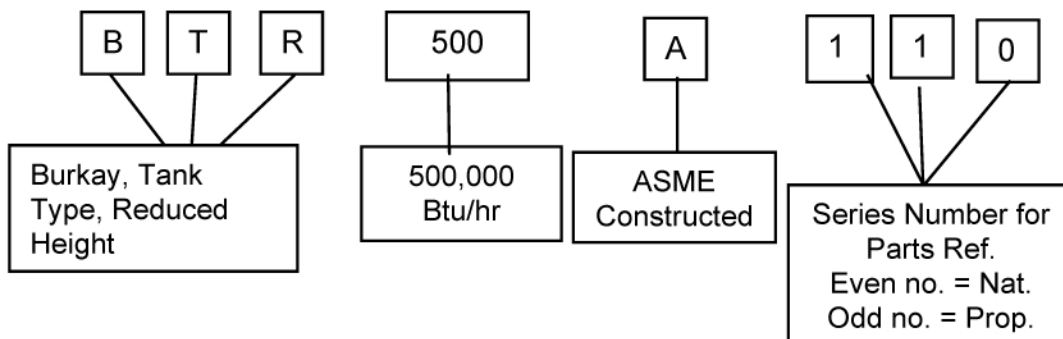
Tools Required:

- Phillips head screwdriver
- standard screwdrivers
- a 3/8 and 7/16 inch open end wrench
- set of marked drill bits
- an electrical multimeter tester capable of measuring continuity
- gas pressure gauge or manometer
- water pressure gauge
- thermometer
- 1/2 inch socket with extension for removal of the clean out cover,
- 1 1/16 inch socket with extension for anode removal.

CUSTOM COMMERCIAL STORAGE TANK MODEL NUMBER BREAKDOWN

Model Breakdown

BTR 500A 110

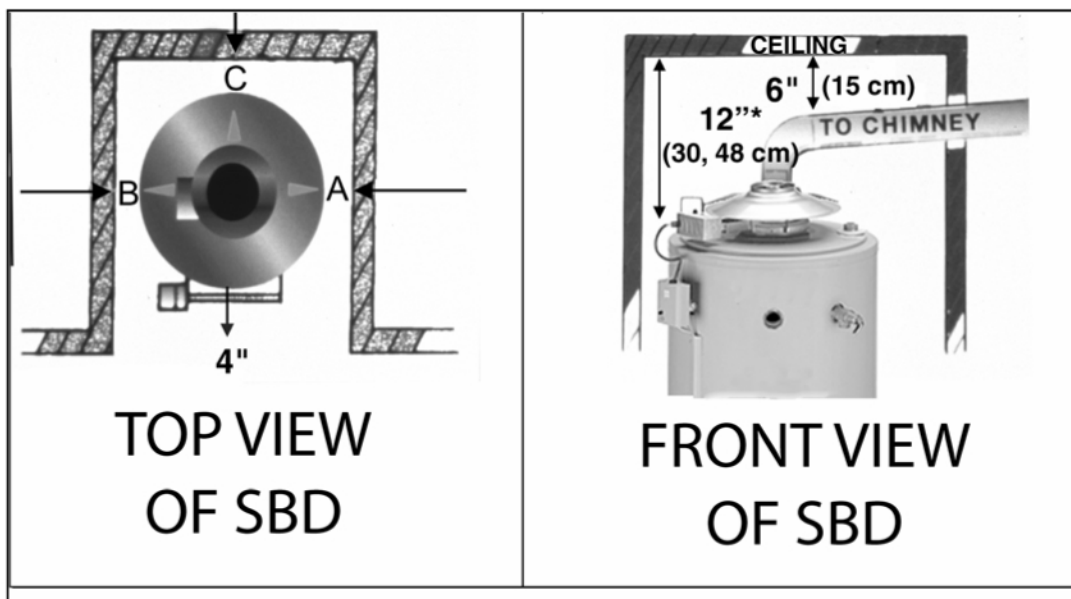


**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

INSTALLATION

This portion of the handbook will review some often overlooked installation considerations, taking note of necessary installation requirements for the BTR120 through BTR 500 model heaters. The installation manual covers most of these items in detail.

CLEARANCES FROM COMBUSTIBLES



Clearance to Combustibles Table

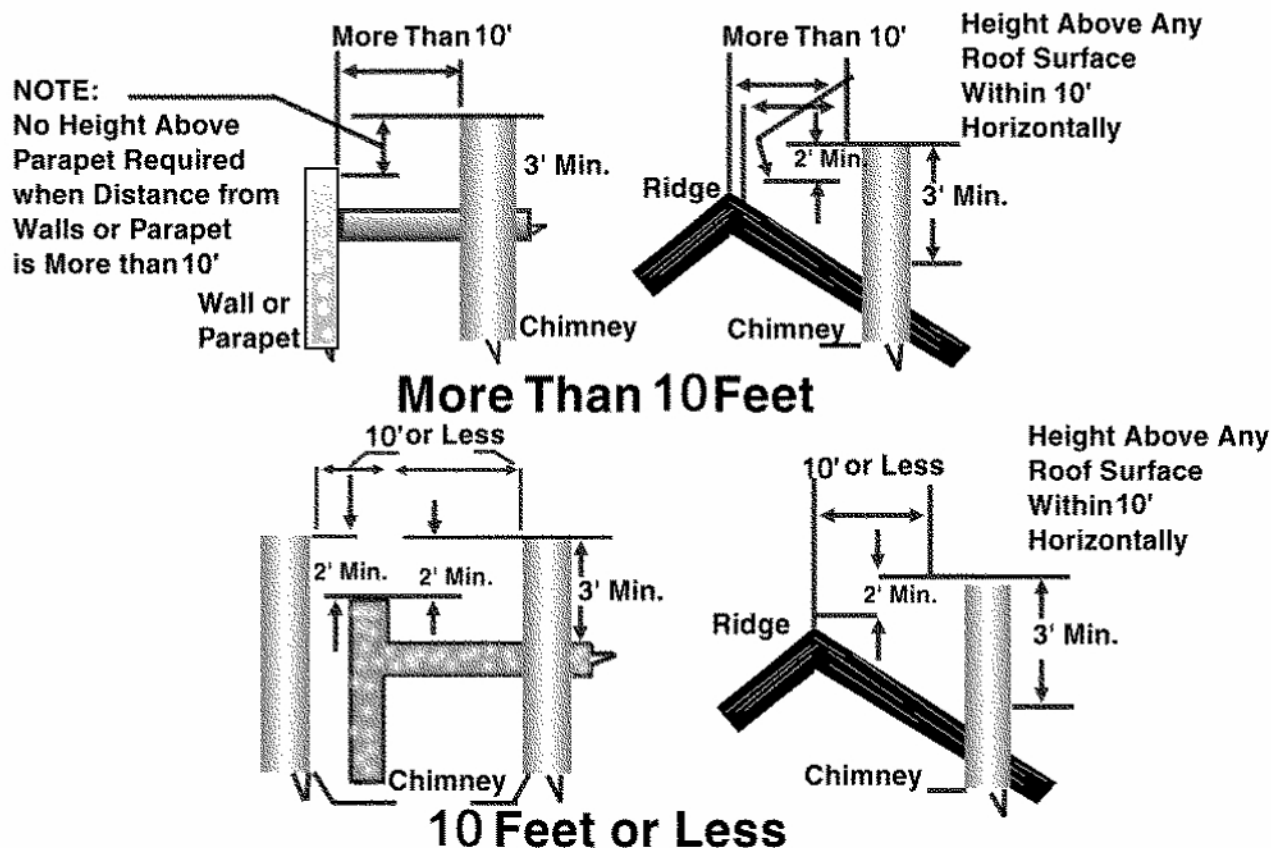
MODEL	A	B	C
120 - 200	1" (2.54CM)	1" (2.54CM)	1" (2.54CM)
250 - 305	2" (5.08CM)	2" (5.08CM)	2" (5.08CM)
365 - 400	3" (7.75CM)	3" (7.75CM)	3" (7.75CM)
500	5" (12.7CM)	5" (12.7CM)	5" (12.7CM)

A 24 inch clearance for all serviceable parts is recommended. Clearances may vary between BTR models – See instruction manual or the label on the heater, for clearances applicable to your specific model.

*20" (50.8CM) for 500 models.

EXTERIOR CLEARANCE

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

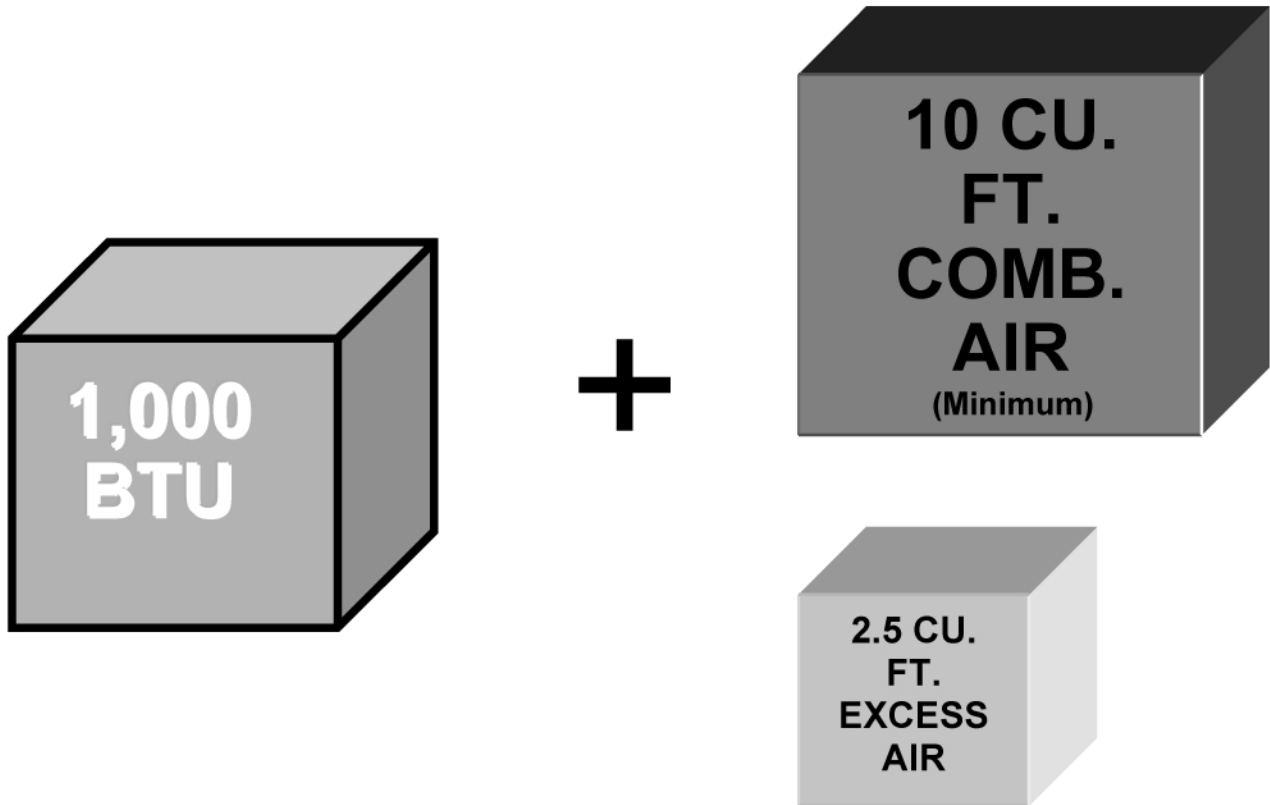


"Copyright by the American Gas Association. Used by permission of the copyright holder".

This illustrates the exterior roof clearances for BTR units with natural draft venting. The vent shall extend at least 3 feet above the highest point where it passes through a roof of a building, and at least 2 feet higher than any portion of a building within a horizontal distance of 10 feet (for vents of 12" in diameter or less). (NFPA 54 ANSI Z 223.1 may allow reduction to 8 feet with a "Listed vent cap").

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

**AIR FOR COMBUSTION
10 CUBIC FEET OF AIR PER 1,000 BTU**

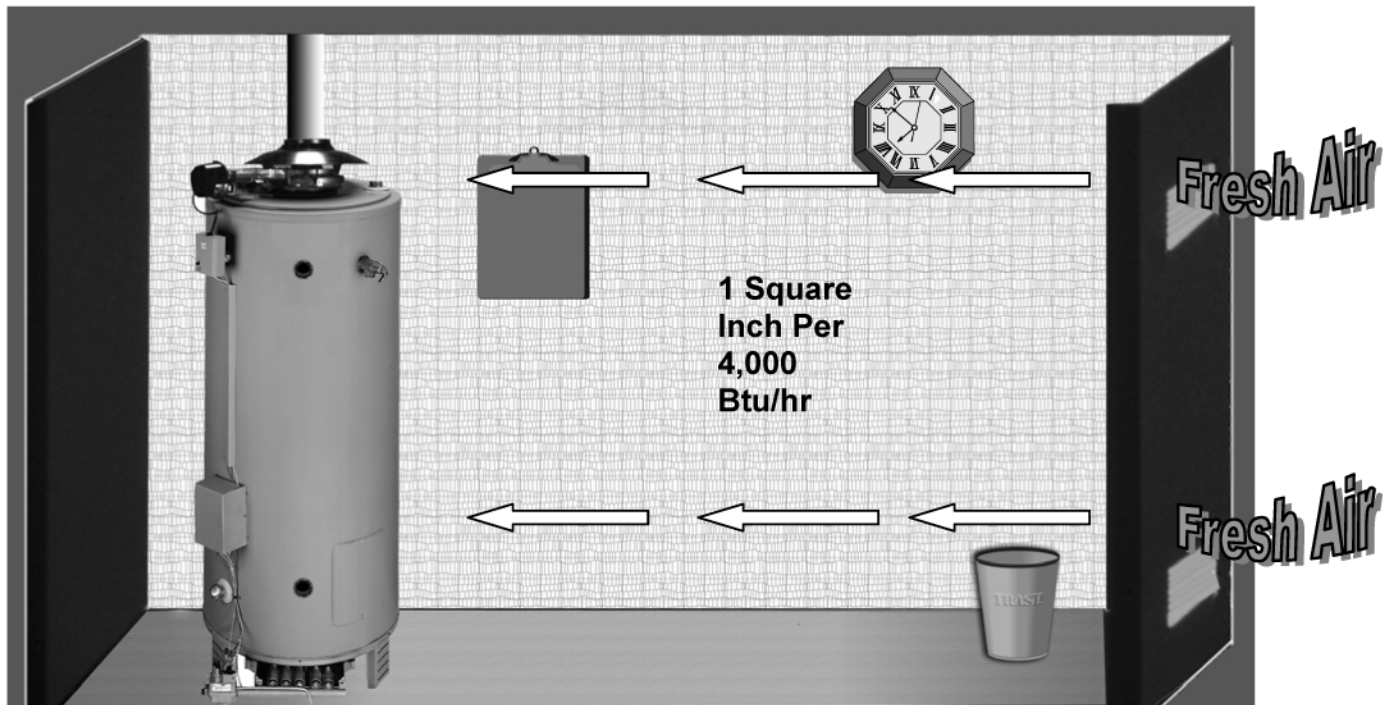


Stoichiometric or theoretical complete combustion requires 10 cubic feet of air per 1000 BTU/HR input of the gas input. The National Fuel Gas Code also recommends an additional 2.5 cu.ft. of "excess" air. This 12.5 cu.ft minimum supply air per 1000 Btu/hr input applies to natural and propane gas models.

The National Fuel Gas Code also specifies minimum make-up air opening sizes for various building installations. (Ref: NFPA 54, ANSI Z223.1, sec 5.3)

BTR TANK TYPE HEATERS SERVICE HANDBOOK

MAKE-UP AIR DIRECT COMMUNICATION



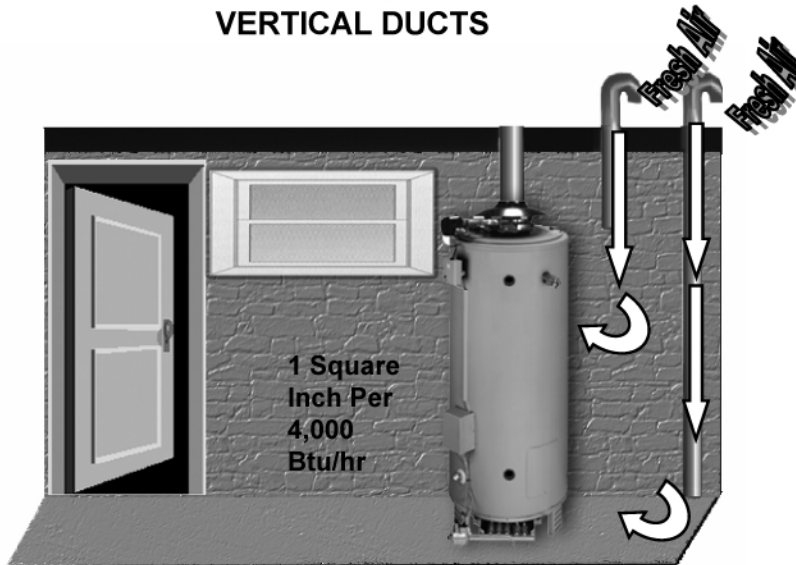
A fresh supply of make-up air for combustion can be supplied to the heater through make-up air ducts which directly communicate with the out of doors. Two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 Btu/hr of the total input of all appliances within the enclosure.

The lower opening is primarily providing combustion air. The upper opening is providing vent dilution air and acts as a relief opening for flue gases should the vent become obstructed or a downdraft condition occur. Additionally, when the heater is installed in a confined space, and communicating with the outdoor air, one permanent opening, commencing within 12 in. (30 cm) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 in. (2.5 cm) from the sides and back and 6 in. (16 cm) from the front of the appliance. The opening shall directly communicate with the outdoors and shall communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and shall have a minimum free area of:

- 1 sq. in. per 3000 Btu/hr (7 cm^2 per kW) of the total input of all equipment located in the enclosure, and
- Not less than the sum of the areas of all vent connectors in the confined space.

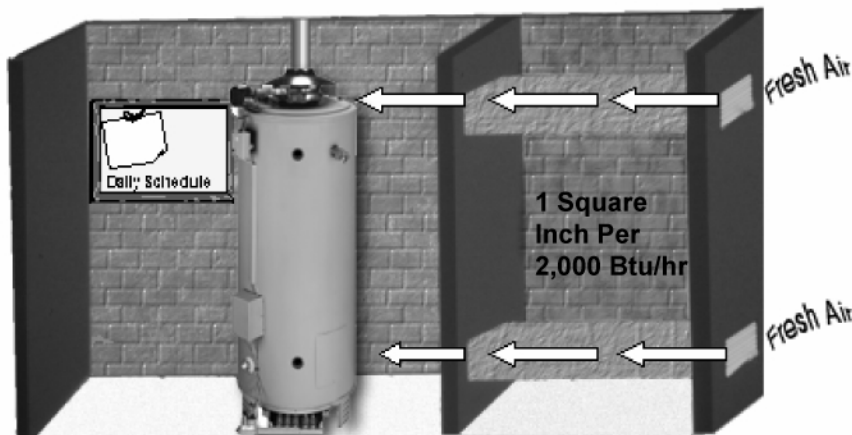
**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

**MAKE-UP AIR
VERTICAL DUCTS**



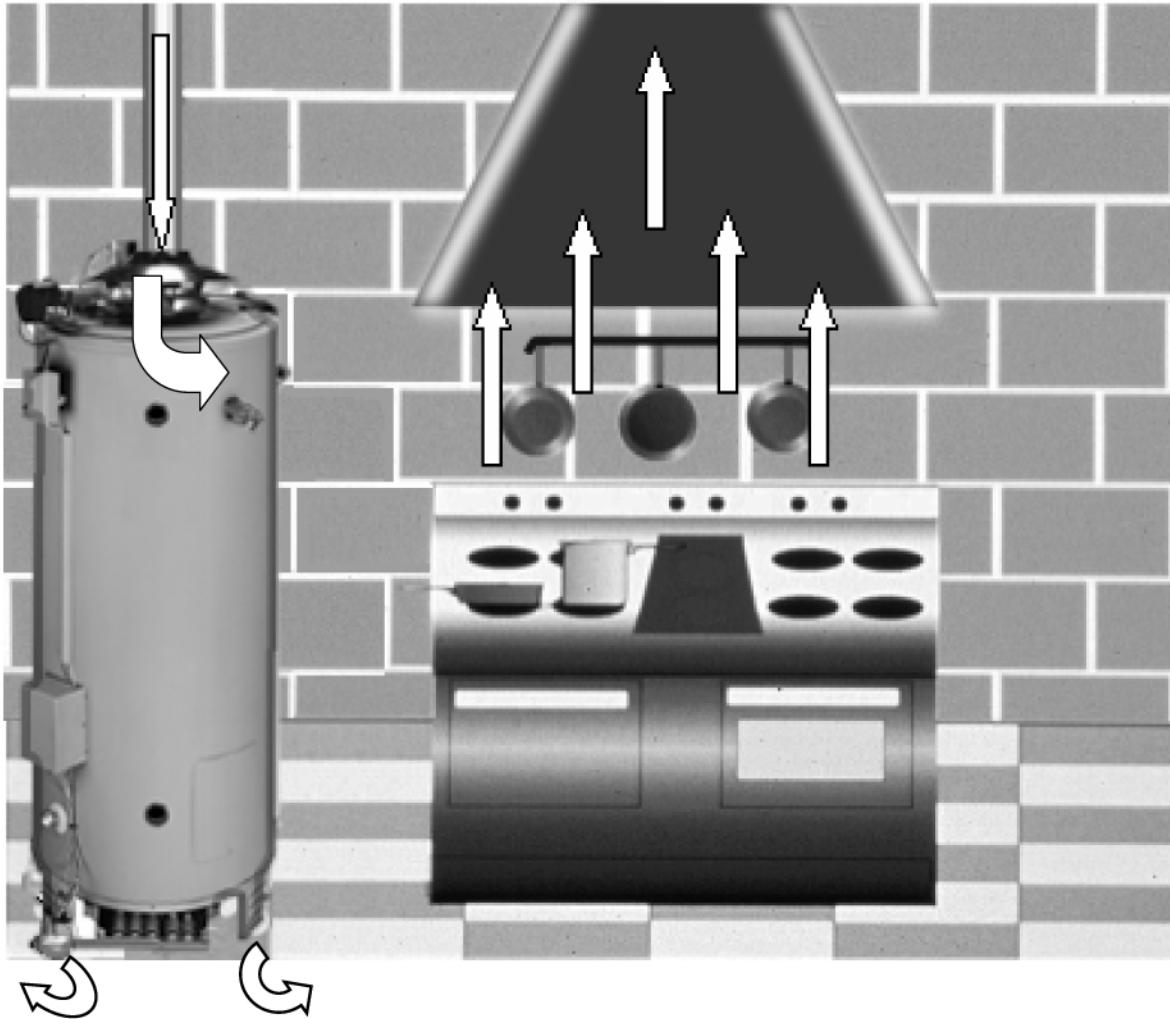
Often it is more practical to install vertical make-up air ducts to the out doors. Again, two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 4000 Btu/hr of the total input of all appliances within the enclosure.

**MAKE-UP AIR
HORIZONTAL DUCTS**



When the heater is installed in an interior room with no roof access for vertical ducts, horizontal make-up air ducts should be installed. When using horizontal ducts, two openings are required - one within 12 inches of the top of the enclosure and one within twelve inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 2000 Btu/hr of the total input of all appliances within the enclosure.

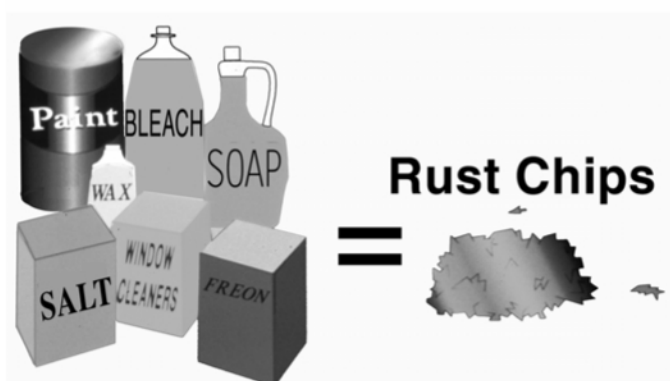
**INSUFFICIENT MAKE-UP AIR
BACKDRAFT**



Insufficient make-up air is a major cause of combustion problems. One common example is in a restaurant installation where exhaust vent equipment was not considered in sizing make-up air requirements. This may result in air being back drafted by the restaurant exhaust equipment through the heater causing flue gas spillage, flame roll out, improper combustion, inconsistent pilot operation, and/or erratic heater shut down.

BTR TANK TYPE HEATERS SERVICE HANDBOOK

CONTAMINATED AIR



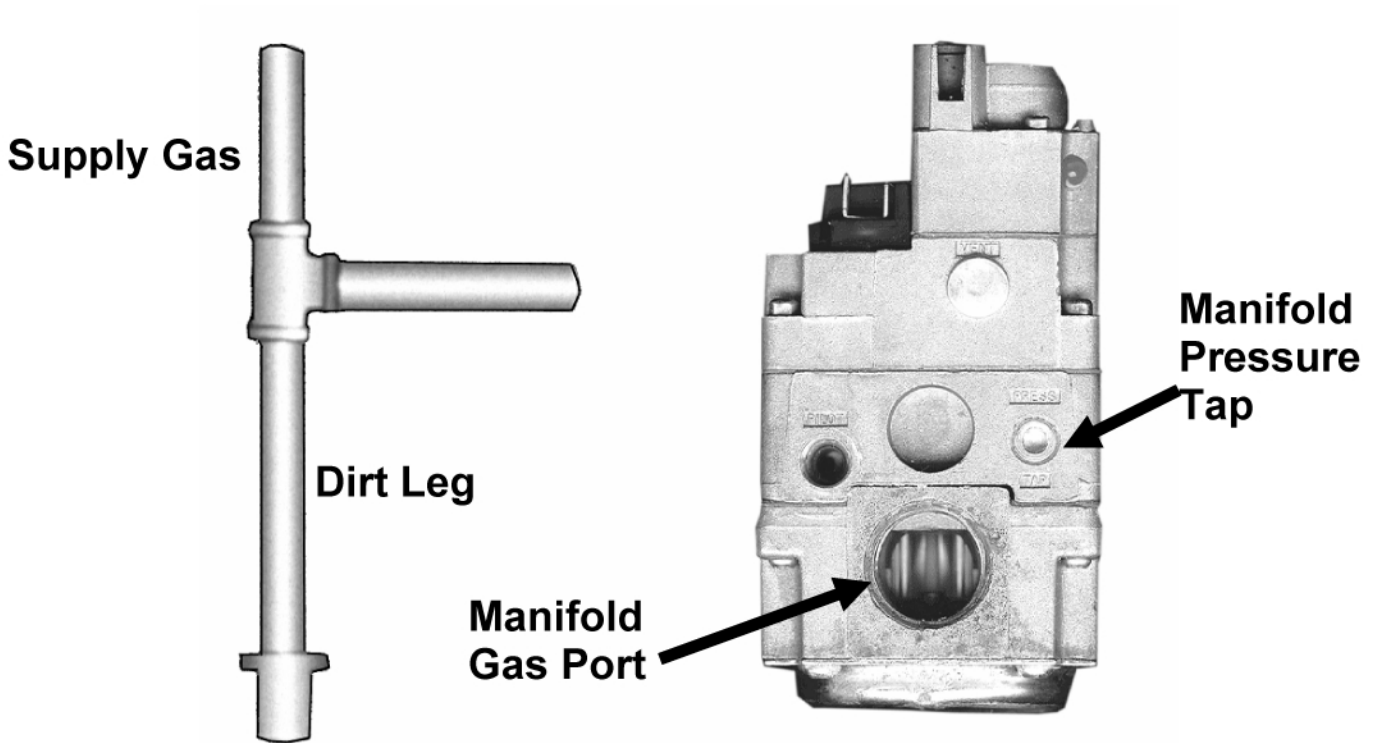
Along with adequate make-up air, the quality of the air is important. Contaminants in combustion air can lead to premature heater failure. Vapors from bleaches, soaps, waxes, salts, etc. are drawn into the combustion chamber with the make-up air and, once fired, mix with water vapor in the gases to form extremely corrosive hydrochloric or hydrofluoric acid and other corrosive byproducts.

AIR FOR COMBUSTION Flammable Items



Flammable items, pressurized containers or any other potentially hazardous articles must never be placed on or adjacent to the heater. Open containers of flammable material should not be stored or used in the same room with the heater.

GAS PRESSURE REQUIREMENTS



	Natural Gas	Propane Gas
Maximum Supply Pressure	10.5" W.C.	13.8" W.C.
Minimum Supply Pressure	5.0" W.C.	11" W.C.
Manifold Pressure	4.0 " W.C.	10" W.C.

The supply gas pressure is normally measured at the dirt leg or at the gas pressure tapping on the gas supply shutoff valve. This reading must be measured with 'flowing' gas.

The manifold gas pressure is measured at the manifold pressure tap of the gas valve when the gas is flowing.

BTR TANK TYPE HEATERS SERVICE HANDBOOK

BTR GAS VALVE

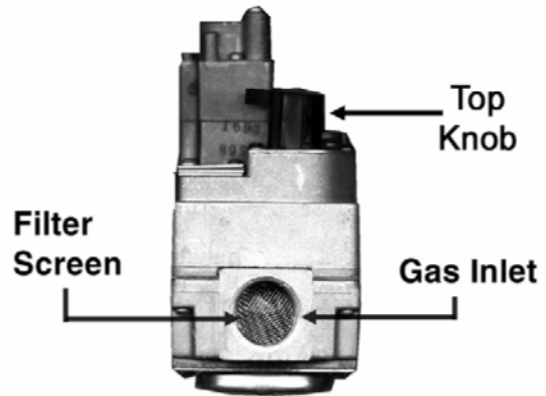
The gas valves used on all BTR water heaters are 24 volt AC combination step opening gas valves. They incorporate the pilot valve, main valve, and gas pressure regulators into one body. The inlet view of the valve features a filter screen and the top knob. The top knob is a manual on/off gas control for both the pilot and main gas valves. When the top knob is placed on the black mark, gas is supplied only to the pilot valve.

On the top view, we see the pilot solenoid and pilot and main gas regulators. The top view also displays the "TH and "TR" terminals. The pilot gas regulator is found under its cover screw. It is factory preset at 3.5" W.C. but can be adjusted from 2.5 to 5 inches water column. The main gas regulator is found under its cover screw. It is factory preset to 3.5 inches W.C. and adjusts gas pressure output from 2.5 to 5 inches water column. The two electrical terminals are marked TH and TR. The TH terminal is the common between the pilot valve solenoid coil and the main valve solenoid coil. The other wire emerging from the pilot solenoid connects to the pilot valve electrical output on the IID terminal PV. The TR terminal connects directly to the main valve electrical output from the IID module terminal MV.

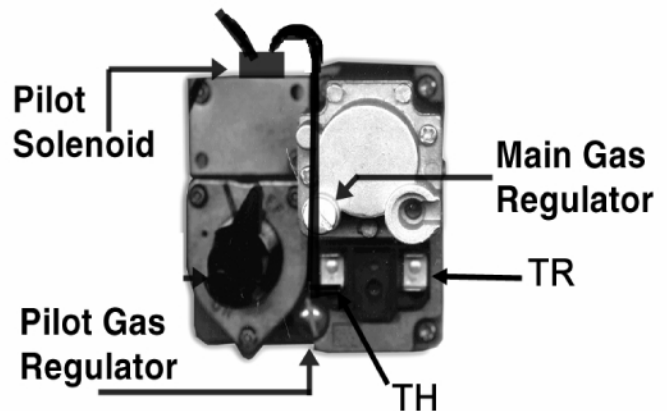
On the outlet view of the gas valve, we see the pilot gas connection port, manifold gas connection port, a limited bleed vent port, the manifold gas and pressure tap.

See step 18 for BTR-500 gas valve illustration

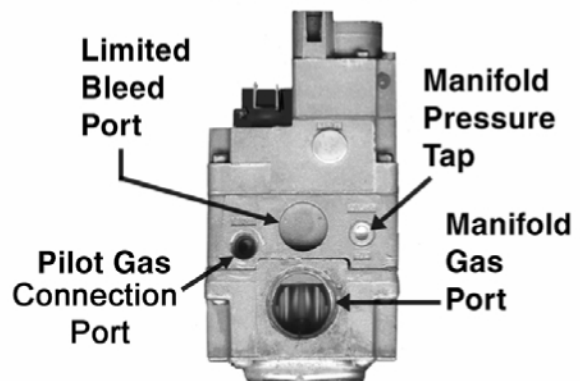
INLET VIEW



TOP VIEW



OUTLET VIEW



**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

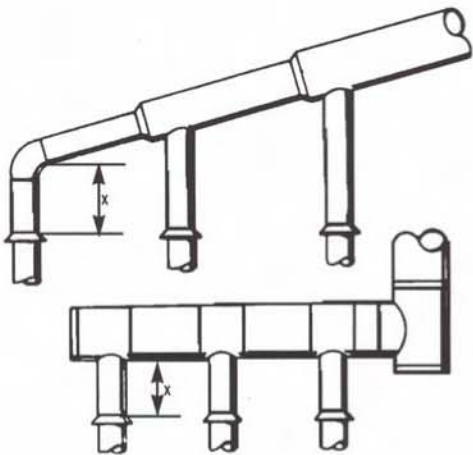
**VENTING
Atmospheric, Single, and Multiple Heaters**

All BTR water heaters are classified by ANSI as category I (non-condensing, negative pressure venting) appliances. They are approved for type B vent.

For larger applications, BTR water heaters can be common vented together either in a tapered manifold or constant size manifold. (Follow National Fuel Gas Code requirements for sizing and installation.)

Combined Vents

When vents are combined, the area of the combined vent should be equal to area of the largest single vent, plus 50% of area of all others joining.



EXAMPLE: To combine two 6" vents with an 8" vent, the area of a combined vent should be one half area of two 6 inch vents (14 + 14) plus area of 8 inch vent (50) or 78 sq. inches. Referring to chart, 78 sq. inches require 10" diameter vent.

Vent Size	Area in Square Inches	Vent Size	Area in Square Inches
5"	20	10"	79
6"	28	12"	113
7"	38	14"	154
8"	50	16"	201
9"	64	18"	254

Nine Rules for Good Vents

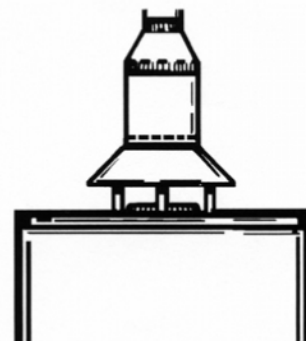
1. The vent pipe should ALWAYS be the same size as the outlet of the draft diverter or factory supplied vent reducer.
 - Model BTR 120 are supplied with a 6" to 5" reducer.
 - Models BTR 250, 251 and 275 are supplied with a 8" to 6" reducer.



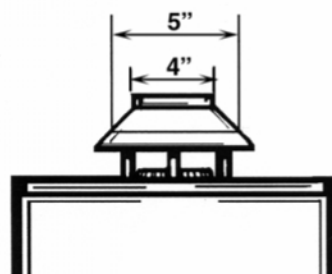
BTR TANK TYPE HEATERS SERVICE HANDBOOK

Nine Rules for Good Vents (continued)

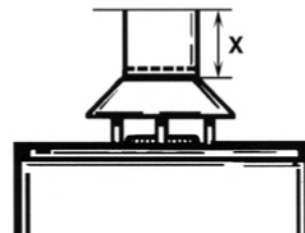
2. The diameter of a vent pipe should NEVER be reduced, no matter what the circumstances.



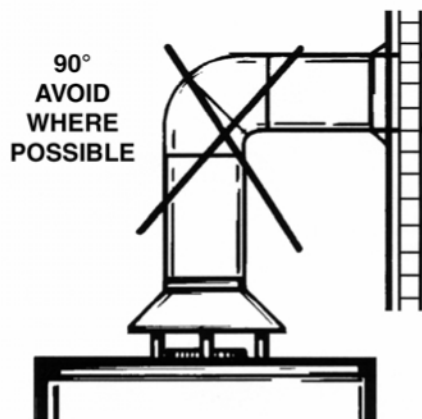
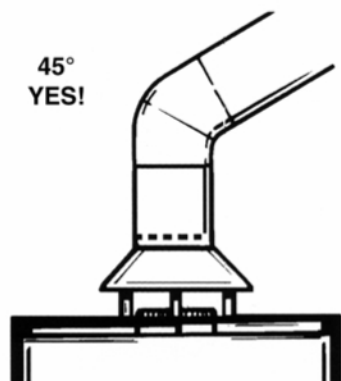
3. In some cases it may be necessary to run a vent larger than the draft diverter outlet.



4. Take the maximum vertical rise possible immediately above the draft diverter.



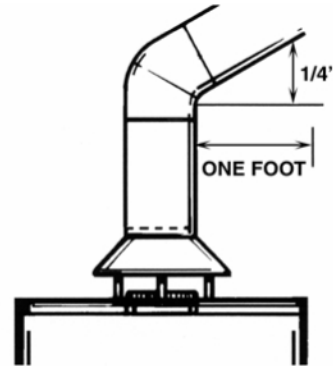
5.



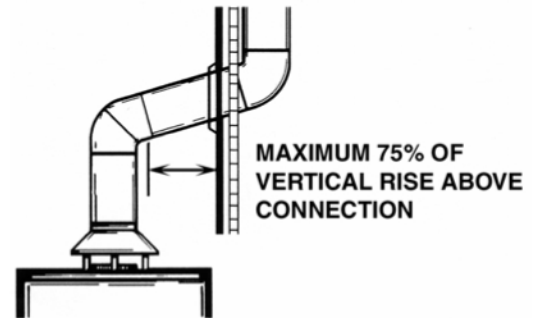
BTR TANK TYPE HEATERS SERVICE HANDBOOK

Nine Rules for Good Vents (continued)

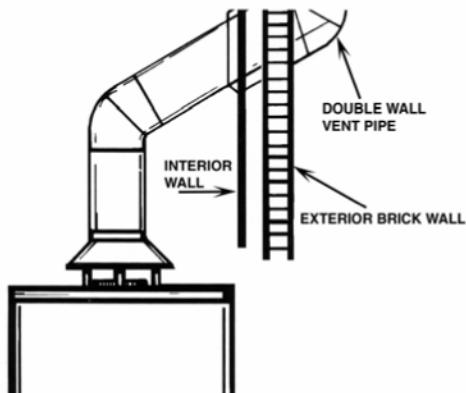
6. Horizontal pipe should be sloped upward at a minimum of $\frac{1}{4}$ " per foot.



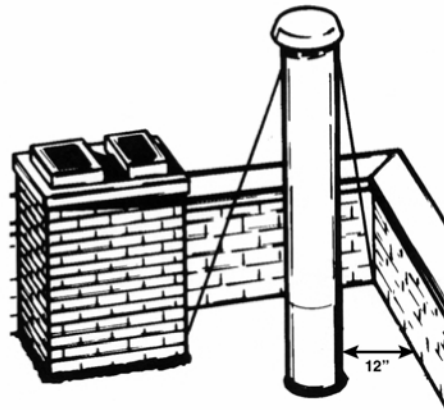
7. Horizontal elements should be limited to 75% of the vertical rise of the vent above the connection.



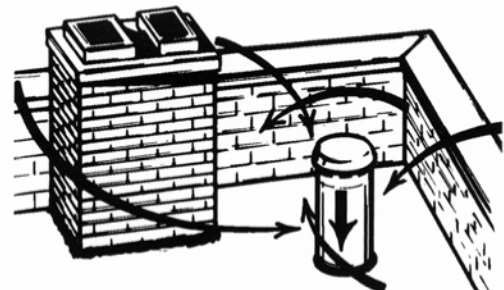
8. Flue gases must be kept hot for proper venting.



The vent pipe should be extended to meet local codes

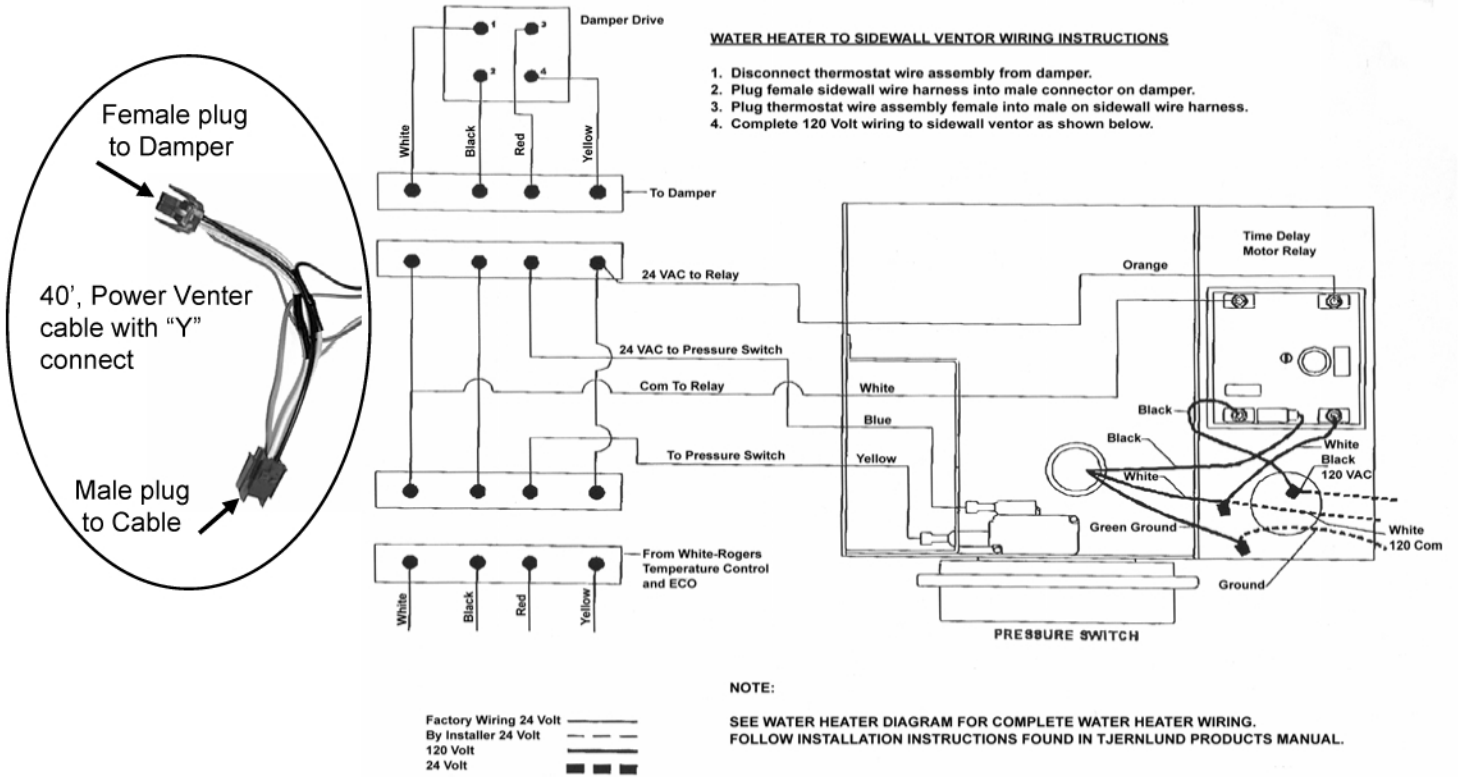


9. Obstructions can cause down drafts.

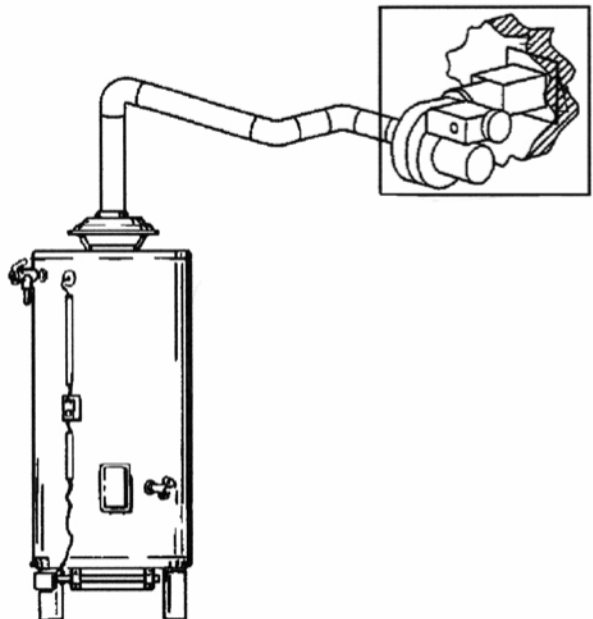


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POWER VENT KITS FOR SIDEWALL VENTING

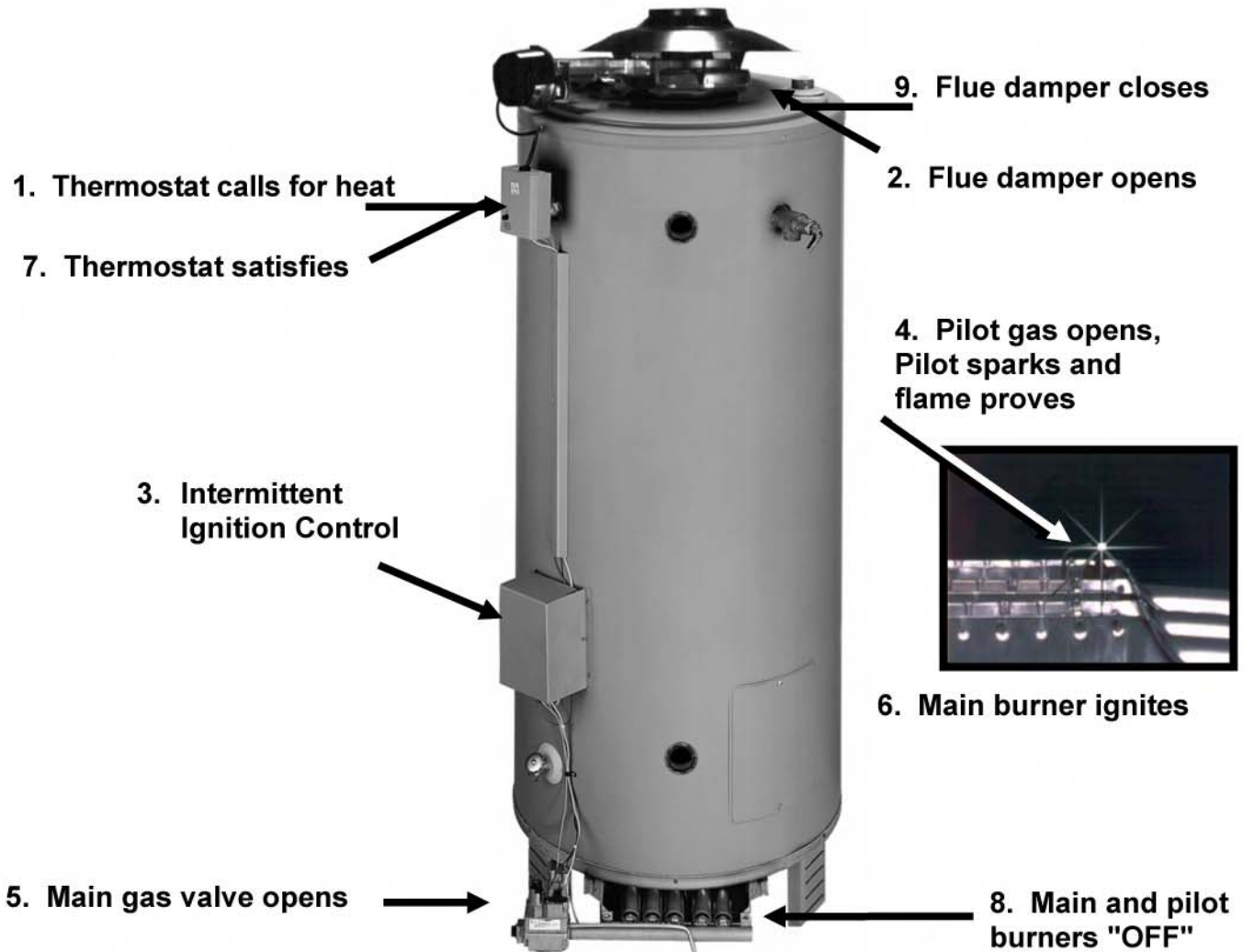


BTR water heaters can be used with power vent kits for sidewall venting. AOS offers power vent kits for use on installations with a maximum of 100 equivalent feet of vent piping. The power vent kits also use type B vent materials. When power venting, specific exterior clearances must be maintained as outlined in the National Fuel Gas Code. (NFPA 54, ANSI A223.1, sec 7.8)



**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

BTR SEQUENCE OF OPERATION



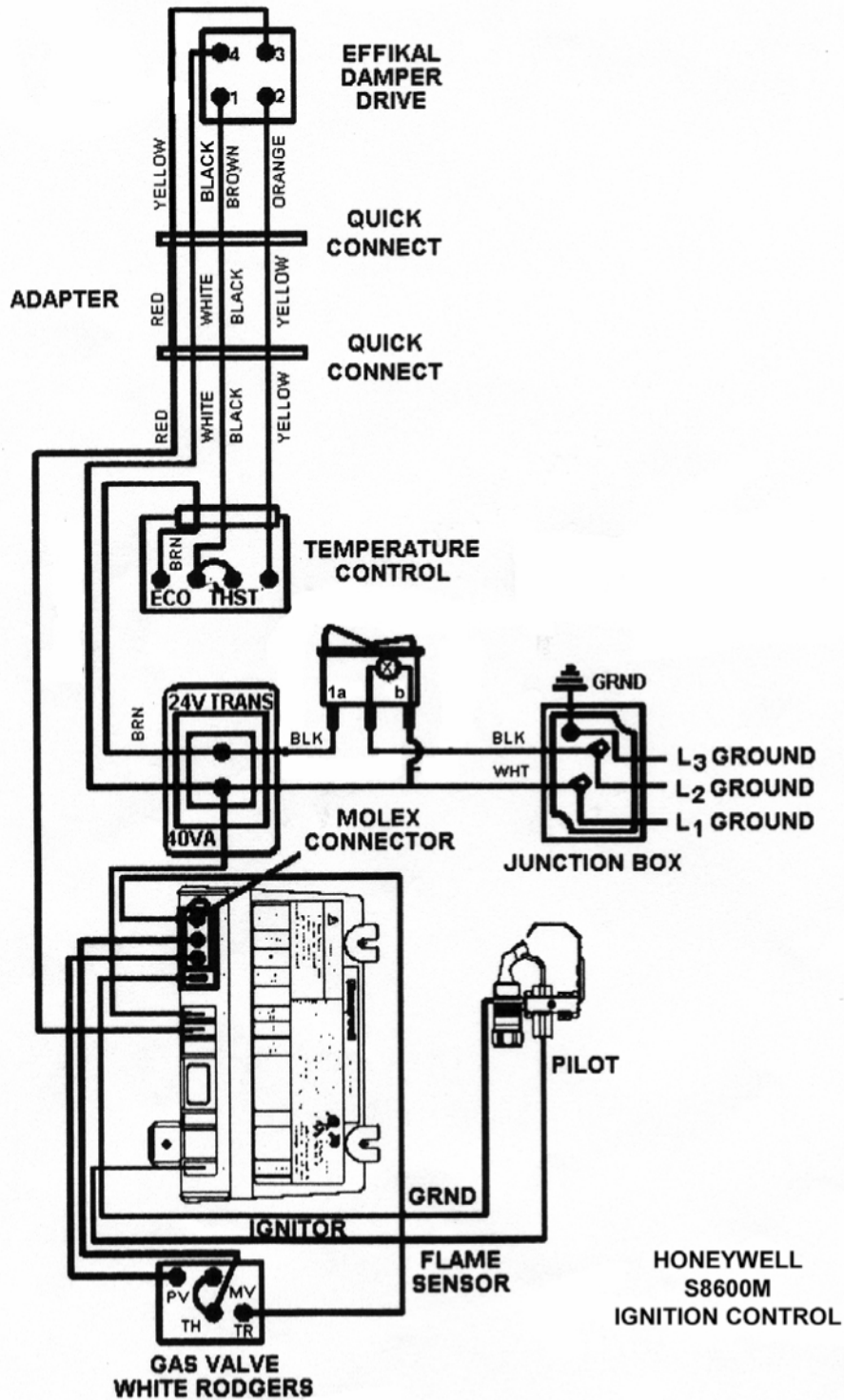
SEQUENCE OF OPERATION

To understand BTR tank type water heaters, an examination of their sequence of operation is necessary.

When the thermostat calls for heat, the relay in the draft hood assembly activates the flue damper motor. The damper opens and power flows to the IID (Intermittent Ignition Device). This activates the IID module to open the pilot valve and begin sparking at the pilot burner assembly. Once the pilot flame is established and confirmed back to the IID, the sparking is stopped and the main gas valve is opened, allowing gas flow to the main burner. When the thermostat satisfies, main and pilot gas is shut off. Damper is returned to closed position.

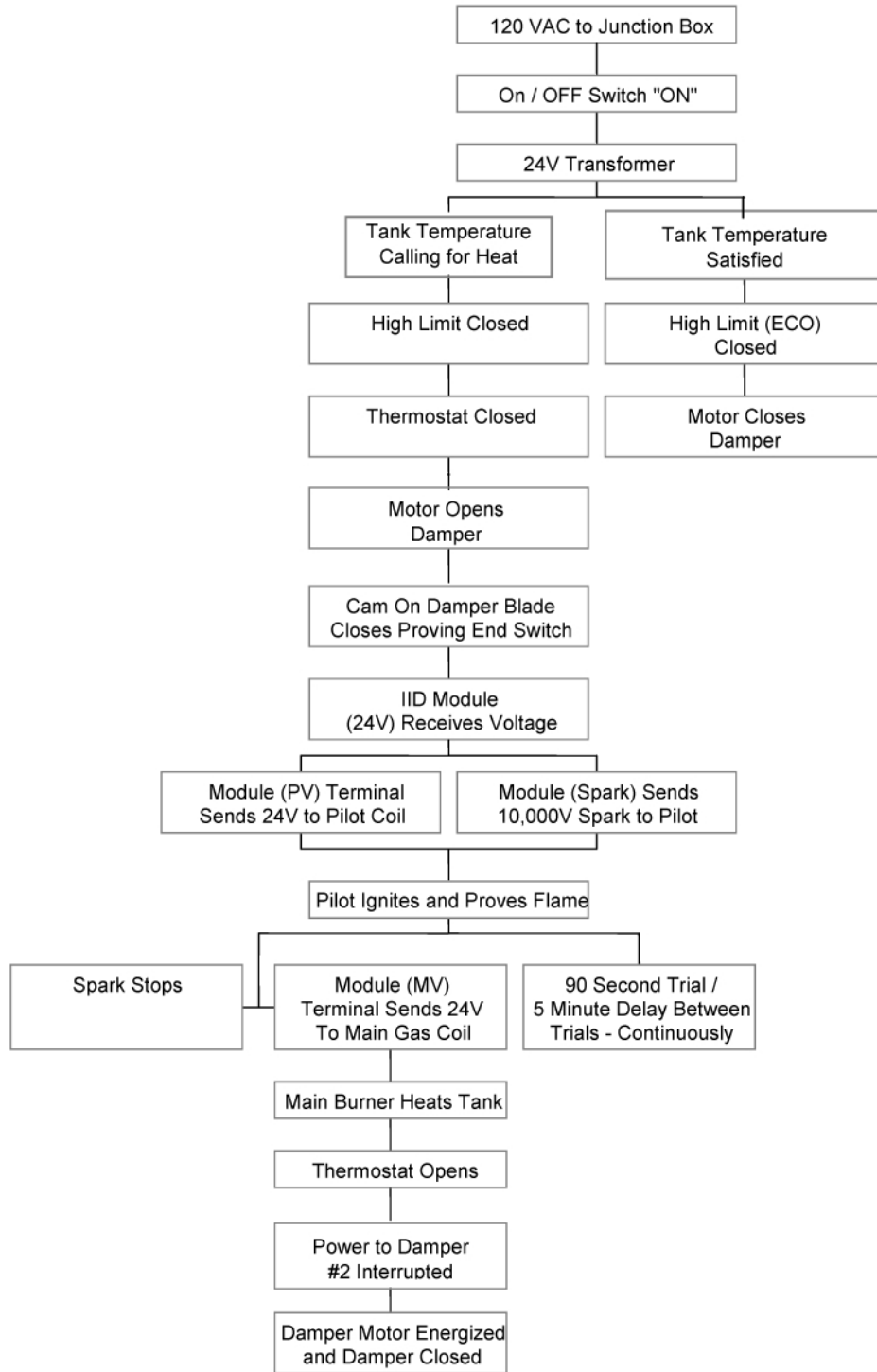
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SERVICE HANDBOOK**

**BTR ELECTRICAL SEQUENCE
110 – 111 Series**



**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

**SBD ELECTRICAL SEQUENCE OF OPERATION
115/60/12A**



**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

TROUBLESHOOTING BTR WATER HEATERS

To troubleshoot a BTR water heater check that:

- 120 VAC is supplied to the heater
- the tank is full of water
- gas is supplied to the unit

STEP 1

TEST THE TRANSFORMER



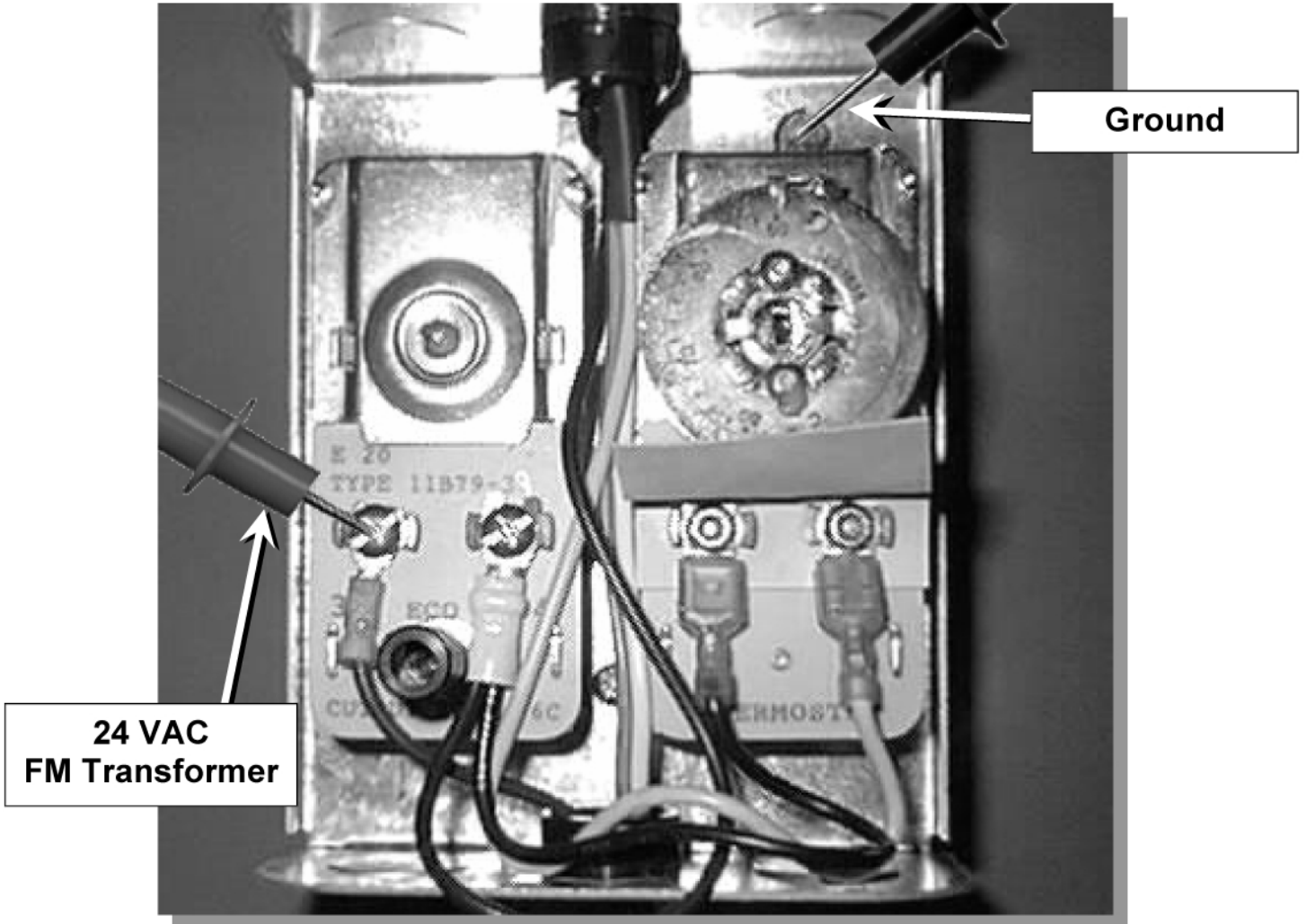
STEP 1 - TO TEST THE TRANSFORMER - Using a multimeter, test for 24 VAC between the secondary transformer terminals.

IF	THEN
The meter does not read 24 VAC:	<ul style="list-style-type: none">• Check that the 120 VAC is supplied from the On/Off Switch – if not, replace switch.• Check that the 120 VAC is supplied from transformer.
The meter reads 24 VAC:	<ul style="list-style-type: none">• Go to step 2.

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SERVICE HANDBOOK

STEP 2

HIGH LIMIT, LEFT TERMINAL TEST



STEP 2. HIGH LIMIT, LEFT TERMINAL TEST. Test for 24 VAC between the left high limit terminal and ground.

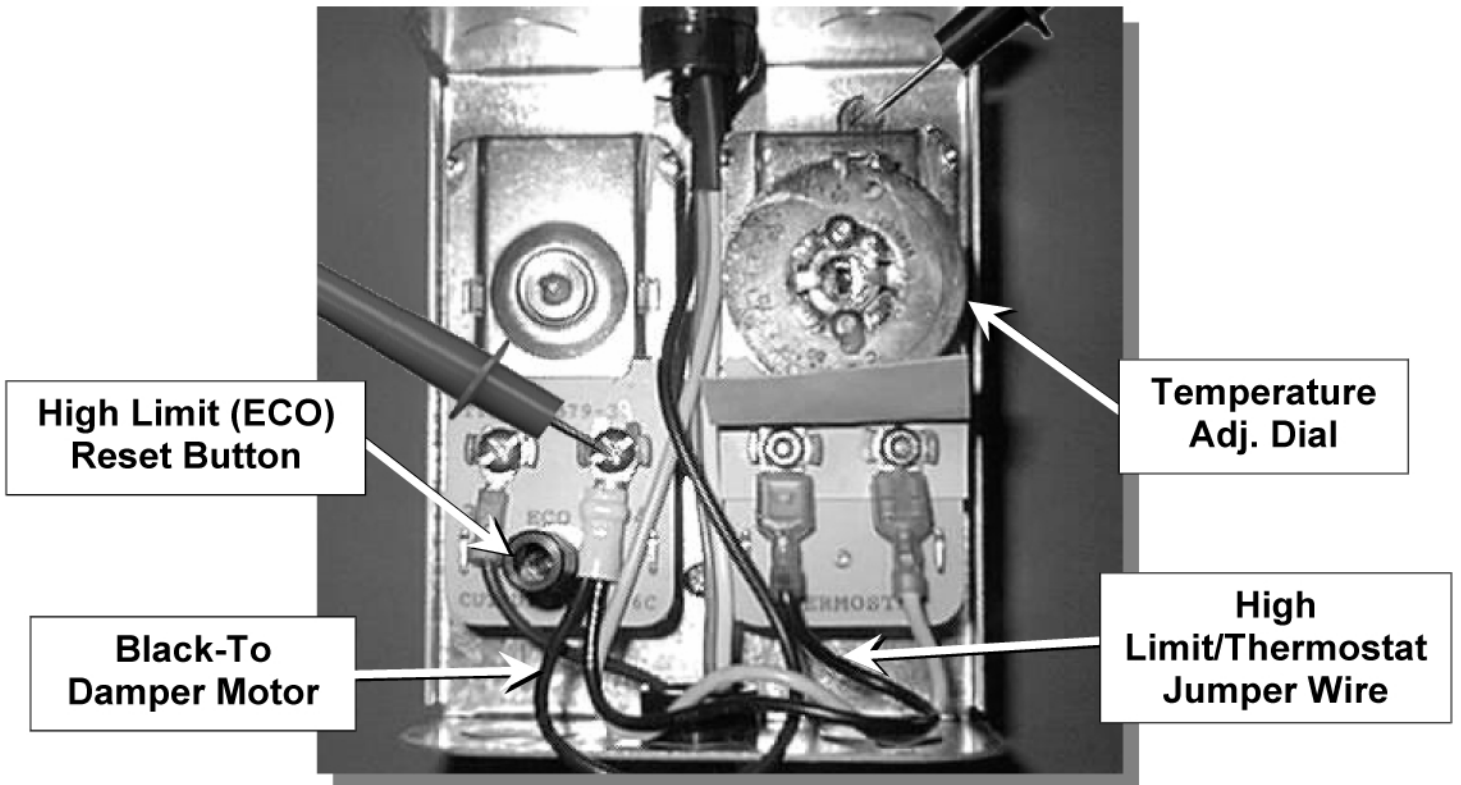
IF	THEN
The meter does not read 24 VAC:	<ul style="list-style-type: none">• Check wiring between transformer and high limit.
The meter reads 24 VAC:	<ul style="list-style-type: none">• Go to Step 3.

Note: The high limit (Energy Cut Off) opens if the tank water temperature exceeds 205 degrees. The control is resettable (manually) when the tank water temperature drops below 185 degrees.

**BTR TANK TYPE HEATERS
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STEP 3

TEST HIGH LIMIT RIGHT TERMINAL



STEP 3. TO TEST HIGH LIMIT RIGHT TERMINAL. Ensure that the jumper wire between the high limit and thermostat is connected, and the damper motor power line is connected. Test for 24 VAC between the high limit right terminal and ground.

IF	THEN
The meter does not read 24 VAC:	<ul style="list-style-type: none"> • Push the reset button and redo the test (storage water temperature below 185 degrees).
The meter reads 24 VAC:	<ul style="list-style-type: none"> • Go to step 4.

After Push in Reset - 24 VAC is now present

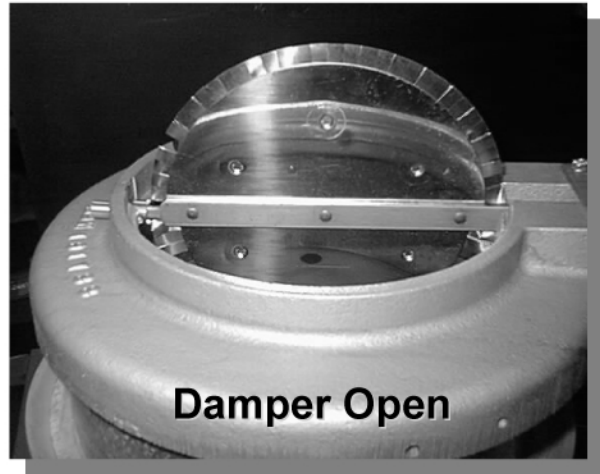
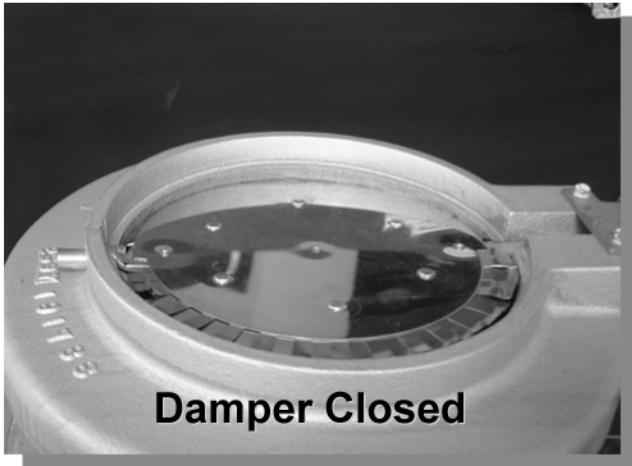
Reasons For Resetting		
Condition	Cause	Solution
High limit open	Never set on initial installation	Push high limit button
Excessive water temperature	Faulty thermostat	Replace dual control
Heater shut down before reaching thermostat setting	Faulty high limit	Replace dual control

Note: The right terminal of the high limit has a jumper wire connected to the left terminal of the thermostat. There is also a black wire connecting to the damper (brown) PC board. This black wire supplies power to the motor to close the damper during periods of standby.

**BTR TANK TYPE HEATERS
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STEP 4

INSPECT THE DAMPER



STEP 4. INSPECT THE DAMPER. Lower the thermostat setting so the unit will not be calling for heat, then inspect the damper.

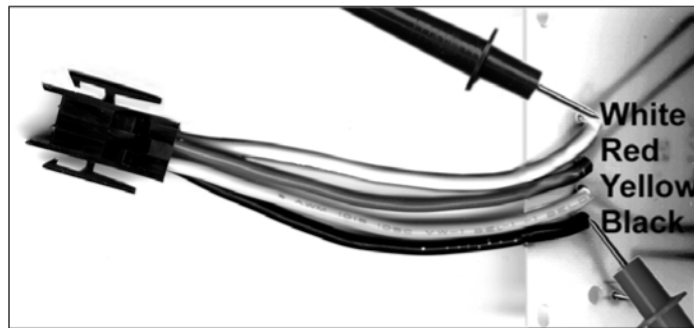
IF	THEN
If the damper is open:	<ul style="list-style-type: none"> • Verify that the Service Switch is in the "automatic" position • Go to step 5.
If the damper is closed:	<ul style="list-style-type: none"> • Go to step 7.

Note: If the water temperature in the tank is below 120 degrees F, temporarily disconnect the jumper wire between the high limit and thermostat to simulate a satisfied thermostat.

STEP 5

CHECK THE PC BOARD

*See page 25
for wire colors*



STEP 5. CHECK THE PC BOARD. Test for 24 VAC between the brown PC board wire connection and neutral (black).

IF	THEN
24 VAC is not present:	<ul style="list-style-type: none"> • Check the black wire connections between PC Board and high limit.
24 VAC is present:	<ul style="list-style-type: none"> • Replace Damper Drive

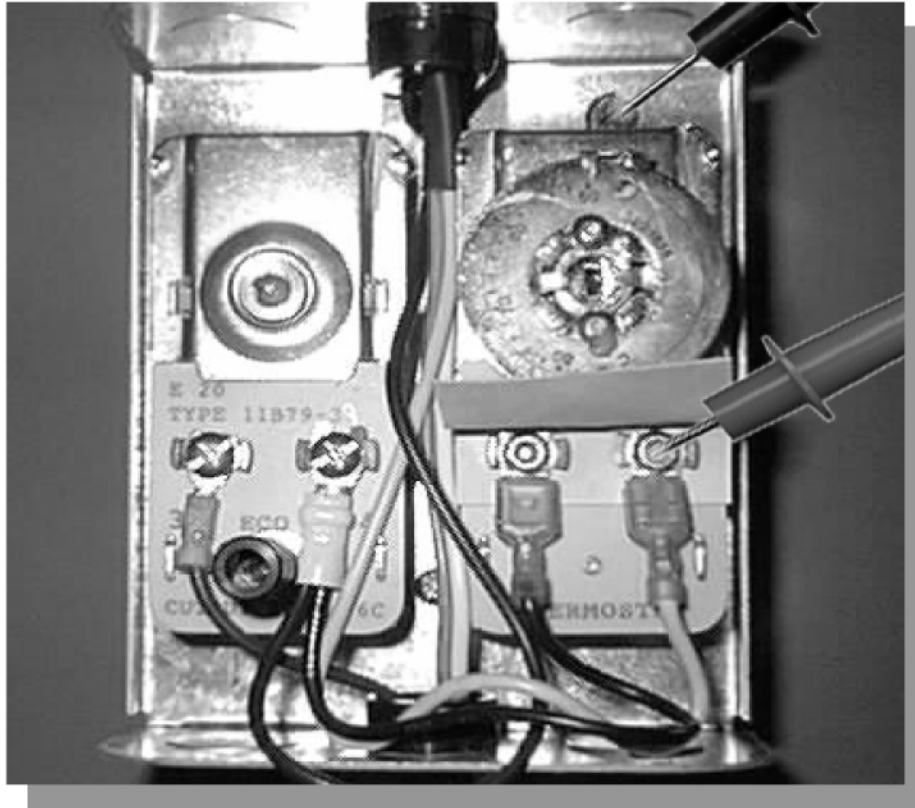
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Note: The service switch may be used to bypass the damper, while waiting for a replacement part.

WARNING - In the event of damper motor failure, verify that the damper is in the "open" position before utilizing the service switch

STEP 6

THERMOSTAT TEST



STEP 6. THERMOSTAT TEST. Set the thermostat to call for heat. Using your multimeter, test for 24 VAC between right terminal and ground.

IF	THEN
The meter does not read 24 VAC and the jumper wire between the high limit and the thermostat is in place:	<ul style="list-style-type: none">• Replace the thermostat
The meter reads 24 VAC:	<ul style="list-style-type: none">• Go to step 7.

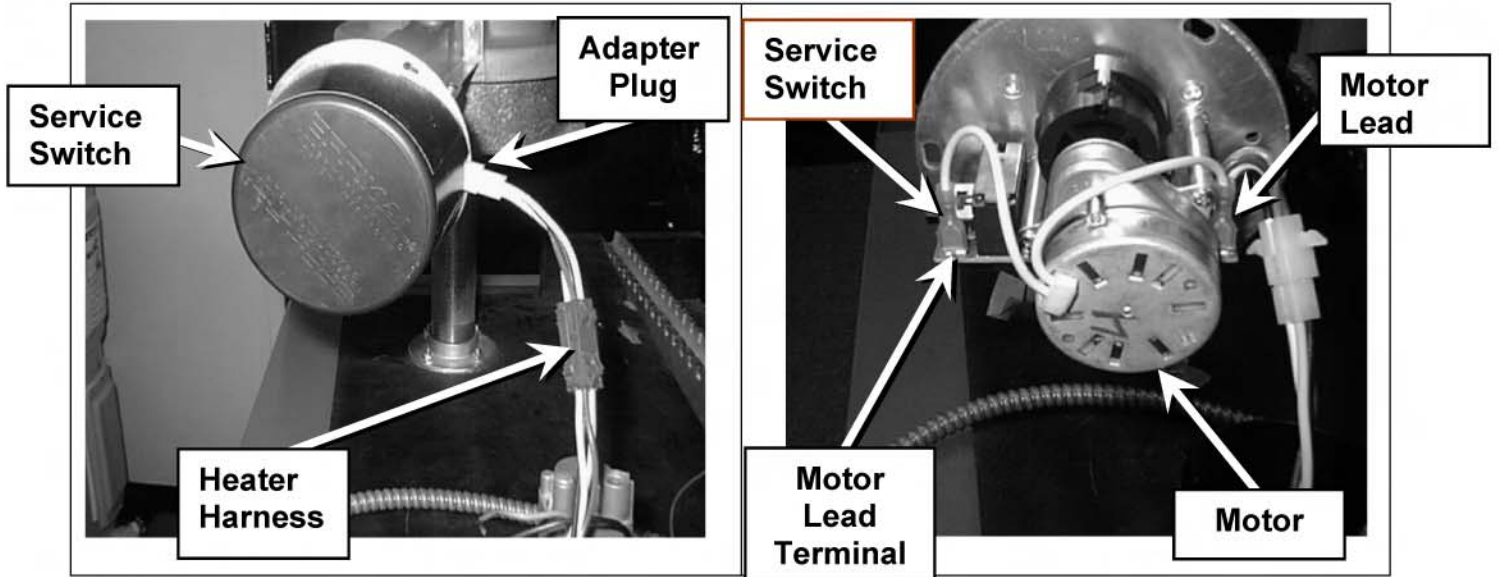
Note: If the high limit to thermostat jumper wire was disconnected earlier to simulate a satisfied thermostat, reconnect the jumper to the terminals.

Note: A yellow wire from this thermostat terminal connects to the damper PC board orange wire.

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

EFFIKAL DAMPER

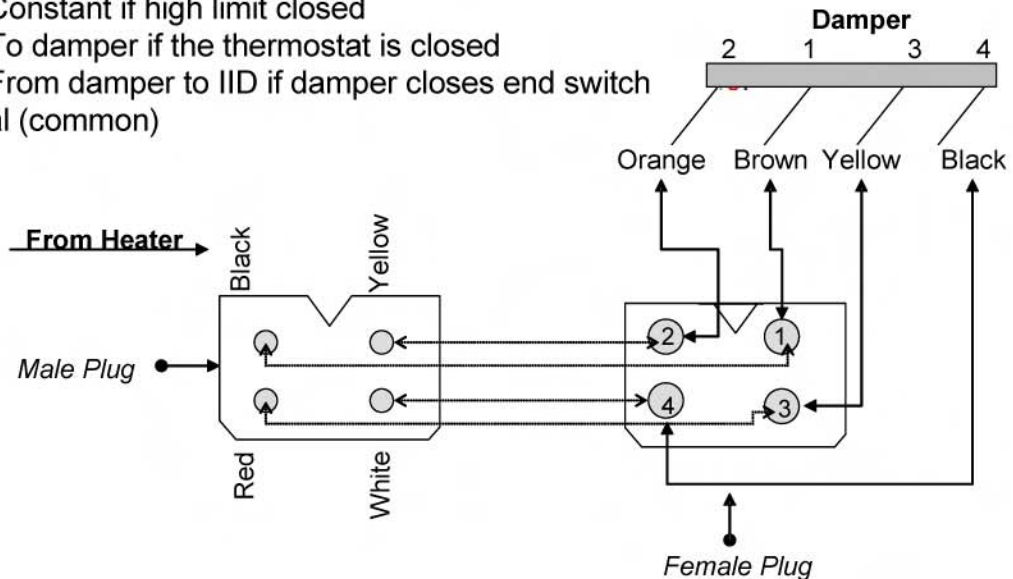
The wiring colors from the damper PC Board are different colors than the wires on the heater wiring harness. The male/female plugs to connect the damper board to the heater harness join in only one way.



Control Cover (Photo of kit mounting)

The heater harness wires still serve the same function:

- Black – 24V Constant if high limit closed
- Yellow – 24V To damper if the thermostat is closed
- Red – 24V From damper to IID if damper closes end switch
- White – Neutral (common)



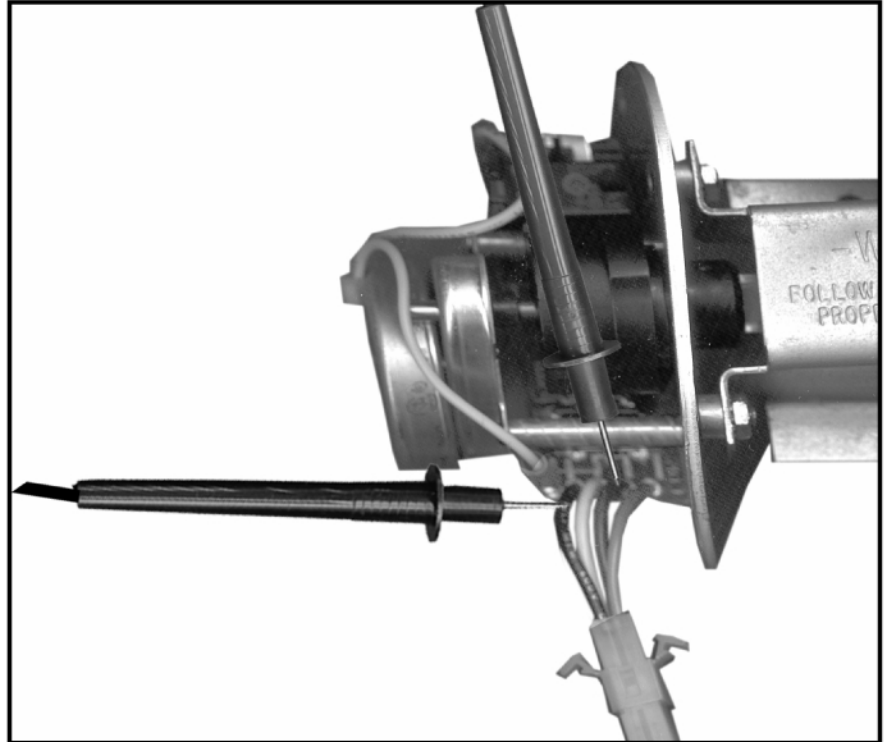
**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

HARNES CHART

Heater Harness	Function	Damper Harness
Black	24V Hot	1-Brown
Yellow	24V from Thermostat	2-Orange
Red	24V from damper	3-Yellow
White	24V common	4-Black

Condition:

- Thermostat Closed
- Damper closed
- High Limit closed



STEP 7	TEST FOR 24VAC BETWEEN BLACK AND ORANGE ON DAMPER PC BOARD
---------------	---

IF	THEN
24VAC is present – damper NOT opening	Check Service Switch Position Replace Damper Assembly.
24VAC is not present	Check Wiring Harness to Thermostat
24VAC present – Damper Opens	Continue to step 8

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

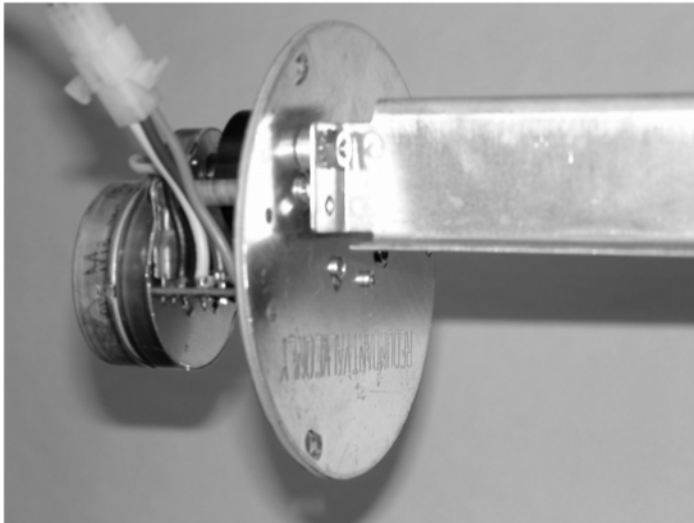
TROUBLESHOOTING THE DAMPER

Condition:

Damper rotates continuously

STEP 8

ADJUST END SWITCH TO CAM CONTACT



IF	THEN
Damper stops in proper position	24 VAC should be open on a call for heat and close during standby/
Damper does not stop in proper position	<ul style="list-style-type: none">• Replace damper assembly.

Condition:

Thermostat closed, damper is open fully, no power to IID module

STEP 9

TEST FOR 24VAC BETWEEN BLACK AND YELLOW ON DAMPER PC BOARD

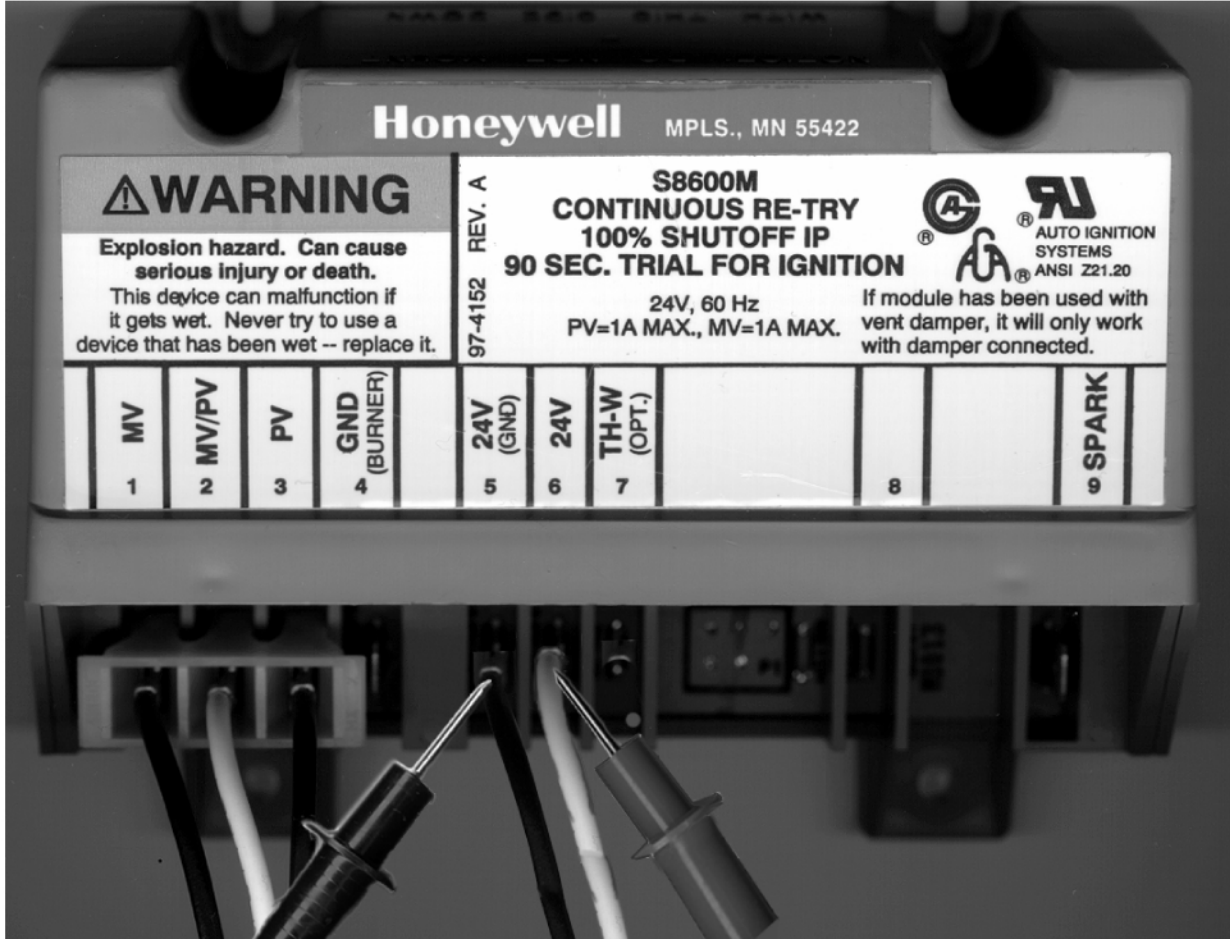
IF	THEN
24VAC is present	This is correct – continue to Step 10
24VAC is not present	<ul style="list-style-type: none">• Check Service Switch position.• Check the harness plug connections.• Check that cam on shaft rotates with shaft.• Replace the damper assembly.

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

STEP 10	WIRE HARNESS TEST
----------------	--------------------------

Condition:

Thermostat closed, Damper Open, no 24VAC to module "24V" terminal



STEP 10. WIRE HARNESS TEST. Test for 24 VAC between terminal 24V on the IID module, and 24V GND.

IF	THEN
24 VAC is not present:	<ul style="list-style-type: none"> Check the wiring harness.
24 VAC is present:	<ul style="list-style-type: none"> Go to step 11.

Note: This test may be easier to conduct by removing the red wire from the IID terminal. Test for 24 VAC between the red wire and ground. Reconnect the red wire to the 24V terminal after the test.

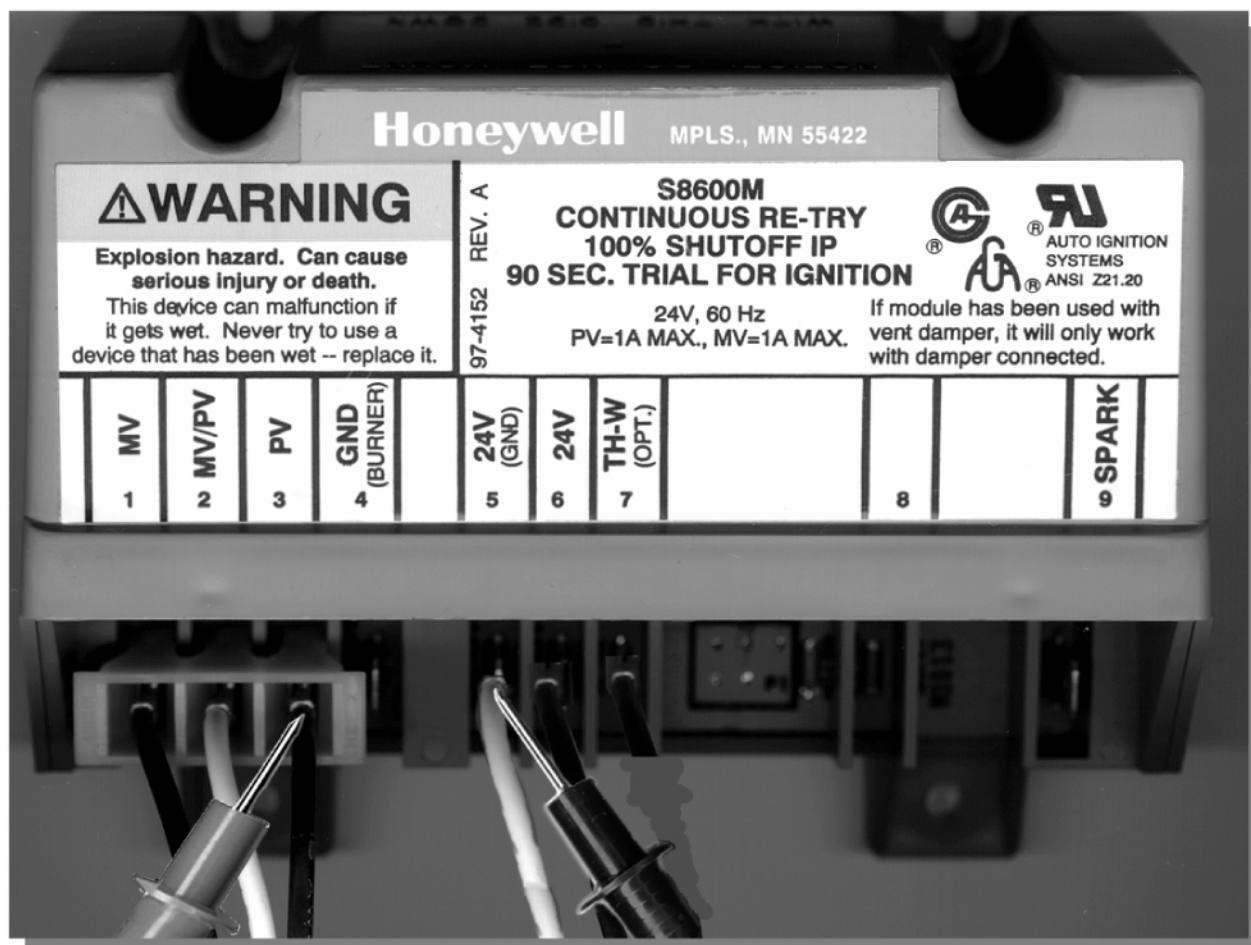
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STEP 11

IID MODULE TEST

Condition:

24VAC to module, no pilot



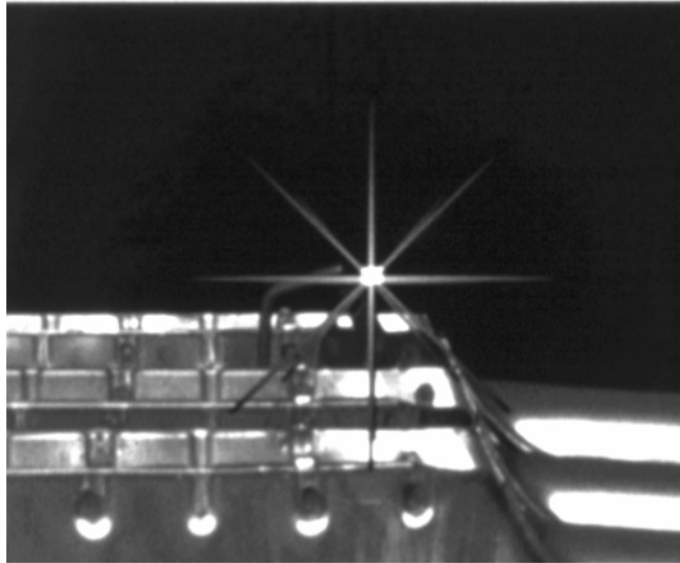
STEP 11. IID MODULE TEST (Power to the Pilot Valve). Using a multimeter, test for 24 VAC between terminal PV and 24V (GND) on the IID during the 90 second trial for ignition.

IF	THEN
The meter does not read 24 VAC and the IID module is not between ignition trials:	<ul style="list-style-type: none"> Replace the module.
The meter does read 24 VAC:	<ul style="list-style-type: none"> Go to step 12

**BTR TANK TYPE HEATERS
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STEP 12	PILOT SPARK TEST
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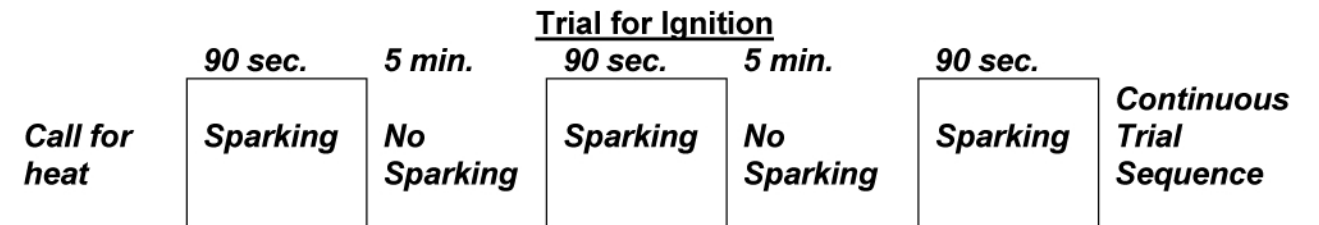
Condition:
24V at PV, No pilot



STEP 12. PILOT SPARK TEST. Visually/audibly check for spark at the pilot assembly.
Note: The pilot burner mounts on the left side of the main burner.

IF	THEN
The igniter is not sparking during the 90 second trial for ignition:	Check for: <ul style="list-style-type: none"> • A 7/64" spark gap • Spark cable continuity • Ground cable continuity • Replace module
Sparking is present:	<ul style="list-style-type: none"> • Go to step 13.

Power To Module May Be Interrupted To Reset .



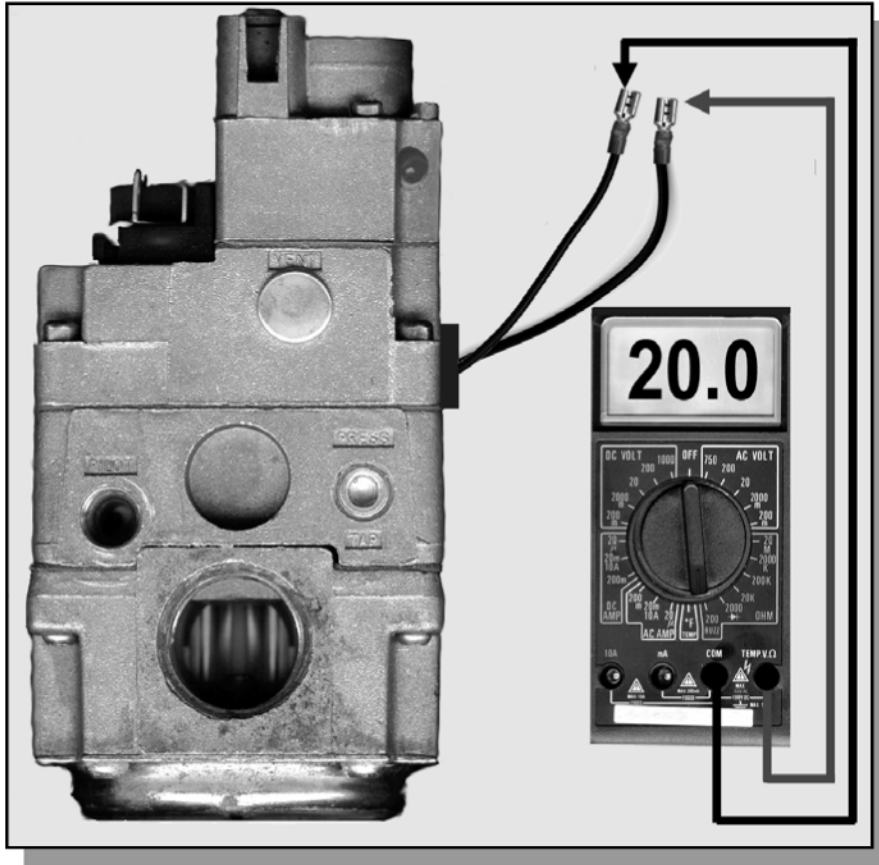
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STEP 13A

PILOT VALVE - OHM TEST – BTR 120 - 400

Condition:

Pilot Sparking, 24VAC from PV, No Pilot Flame



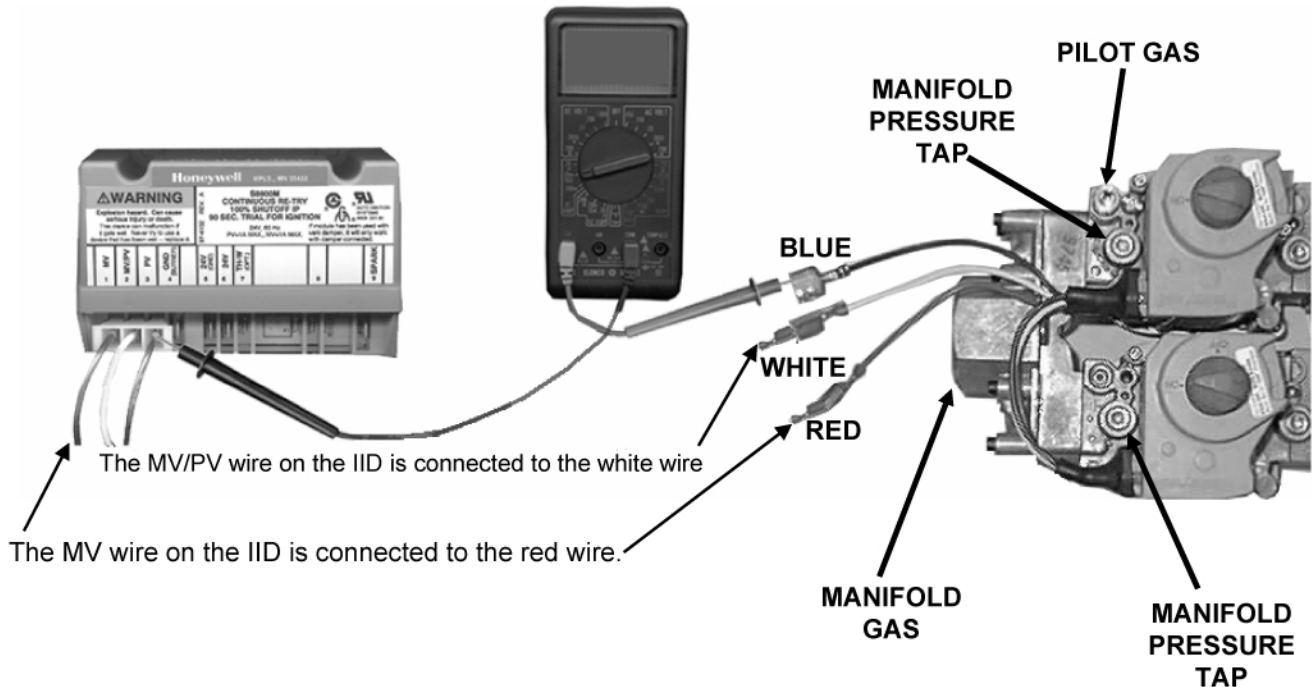
STEP 13A. PILOT VALVE - OHM TEST. If pilot assembly is sparking but no pilot flame is established, disconnect the pilot valve solenoid leads. Using a multimeter, (set to read ohms) test for 20* ohms resistance +/- 5 through the solenoid coil.

IF	THEN
The meter does not read 20 ohms plus or minus 5:	<ul style="list-style-type: none">• Replace gas valve
The meter does read 20 ohms plus or minus 5:	<ul style="list-style-type: none">• Gas valve should work. Also check that pilot gas is present and pilot tube or orifice are not blocked

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STEP 13B

PILOT VALVE TEST – BTR 500 ONLY



STEP 13B. PILOT VALVE TEST – BTR 500 ONLY. Testing the two coils of the Honeywell VR8404P 5004 gas valve used on the model BTR 500 only. Because of built in diodes, it is difficult to test for ohms resistance through these coils. The following is a DC amperage check of the main and pilot coils.

Condition:

- Tank calls for heat
- PV terminal of module has 24 VAC to pilot flame

Test Procedure:

- Turn off power to heater
- Meter set to test for DC amperage (on meters, the black wire is in the “com” port, the red wire is in the “10A” port, the dial is set to 20M/10A in the DC AMP test area).
- Blue “PV” wire is disconnected from the ignition PV terminal.
- Install meter in series between gas valve and ignition module – 10A wire to blue gas valve lead, common wire to PV module terminal.
- Turn power on to heater, after module receives 24V

Test DC Amperage through Pilot coil of gas valve

IF	THEN
.75 to .85 DCA is not present:	<ul style="list-style-type: none"> • Replace the gas valve
.75 to .85 DCA is present	<ul style="list-style-type: none"> • Pilot should work if gas (not air) is present to pilot

Power off; reattach blue gas valve wire to PV terminal of module.

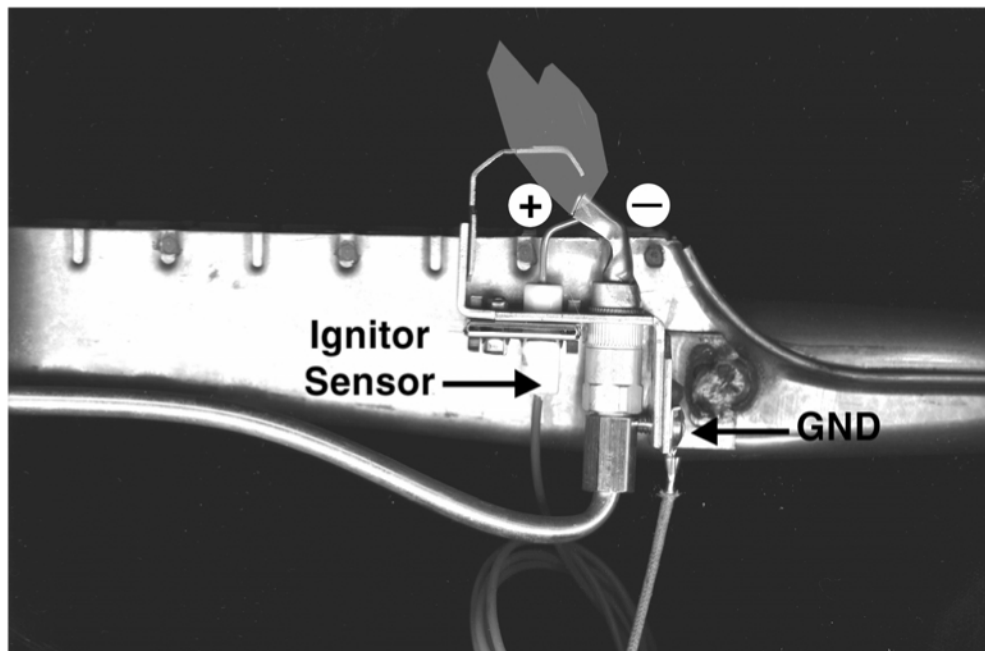
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STEP 14

FLAME RECTIFICATION

Condition:

Pilot Flame Noted, Pilot Sparking Continues, No Main Burner



STEP 14 FLAME RECTIFICATION

Note: Flame rectification means that an alternating current (AC) signal is changed to a direct current (DC) signal. The pilot flame is the 'switch' which connects the pilot hood to the igniter and ground. If the pilot hood and igniter sensor had the same surface area, the flame 'switch' would conduct an AC signal. Because the pilot surface is greater than the igniter surface, the signal becomes a DC current that the module can interpret. The pilot hood must be properly grounded and the pilot flame must remain in contact with both surfaces for the flame proving signal to remain constant.

If the signal is broken for just 8 tenths of a second, the heater will cycle off.

Sparking at the pilot will continue if an insufficient signal is received by the module.

Sparking at the pilot will stop almost immediately after the ignition module senses the pilot flame.

IF	THEN
Sparking continues after pilot is established:	<ul style="list-style-type: none"> • Check wire connections • Check flame contact between hood and lighter • Clean pilot burner surfaces • Replace pilot assembly
Sparking stops:	<ul style="list-style-type: none"> • Go to step 15.

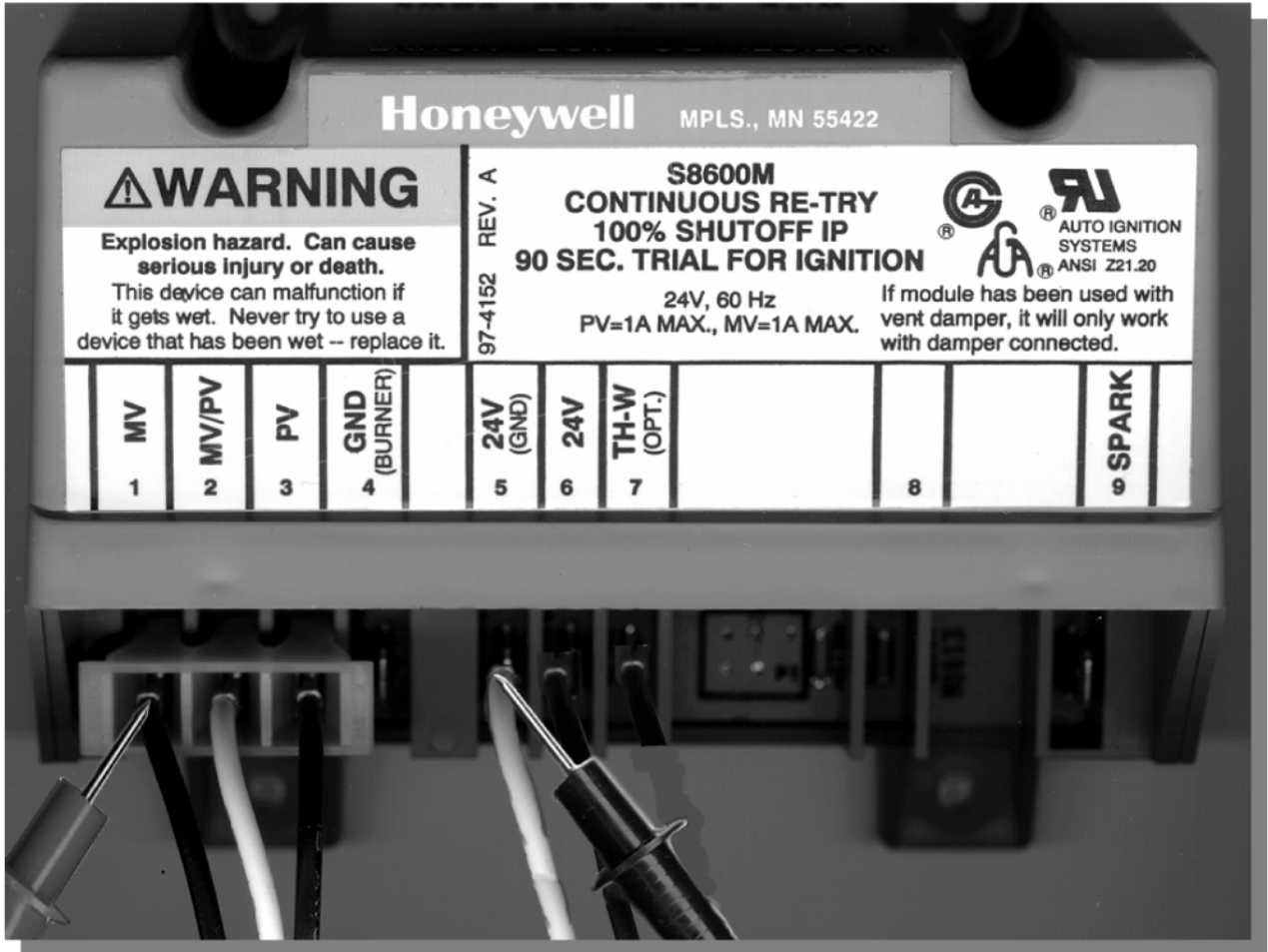
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STEP 15

IID MODULE TEST

Condition:

Pilot Flame Noted, No Sparking, No Main Burner



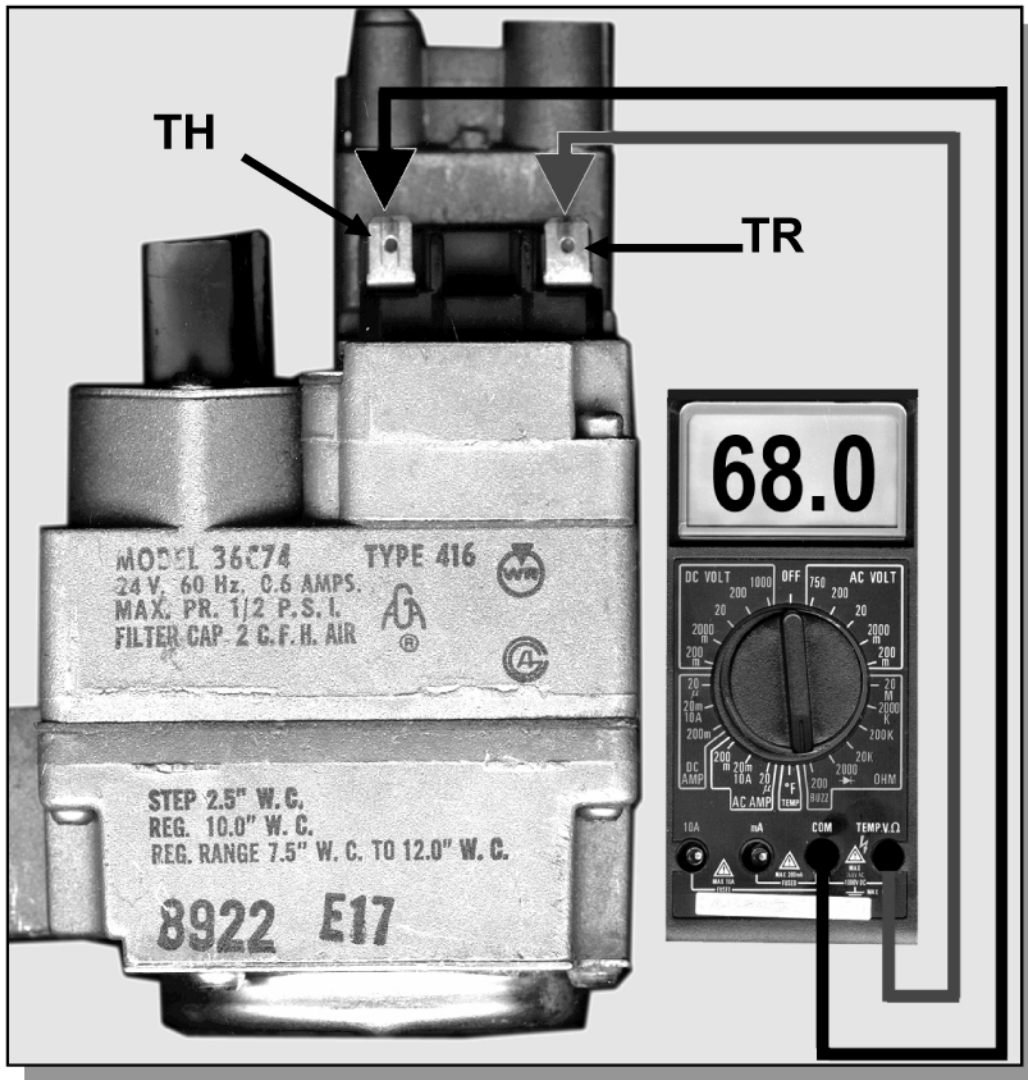
STEP 15. IID MODULE TEST (Power to the Main Valve). Using a multimeter, test for 24 VAC between terminal MV on the IID and 24V (GND).

IF	THEN
24 VAC is not present:	<ul style="list-style-type: none"> Replace the IID module. Conduct Step 16 before applying power to replacement module.
24 VAC is present:	<ul style="list-style-type: none"> Go to step 16.

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STEP 16A

MAIN GAS VALVE CHECK – BTR 120 - 400

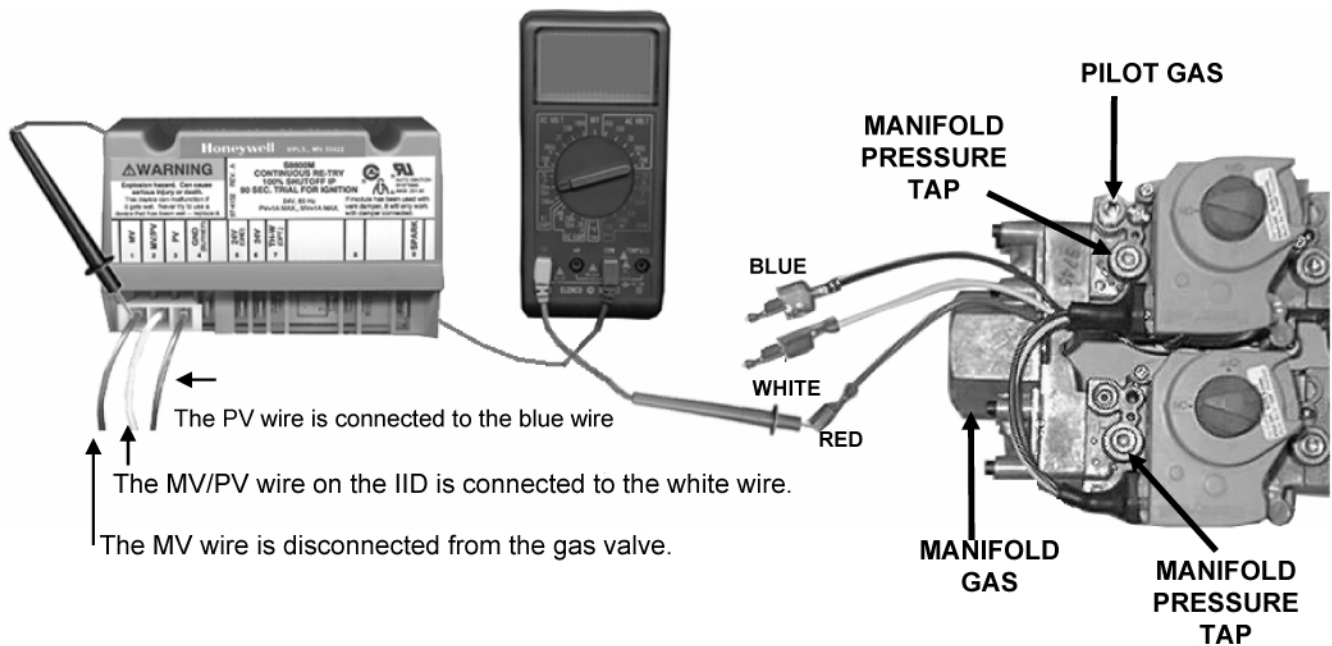


STEP 16A. MAIN GAS VALVE CHECK. Disconnect wires from gas valve TH and TR terminals. Using a multimeter, test for 68 ohms plus or minus 5 between TH and TR on the main valve coil.

IF	THEN
The meter reads 'O' or infinity	<ul style="list-style-type: none"> • Replace the gas valve
The meter reads 68* ohms plus or minus 5	<ul style="list-style-type: none"> • The main burner will ignite

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STEP 16B MAIN GAS VALVE COIL CHECK – BTR 500 ONLY



STEP 16B. MAIN GAS VALVE COIL CHECK – BTR 500 ONLY

Condition:

- Pilot lights
- Sparking stops
- No main burner ignition

Test Procedure:

- Power off
- Disconnect red, main valve wire from module MV terminal
- Meter set to test for DC amperage
- 10A wire to red gas valve wire, COM wire to MV terminal of ignition module
- Turn power on to heater
- After pilot lights and sparking stops

IF:	THEN:
.25 to .35 DC Amps is not present	<ul style="list-style-type: none"> • Replace the gas valve
.25 to .35DCA is present	<ul style="list-style-type: none"> • Main burner gas should ignite.

Be certain to correct you meter wire connections and setting before performing further tests.

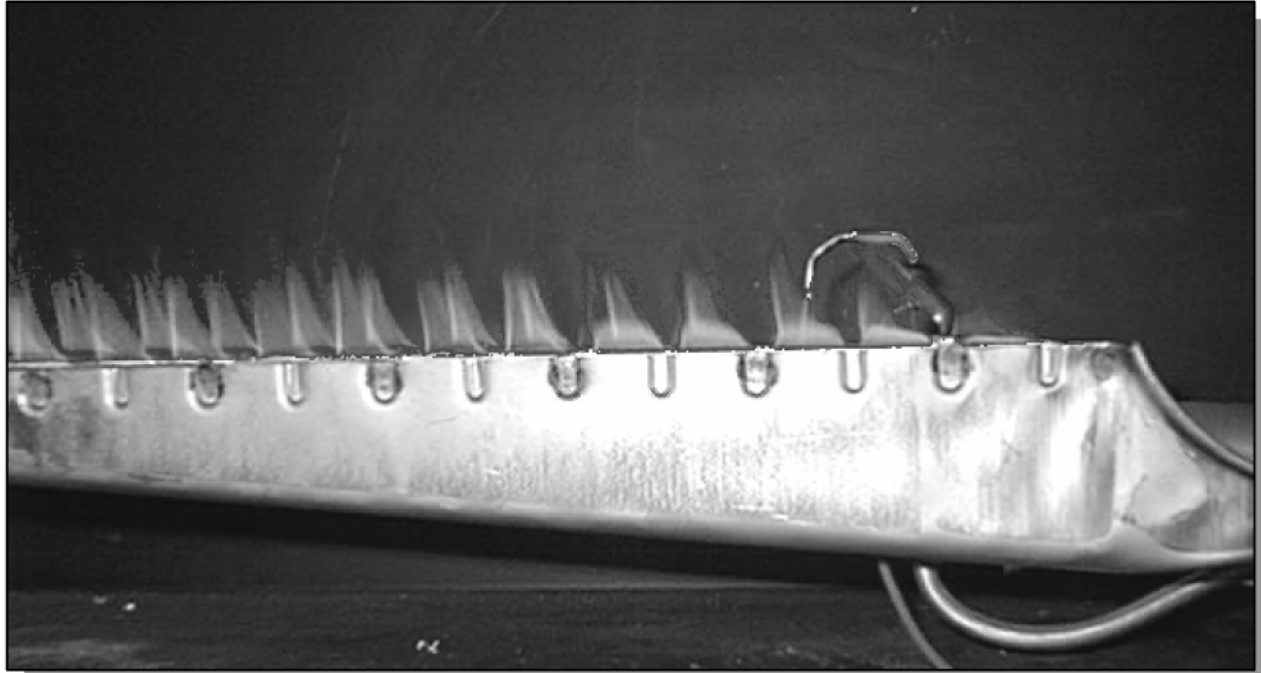
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STEP 17

MAIN BURNER TEST

Condition:

Pilot Flame Noted, Main burner Check



STEP 17. MAIN BURNER TEST. Visually check for main burner.

IF	THEN
The main burner ignites:	<ul style="list-style-type: none">• Sequence is complete
The main burner does not ignite	<ul style="list-style-type: none">• Check gas supply• Replace Gas Valve

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

GENERAL SERVICE CHART

CONDITION	CAUSE	SOLUTION
DAMPER OPENS NO POWER TO IID MODULE	. DAMPER NOT FULLY OPEN	.EFFIKAL – REPLACE DAMPER CONTROL ASSEMBLY . REPLACE DAMPER
	. DEFECTIVE PROTECTOR SWITCH	. REPLACE PC BOARD
PILOT LIGHTS, SPARKS CONTINUOUSLY	PILOT FLAME NOT PROVING	SEE FLAME RECTIFICATION - STEP 14
HEATER WILL NOT IGNITE	NOT PROVING PILOT FLAME EXISTANCE	INTERRUPT 120 VAC POWER . CHECK GROUND WIRE ATTACHMENT . CLEAN OR REPLACE PILOT ASSEMBLY
	PILOT GAS NOT COMPLETELY INTERRUPTED AT END OF HEATING CYCLE	. CHECK SUPPLY GAS PRESSURE . REPLACE GAS VALVE
WEEPING TEMPERATURE AND PRESSURE RELIEF VALVE	. THERMAL EXPANSION	ADD THERMAL EXPANSION TANK
	. FAULTY VALVE	REPLACE RELIEF VALVE
LARGE VOLUME WATER RELIEF FROM T&P VALVE	. EXCESSIVE WATER TEMPERATURE	. CHECK WIRING . REPLACE DUAL CONTROLLER
	. FAULTY RELIEF VALVE	REPLACE RELIEF VALVE
PREMATURE TANK LEAKAGE	CONDENSATION	. INCREASE STORED WATER TEMPERATURE AND CONFIRM PROPERLY SIZED APPLICATION
	CONTAMINATED AIR	. REMOVE CONTAMINANTS. . SUPPLY CLEAN COMBUSTION AIR.
	WATER HAMMER	. ADD WATER HAMMER ARRESTOR. . REDUCE WATER PRESSURE. . REMOVE UNNECESSARY CHECK VALVES.
	THERMAL EXPANSION	ADD THERMAL EXPANSION TANK.
	DEPLETED ANODES	SCHEDULE ANODE CHECKS - REPLACE AS NEEDED.
DAMPER WILL NOT OPEN	BINDING SHAFT	SUPPORT VENTING
	DAMPER MOTOR	EFFIKAL-REPLACE DAMPER CONTROL ASSEMBLY
NO SPARK AT PILOT - DAMPER FULLY OPEN	DAMPER ASSEMBLY	SEE STEP 12 Services Switch may bypass problem until replacement part is received. REPLACE DAMPER CONTROL ASSEMBLY
	IID MODULE	REPLACE IID STEP 12
	SPARK CABLE	REPLACE CABLE STEP 12

BTR TANK TYPE HEATERS SERVICE HANDBOOK

GENERAL QUESTIONS AND ANSWERS

- Q: What is unique about the Canadian – BTR-CGA – models vs. U.S. BTR models?**
A: The Canadian models have different dimensions to meet Canadian code requirements.
- Q: How much electrical power is required for a BTR water heater?**
A: The BTR models draw approximately .7 Amps at 120VAC.
- Q: The units require "leg kits" to meet National Sanitation Foundation standards.**
- Q: When should BTRs be delimed? NOTE: The "Eliminator™" should eliminate or greatly reduce the lime build up rate from the water heater.**
Many variables affect the liming up process including:
water temperature - The amount of lime precipitation during the same period of time will be nearly 2 times greater if water is stored at 140 degrees F than at 120 degrees F. A 180 degree setting will precipitate lime about seven times as fast as a 140 degree F setting.
volume of water - The more gallons flowing through the BTR, the more exposure to accumulation.
hardness – The harder the water the higher the possibility of lime build up. 1 to 3.5 grains per gallon is "soft", 3.5 to 7 grains per gallon is "moderate", 7 to 10.5 grains per gallon is "hard" and 10.5 + grains per gallon is "very hard". (An aspirin is about 5 grains. One grain is equal to 17.1 parts per million.)
A: Deliming should be done when a slight rumbling or popping sound is detected when the main burners are on.
- Q: What effect will lime build-up have on the BTR water heater?**
A: One eighth inch of scale build-up may reduce efficiency as much as 22%; a 1/4 inch build-up, as much as 38%.
A: Less efficient heat transfer means more bottom head expansion/contraction stress and premature leakage.
A: Heavy build-up on the bottom head and bottom portion of the flue pipes leads to more heat transfer at the top of the flues. This can lead to stacking or erratic thermostat operation.
A: The "Eliminator" greatly reduces the possibility of lime build-up.
- Q: Anode rods provide additional protection against corrosion. When should these be replaced?**
A: When large gouges or pits appear in the anodes, replace them. It is recommended that these be inspected every 6 months.

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COMPONENT PART INFORMATION

	NAME	SPECIFICATIONS
DUAL CONTROLLER	THERMOST AT	120-180° RANGE, ± 4°, 5° DIFFERENTIAL, LIQUID FILLED, ANTI- STACKING
	HIGH LIMIT (ECO)	OPENS - 205° FIXED, MANUAL RESET BELOW 185°
GAS VALVE	NATURAL GAS	BTR 120-400;24VAC, 60hz, .6A,.7" to 3.5" W.C., STEP OPEN
		BTR 500; 24VAC, 60hz, Dual Gas Valve, STEP OPEN
	PROPANE GAS	BTR 120-400; 2.5 – 10" W.C. STEP OPEN
		BTR 500; 24VAC, 60hz, Dual Gas Valve, STEP OPEN
INTERMITENT IGNITION DEVICE CONTROL	NATURAL GAS AND PROPANE GAS	24 VAC, 50-60 HZ, .1A; .7 MICROAMP SIGNAL CONTINUOUS RETRIAL
DAMPER	COMPLETE OR ASSEMBLY	
TRANSFORMER		120 V PRIMARY, 24 VAC SECONDARY, 40 VA, 50-60 HZ, CLASS 2 "B"

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

BTR SERVICE CHECKLIST

(This service checklist may be photo copied to assist with BTR service call.)

This checklist is intended to aid the Service Agent in determining that the AOS BTR Water Heater has been properly installed and is operating correctly. Because the circumstances of each installation may vary greatly, it is not intended to be an all-inclusive list of the problems that the Service Agent may encounter. Any item checked "no" on this list should be thoroughly investigated and corrective action taken, if required.

SERVICE AGENT _____ INSTALLATION DATE _____
MODEL NUMBER _____ SERVICE DATE _____
SERIAL NUMBER _____ LOCATION ADDRESS _____

GAS TYPE - CHECK ONE

NATURAL _____ PHONE () _____ - _____
PROPANE _____

- I. Check Clearances (circle answer)
- | | | |
|--------------------------------------|-----|----|
| A. Are exterior clearances adequate? | yes | no |
| B. Are interior clearances adequate? | yes | no |
- Comments:
- II. Check Makeup Air Requirements
- | | | |
|--|-----|----|
| A. Is the quantity of make-up air adequate per the National Fuel Gas Code? | yes | no |
|--|-----|----|
- Comments:
- | | | |
|--|-----|----|
| B. Is the quality of make-up air adequate? | yes | no |
|--|-----|----|
- Comments:
- III. Gas Pressure (fill in blank)
- | | | |
|---|--|--|
| A. Supply gas pressure _____ inches of W.C. | | |
| B. Manifold gas pressure (main burner) _____ inches of W.C. | | |
- Comments:
- IV. Venting (check)
- | | | |
|--|-----|----|
| A. Properly sized per the National Fuel Gas Code? | yes | no |
| B. Does the installation have mechanically assisted venting? | yes | no |
- If so, is it operational? yes no
- Comments:

BTR TANK TYPE HEATERS SERVICE HANDBOOK

V.	WATER PIPING		
	Is the system properly sized?	yes	no
	Is the system properly installed?	yes	no
	Are there any water leaks?	yes	no
	Does the installation have a recirculating system?	yes	no
	If so, is it operational?	yes	no
VI.	PROPER SEQUENCE OF OPERATION		
	During standby does damper close on standby?	yes	no
	During standby is pilot flame off?	yes	no
	On a call for heat does thermostat close?	yes	no
	On a call for heat does damper open completely?	yes	no
	Does sparking begin at pilot?	yes	no
	Is pilot flame established?	yes	no
	If so, does sparking stop?	yes	no
	Does main burner ignite?	yes	no
	Does the thermostat satisfy?	yes	no
	Does damper close?	yes	no
	Comments:		
VII.	SAFETY		
	A. Gas		
	Does pilot flame prove before main burner ignites?	yes	no
	Does damper blade fully open before ignition sequence occurs?	yes	no
	Is burner cover plate in place?	yes	no
	Is burner floor shield in place?	yes	no
	Does IID lockout occur after 30 sec. trial for ignition? (Propane models only)	yes	no
	B. Water Temperature		
	Is the thermostat adjusted to the lowest acceptable temperature?	yes	no
	Does the installation have a mixing valve?	yes	no
	If so, is it operational?	yes	no
	What is the outlet temperature of the mixing valve? _____		
	Is a properly rated temperature and pressure relief valve installed?	yes	no
	C. Electrical		
	Is the 120 VAC electrical power supply properly wired?	yes	no
	Are all the BTR control covers in place?	yes	no
	Is the 120 VAC electrical power supply properly fused?	yes	no
	D. Flammables		
	Are flammable materials located in the area of the water heater?	yes	no
	Are flammable vapors located in the area of the water heater?	yes	no

(This service checklist may be photo copied to assist with BTR service call.)

COMMENTS

Author: Terry Mulder

**BTR TANK TYPE HEATERS
SERVICE HANDBOOK**

Visit the “Information Central” link of
www.aosmithwaterheaters.com for a listing
of available Service Handbooks.

Prepared by the Technical Training Department
Ashland City, Tennessee

For additional information contact

A.O. Smith Technical Information Department

at 1-800-527-1953 or visit

www.aosmithwaterheaters.com

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