

**LEGEND HEATERS
SERVICE WORKBOOK**

LEGEND 2000 ORIFICE TABLE LW/LB-1000

Model	Size (In.)	Elevation (Ft.)
LW/LB 1000	0.555	0-2000
LW/LB 1000	0.537	2001-3000
LW/LB 1000	0.533	3001-4000
LW/LB 1000	0.333	0-2000
LW/LB 1000	0.329	2001-3000
LW/LB 1000	0.325	3001-4000



**LEGEND 2000
SERVICE WORKBOOK
For Models LW and LB
500, 750 and 1000
Series 920 and 951**

Prepared by
The A.O. Smith WPC
Technical Training Department

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LEGEND WORKBOOK INTRODUCTION

This service workbook is designed to aid in servicing and troubleshooting A.O. Smith Legend Hot Water Supply Boilers in the field. No duplication or reproduction of this book may be made without the express written authorization of the A.O. Smith Water Products 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 date is included to assist you in servicing this product.

The information contained in this workbook is designed to answer commonly faced situations encountered in the operation of the Legend product line and is not meant to be all inclusive. If you are experiencing a problem not covered in this workbook, please contact the A.O. Smith Technical Information Department at 1-800-527-1953 or your local A.O. Smith Water Products Company representative for further assistance. This workbook is intended for use by licensed plumbing professionals and reference should be made to the installation manual accompanying the product. This workbook contains supplemental information to the Legend installation and operation manual.

**LEGEND 2000 ORIFICE TABLE
LW/LB 500&750**

MODEL	SIZE (IN.)	ELEVATION (FT.)
LW/LB-500	0.391	0-2000
LW/LB-500	0.384	2001-3000
LW/LB-500	0.374	3001-4000
LW/LB-500	0.229	0-2000
LW/LB-500	0.226	2001-3000
LW/LB-500	0.223	3001-4000
LW/LB-750(USA)	0.484	0-2000
LW/LB-750(USA)	0.469	2001-3000
LW/LB-750(USA)	0.461	3001-4000
LW/LB-7501(CAN)	0.464	0-2000
LW/LB-750(CAN)	0.450	2001-3000
LW/LB-750(CAN)	0.443	3001-4000
LW/LB-750	0.286	0-2000
LW/LB-750	0.282	2001-3000
LW/LB-750	0.278	3001-4000

*Factory installed orifice.

**LEGEND HEATERS
SERVICE WORKBOOK**

Maintenance – See instruction manual more detailed information

Function	Instructions	Time
Burner Check	Check flame characteristics	Every 6 months
Condensate Tubes	Check that they are tightly connected and free to operate	Every 6 months
Delime	Check for an increase of approximately 5°F in the temperature rise (verse the “clean” temperature rise) through the Legend. Do Not allow a heavy build of lime in this heater. The water passages cannot be individually delimed.	When Necessary
Electrical Connections	Power OFF. Feel for loose wire connections or screws.	Every 6 months
Light Off	Check for smooth light off. May require small adjustment of Rheostat	Every 6 Months
Pressure Relief Valve	On the heater outlet. Check that the valve operates freely	Every 6 Months
Pressure and Temperature Relief Valve	On the storage tank. Check that the valve operates freely	Every 6 Months
Pressure Switches	Ensure that the air tubes are tightly connected and free to operate	Every 6 Months
Pump	Oil the pump bearing	Every 6 Months
Water By-pass	Adjust as necessary to maintain 140° + water into the Legend during normal operation	Every 6 Months
Water Flow Adjust.	Adjust to ensure an approximate temperature rise through the Legend of 20°F	Every 6 Months

**LEGEND HEATERS
SERVICE WORKBOOK**

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

Tools Required:

- Phillips head screw driver
- Standard screw drivers
- a 3/8 and 7/16 inch open end wrench
- an electrical multimeter tester capable of measuring continuity, microamperage and voltage
- (2) gas pressure gauges or manometers
- water pressure gauge
- Allen wrench – 3/16 inch
- pipe wrenches (2) expandable to 3 inches
- combustion analysis equipment for:
 - CO₂
 - CO
 - O₂
 - Flue Gas Temp
 - Draft

Terms:

Category IV – An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

- Condensate – Corrosive moisture resulting from flue gases being cooled below their dew point.

Through the Wall Vent – Vent piping terminates through a side wall. Room air is used for combustion.

Direct Vent – Appliances that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

HSI – Hot Surface Ignitor – On the Legends, this hot surface ignitor glows red until main gas is ignited then the ignitor becomes the flame sensor – glow diminishes.

INSTALLATION

This portion of the workbook will review some often overlooked considerations, taking note of necessary installation requirements for the Legend. The installation manual covers most of these items in detail.

INSTALLATION CLEARANCES

This boiler is approved for installation on combustible flooring in an alcove with minimum clearances to combustibles of:

4" Rear ; 0" Top and Sides ; 6" Vent

Two inch clearance is allowable from combustible construction for hot water pipes.

SERVICE CLEARANCES

Sufficient area should be provided at the front and rear of the unit for proper servicing. Service clearances of 24" in front, rear, top and left side are recommended. In a utility room installation, the door shall be wide enough to allow the boiler to enter or to permit the replacement of another appliance such as a water heater.

Dimension Table (Inches)

Model	Height	Width	Depth	Vent
LW-500	53	23	32	6
LW-750	53	23	32	6
LW-1000	60 1/2	27 1/8	38 3/16	7

Note: Connections are on the rear of the unit.
 Gas pipe nipple extends 5 1/2" beyond back of the jacket.
 AL-29 4C Safety Vent boot tee installation extends approximately 19" from the back of the jacket.
 Approved for installation on combustion floors.

6. Water Temperature Indicators

- These LED indicators are very sensitive. If you adjust water flow through the Legend, the indicators will take a minute or so to stabilize on the new water temperature.
- "Wandering" water temperature indications usually indicates that the "temperature indicators power supply" pack is about to fail and needs to be replaced.

7. Water Piping

- Note the water piping diagrams in the installation manual. This is not the familiar A.O. Smith "Cer-Temp 80" type piping and includes a bypass which will normally need adjusting.

8. IRI (Industrial Risk Insurance) Models

On models equipped to meet IRI codes note that:

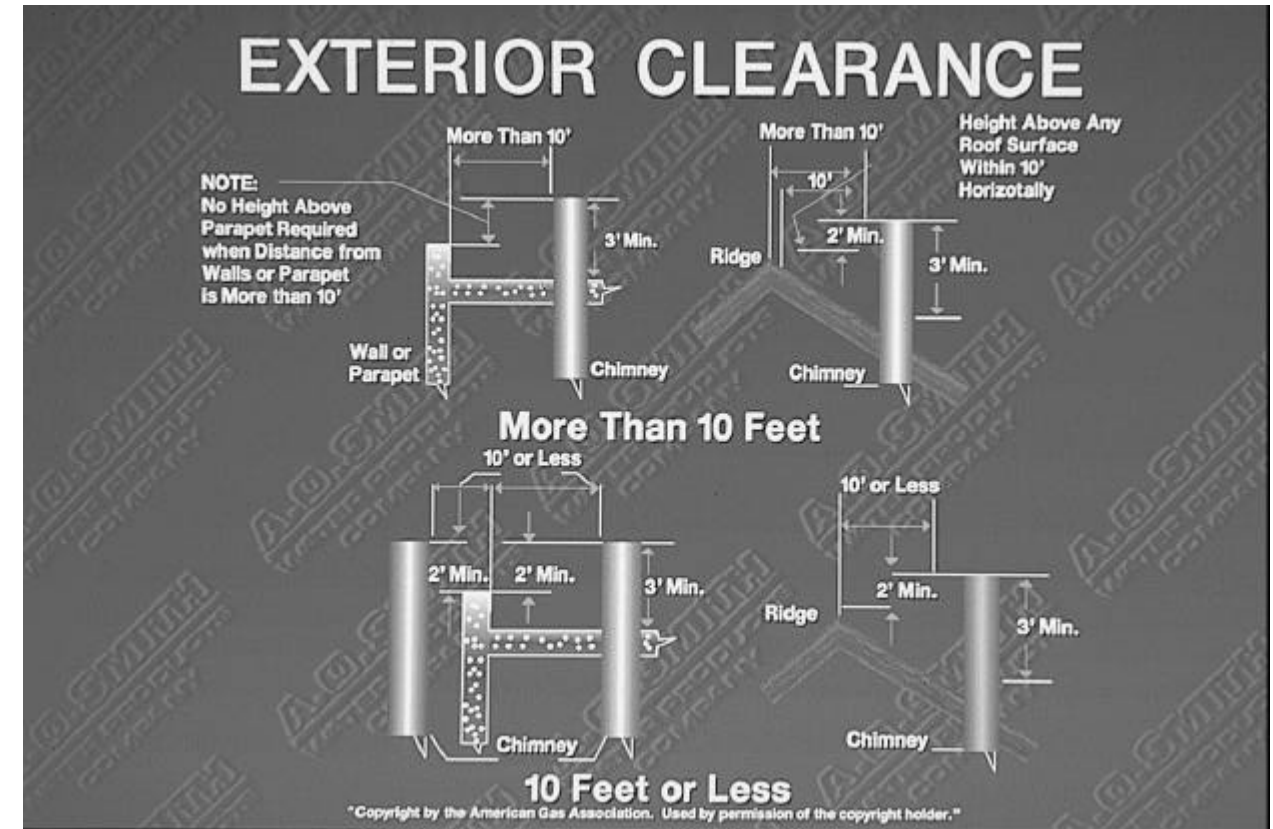
1. The Legend 500, 750 and 1000 all have the same wiring.
2. All have the same IRI controls and valves.
3. None have blowers which reduce speed during light off.
4. Most of the gas control string is mounted external to the right side Legend jacket.
5. Not illustrated on the piping diagram is a manual reset, low water cut-off which mounts on the water supply piping outside the back jacket of the Legend.

INSTALLATION AND SERVICE NOTES

1. Venting
 - Do not exceed the allowable distances.
 - Do not include the “boot tee” in the equivalent footage calculations.
 - Be certain that intake and exhaust caps are above anticipated snow levels.
 - It is important that the intake and exhaust terminal caps be as wide apart as feasible. Flue gas products cannot be allowed to reenter the air intake cap.
 - Exhaust vents cannot be combined.
2. Air Supply
 - These units require a large volume of combustion and excess air. Be certain that supply air is clean - especially if the heaters are operated while the building is under construction. Dirt and dust on blower fan blades and plugging main burner ports affects startup and combustion.
 - The LW and LB 1000 models now have an adjustable air intake shutter. It is often necessary to set this at the time of installation and perhaps readjust this after some time of operation.
3. Ignition
 - These heaters have 4 seconds to ignite and prove flame on a call for heat.
 - Ensure adequate gas supply pressure and volume.
 - Ensure adequate voltage to the gas valves. Low supply voltage may necessitate a 75 VA transformer, in lieu of the 40VA supplied on some Legend models, to ensure rapid gas valve opening.
 - Delayed or rough light off may be a result of an incorrect main gas orifice for the local altitude.
4. Pressure Switch Note:

The restricted gas flow switch is only wired to the Dia-Scan board and will not effect Legend operation.
5. Dia-Scan
 - The Dia-Scan operation and malfunction indications are explained on the back of the Legend installation and operation manual. A temporary red light indication often does not mean a service problem.
 - Dia-Scan wiring does not effect Legend operation except where a loose wire connection or stray strands of wire are shorting to ground. This typically would short the Legend transformer.

EXTERIOR CLEARANCE



In northern climates outside air intake and exhaust terminations should be located so exhausted flue gas moisture will not condense and freeze over the air intake. (Ref: NFPA 54, ANSI Z223.1, Sec 7.8 Guidelines).

AIR FOR COMBUSTION



Complete combustion requires 10 cubic feet of air per 1000 BTUH 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 BTUH 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).

Insufficient make-up air is a major cause of combustion problems. One common example is in a mechanical room where exhaust vent equipment was not considered in sizing make-up air requirements. This may result in air being backdrafted by the exhaust equipment through the heater causing improper combustion, inconsistent ignition operation, and/or erratic heater shut down. A direct vent installation would avoid this possibility.

GENERAL QUESTIONS AND ANSWERS

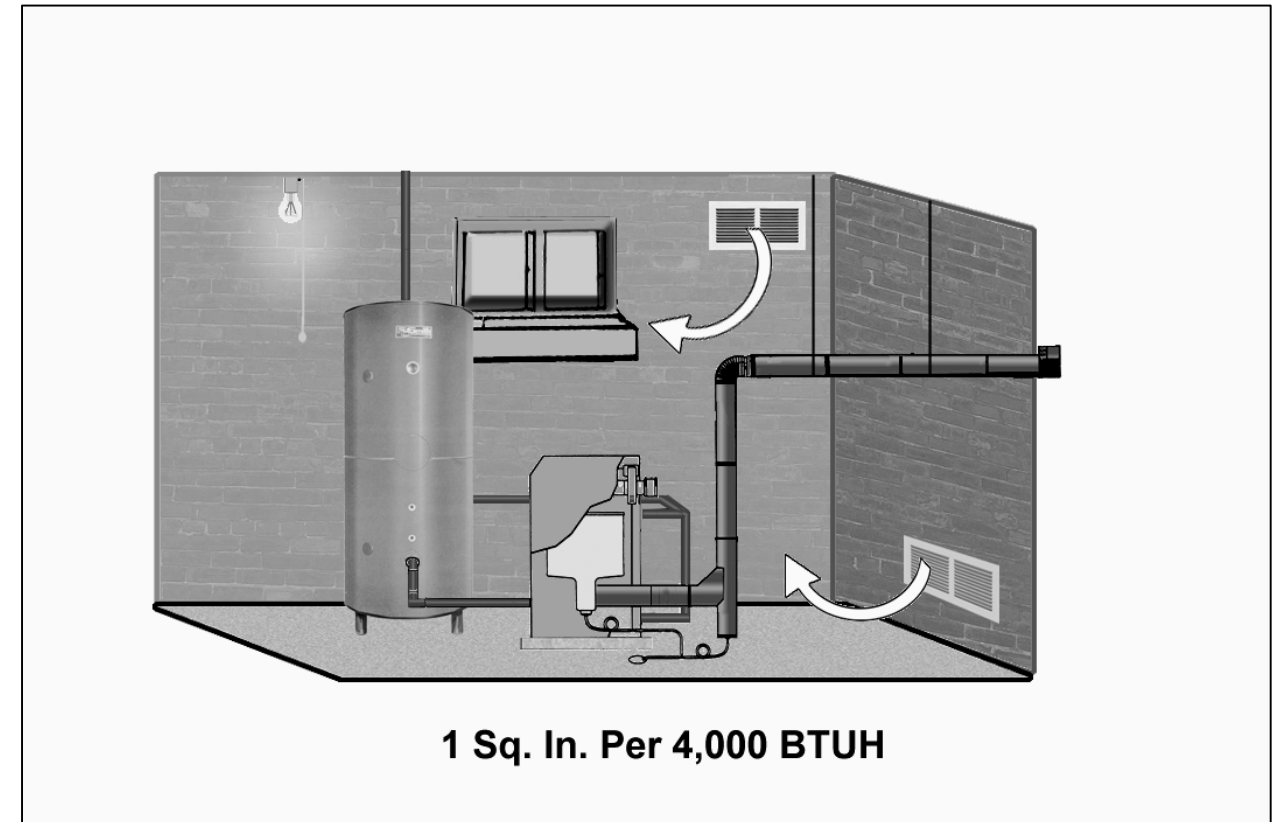
- Q: On installation, what are my main concerns?**
A: Adequate gas supply pressure
Properly installed vent
Clearances
Equivalent footage limitations
Electrical polarity to each Legend
- Q: What can, typically, cause rough light off?**
A: Air shutter not properly adjusted (on LW - 1000)
Rheostat not properly adjusted (on LW - 500 and 750)
- Q: What are the most common reasons for repeated trials for ignition?**
A: Low gas supply pressure
Air adjustment rheostat adjustment
Low supply voltage to the gas valves
Cracked ignitor
- Q: What are the most common reasons for poor combustion?**
A: Poor adjustment of gas or air
Dirty burner ports
Dirty blower fan
- Q: What are the most common reasons for "short cycling" of the Legend?**
A: Incorrect adjustment of system controller (tank temperature control) in relation to the water temperature limits on the Legend
Loss of flame proving signal
- Q: Why is the piping to the tank "different than typically used on a copper heater with tank system?"**
A: Condensation within this high efficiency product is more likely to occur than in a less efficient water heater. Note that the piping design attempts to increase incoming water temperature by blending the incoming water with hot water. The use of the bypass is also included for this reason. Excessive Condensate on the heat exchanger may lead to sooting and poor combustion.

TABLE 3
LEGEND 2000 ORIFICE TABLE
LW/LB-500&750&1000

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LW/LB-500	0.384	2001-3000
LW/LB-500	0.374	3001-4000
LW/LB-500	0.229	0-2000
LW/LEI-500	0.226	2001-3000
LW/LB-500	0.223	3001-4000
LW/LB-750(USA)	0.484	0-2000
LW/LB-750(USA)	0.469	2001-3000
LW/LB-750(USA)	0.461	3001-4000
LW/LB-750(CAN)	0.464	0-2000
LW/LB-750(CAN)	0.450	2001-3000
LW/LB-750(CAN)	0.443	3001-4000
LW/LB-750	0.286	0-2000
LW/LB-750	0.282	2001-3000
LW/LB-750	0.278	3001-4000
LW/LB-1000	0.555	0-2000
LW/LB 1000	0.537	2001-3000
LW/LB 1000	0.533	3001-4000
LW/LB-1000	0.333	0-2000
LW/LB-100	0.329	2001-3000
LW/LB-100	0.325	3001-4000

* Factory installed orifice.

MAKE-UP AIR
Direct Communication

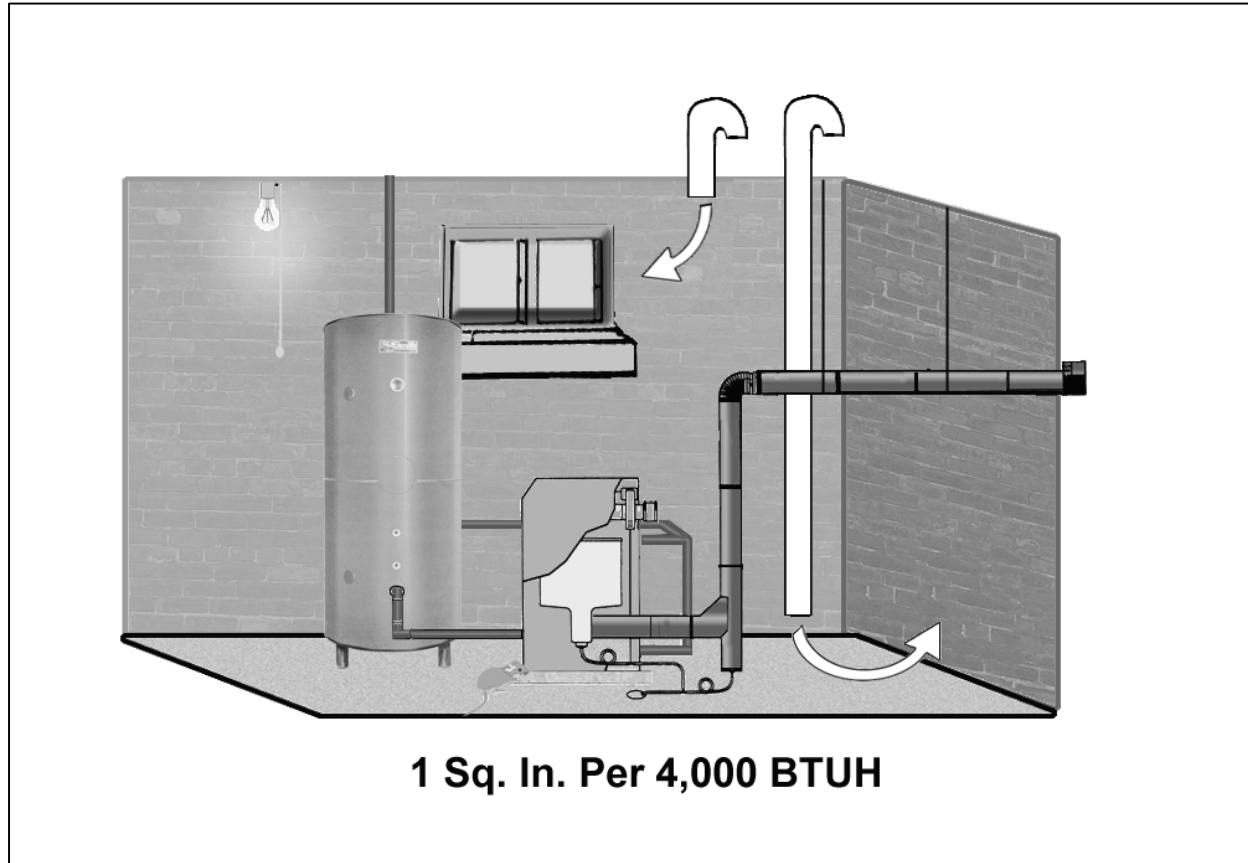


Conventional Venting
(Where room air is used for combustion)

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 12 inches of the bottom of the enclosure. Each opening shall have a free area (add for louvers, screens, etc.) of not less than 1 square inch per 4000 BTUH of the total input of all appliances within the enclosure.

The lower opening is primarily providing combustion air. The upper opening is providing combustion air and acts as a relief opening for room heat. Direct vent installations would draw their combustion air from outdoors through an air intake vent connected directly to the heater.

MAKE-UP AIR
Vertical Ducts



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

Not applicable to direct vent installations.

7. SET THE INTAKE AIR PRESSURE.

Turn off the gas to the burner or boiler so the unit will not fire. Disconnect the tube going from the blower to the pressure switch and connect your manometer here. Start the blower and adjust the air shutter so that the manometer reads a minimum of 4.5" to a maximum of 5.0" of water column. Too much air will cause the unit to backfire and/or collapse the flue.

8. VERIFY SUPPLY LINE GAS PRESSURE

The ideal supply pressure is a minimum 7" water column. Under no circumstances should the supply pressure be less than 5.5" wc. If you find low gas pressure, STOP! You will probably experience hard starting and run the risk of damaging the unit if you try starting it. Have the problem corrected before continuing.

9. ADJUST MANIFOLD GAS PRESSURE

Turn the gas off and run the unit through a firing cycle. The gas pressure should be no less than 3.0" and no more than 3.5" water column pressure. The pressure is factory preset and should only require slight adjustments if any.

10. PERFORM THE START UP PROCEDURE AS LISTED IN THE MANUAL.

You may have to make slight adjustments to blower air and gas pressures to get the unit on rate and within correct combustion specifications. The unit should now operate smoothly and quietly.

MODIFIED GAS TRAIN

This allows the combination valve, which has a diaphragm for pressure regulation, to always "see" inlet supply gas pressure allowing it to respond more rapidly once energized. This gets the correct flow of gas to the burner faster.

Note: Legend boilers built in the plant after January 1, 1997 will have the gas valves arranged like this.

4. POSITION THE BURNER HIGHER

The burner is shimmed up 3/8" in this step. This puts the ports closer to the hot surface ignitor element and allows quicker ignition of the gas & air mixture entering the combustion chamber. Shims are made by sandwiching standard burner gaskets together.

Note: Legend boilers built in the plant after January 1, 1997 will have the burners installed like this.

5. REPLACE THE INTAKE AIR SHUTTER FOR INCREASED ADJUSTMENT

Use a revised air shutter obtained from the parts department. It is included in the spacer kit.

6. DRILL A PRESSURE RELIEF HOLE(S) IN THE PVC AIR INTAKE.

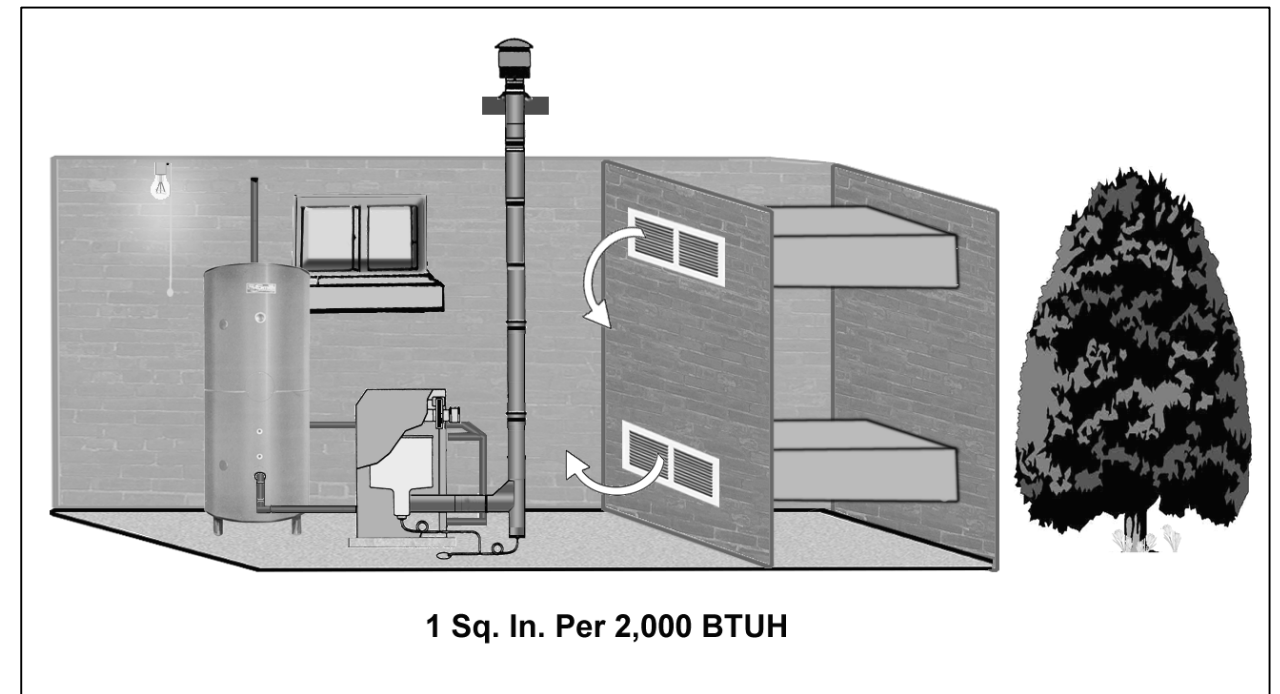
This step only applies to direct vent models. Drill a 1.5", or two 1" holes in the underside of the PVC air intake as close to the blower as practical. This hole(s) allows for the split second back pressure wave created by gas ignition to vent on the low pressure air intake side rather than pressurizing the combustion chamber and exhaust, disrupting the flame pattern, and affecting smooth burner light off.

There is no need to provide additional combustion air to the boiler room. A negligible amount of air is drawn in through the relief hole. The relief holes should be included on any new direct vent installation.

START UP PROCEDURES

The following steps must be followed accurately to ensure smooth boiler operation. You will require the equipment listed at the start of this bulletin. If you do not have the equipment, or are unsure of proceeding, STOP! Get a qualified service technician with the right equipment and expertise to finish the job. Failure to make these adjustments properly could damage the boilers or vent system.

**MAKE-UP AIR
Horizontal Ducts**



When the heater is installed in an exterior 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 12 inches of the bottom of the enclosure. Each opening shall have a free area of not less than 1 square inch per 2000 BTUH of the total input of all appliances within the enclosure.

Not applicable to direct vent installations.

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, hair spray, freon, 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 by products. Dust drawn in may build up on the blower or clog main burner ports. Also, be certain to examine the exterior area around the air intake of a direct vent installation for these contaminants.

FIELD FIXING HARD STARTS AND LOCKOUTS ON 1 MILLION BTU INPUT LEGEND BOILERS AND WATER HEATERS

This set of short instructions should help you diagnose and correct installations involving 1 million Btu input Legend boilers. The start up and adjustment of this equipment requires that you have accurate gauges and combustion analyzers. You must have a manometer or gauge for reading both incoming and manifold gas pressures and combustion air blower pressures. You must also have a combustion analyzer and other gas service related equipment such as a digital multimeter. Do not bother attempting to make the following adjustments if you do not have the equipment. NOTE: Improper adjustments and settings of the gas and air pressures can cause delayed ignition severe enough to crack the tub or collapse the vent!

1. VERIFY CORRECT ELECTRICAL SUPPLY AND POLARITY.

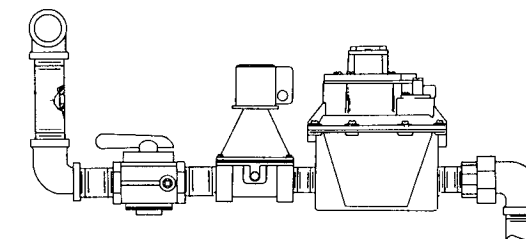
Each LW- 1000 or LB-1000 with a pump on the same circuit requires a minimum breaker size of 30A and supply wiring sized accordingly. For a boiler without a pump on the same circuit, the rating should be 15A. It is very important that each Legend be on its own separate circuit to prevent voltage variations from affecting the ignition. Low voltage and over current conditions will affect blower speed and ignition system performance. This in turn causes hard starts or no starts and lockout.

2. VERIFY GAS SUPPLY LINE SIZING.

Verify that the gas lines to the units are sized according to established guidelines listed in the installation manual or the National Fuel Gas Code handbook. (The tables in the manual are from this book.) If you find undersized supply lines, STOP! You will probably experience hard starting and run the risk of damaging the unit if you try to start the unit. Have the problem corrected before continuing.

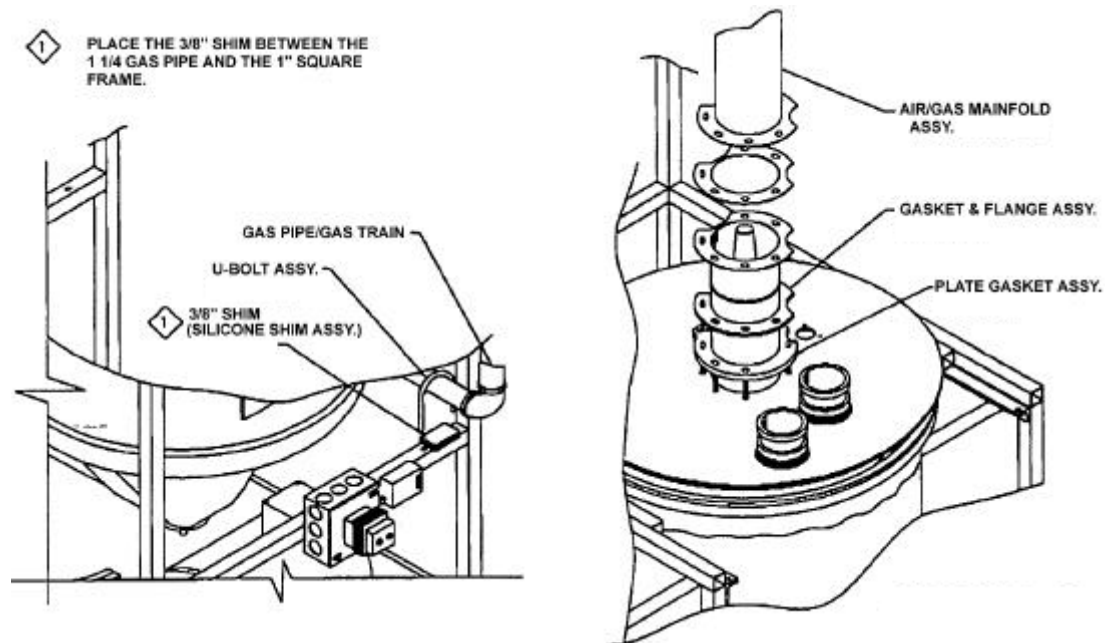
3. MODIFICATION TO THE GAS CONTROL LAYOUT

The combination pressure regulating gas valve and redundant solenoid safety valve must be reversed. Existing Legends have the controls laid out as follows: gas inlet union, gas solenoid valve, combination valve and manual firing valve then main burner orifice. The new arrangement is to have: gas inlet union, combination valve, solenoid valve, firing valve and then main burner orifice. Your modified gas train should look like the picture below.



BURNER SPACER INSTRUCTIONS

- TURN OFF POWER AND SHUT OFF GAS TO THE BOILER.
- REMOVE THE BURNER BY DISCONNECTING THE GAS ORIFICE UNION, THE BLOWER ADAPTER AND REMOVING THE NUT FROM THE SIX STUDS AROUND THE FLANGE AT THE TOP PLATE.
- PLACE THE SPACER WITH THE RED GASKET FACING UP OVER THE STUDS- LEAVE THE ORIGINAL GASKET ON THE TOP PLATE AS SHOW IN THE DIAGRAM.
- PLACE BOTH BURNER INSULATION PADS ON THE BASE OF THE BURNER.
- REPLACE THE BURNER, GASKET AND PREMIX TUBE FLANGE AS SHOWN.
- THE U-BOLTS THAT HOLD THE GAS TRAIN TO THE FRAME MUST BE LOOSENED TO ALLOW THE 3/8" RUBBER SHIM TO BE PLACED BETWEEN THE FRAME AND THE GAS TRAIN PIPE.
- REMOVE THE BLOWER
- REMOVE THE BLOWER SUPPORT BRACKET BY REMOVING THE NUT FROM THE STUD ATTACHED TO THE TUB FRAME.
- REPLACE WITH THE NEW BLOWER SUPPORT BRACKET INCLUDED IN THE KIT. A SCREW HOLE WILL NEED TO BE DRILLED INTO THE JACKET FRAME FOR ADDITIONAL SCREW.
- REMOVE THE BLOWER SHUTTER BY REMOVING THE NUT FROM THE BLOWER ADAPTER ASSEMBLY.
- REPLACE WITH THE NEW BLOWER SHUTTER INCLUDED IN THE KIT.
- REPLACE ALL PARTS REMOVED ABOVE.
- TURN THE GAS SUPPLY AND POWER "ON" AND RESTART THE BOILER.



FLAMMABLE ITEMS

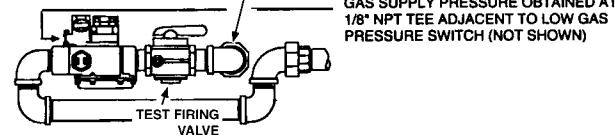


Flammable items or pressurized containers of any other potentially hazardous articles must never be placed on or adjacent to the heater. Open containers of flammable material should not be stored or used in the same room with the heater or in the area of the exterior air intake of a direct vent installation. Direct venting does not eliminate the need to remove flammables or corrosives from the area surrounding the heater.

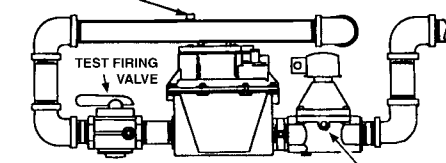
GAS PRESSURE REQUIREMENTS

**LW/LB-500 (NATURAL & PROPANE GAS CANADA)
(PROPANE GAS U.S.A.)**

MANIFOLD PRESSURE TAP LOCATED ON PIPE (NOT SHOWN)
BETWEEN ELBOW AND UNION ORIFICE.
NOTE: RESTRICTED GAS PRESSURE SWITCH MUST BE
REMOVED TO EXPOSE 1/8" NPT OPENING.



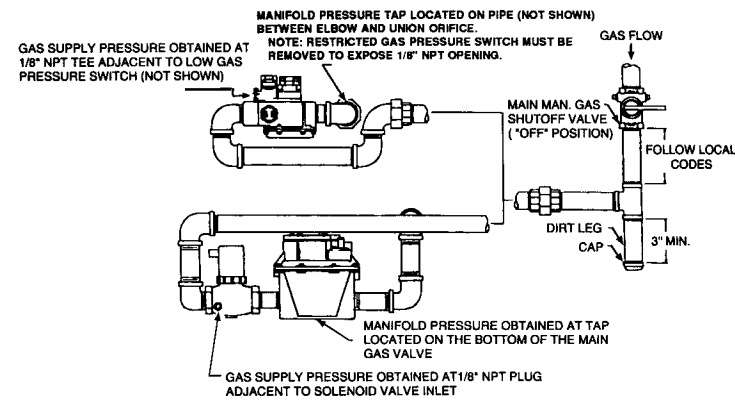
MANIFOLD PRESSURE OBTAINED AT TAP
LOCATED IN CENTER OF PIPE NIPPLE



GAS SUPPLY PRESSURE OBTAINED AT 1/8" NPT PLUG
ADJACENT TO SOLENOID VALVE INLET

**LW/LB-750 (CANADA)
NATURAL GAS**

LW/LB-500 (U.S.A.) NATURAL GAS



**LW/LB-750 (U.S.A.)
NATURAL GAS**

Ref: Operation information table on page 19.

The **supply** gas pressure is measured at the tap indicated. This reading must be measured with 'flowing' gas.

The **manifold** gas pressure is measured at the manifold pressure tap as indicated.

Product Update: Legend Boilers LB/LW-1000

The field repair kit for Legend 1 MBH has been released. This kit is not only recommended for units experiencing hard starts, but is also recommended for units with periodic lock-out problems.

Spacer Kit At Includes:

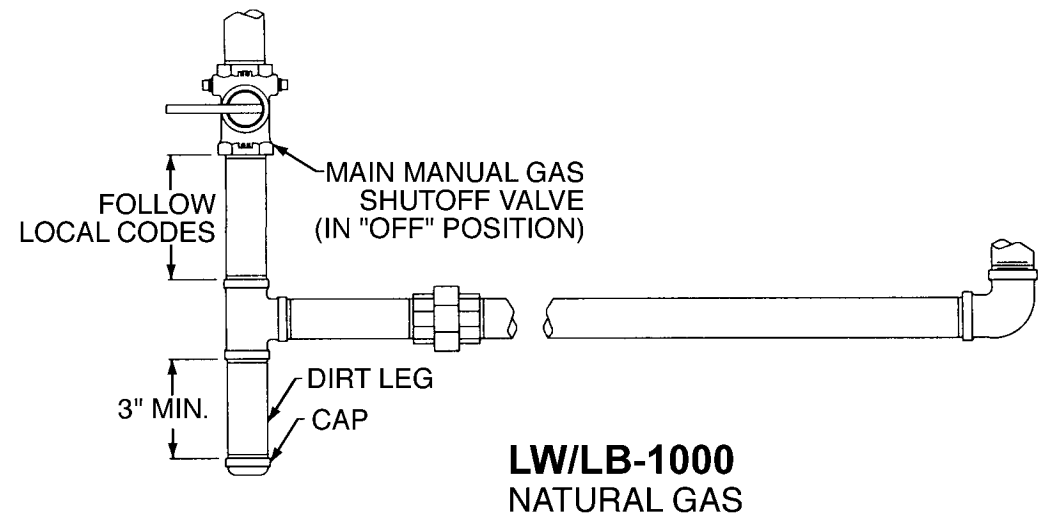
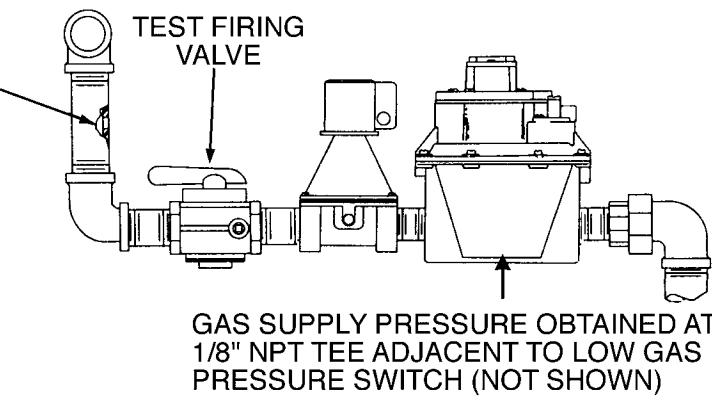
- Burner Spacer Assembly
- Revised Air Shutter
- Blower Support Bracket
- Gas Line Shim
- Instructions

After Burner Spacer Kit has been installed. The service agent needs to repeat the start-up procedures.

- Blower pressure should be set between 4.5" and 5" w.c.
- Gas manifold pressure should be set between 3" w.c. and 3.5" w.c.
- CO₂ readings should be:
8.0 to 9.5% for Natural Gas
8.5 to 10.0% for Propane

GAS PRESSURE REQUIREMENTS

MANIFOLD PRESSURE TAP LOCATED ON PIPE AS SHOWN.
NOTE: RESTRICTED GAS PRESSURE SWITCH MUST BE REMOVED TO EXPOSE 1/8" NPT OPENING



The **supply** gas pressure is measured at the tap indicated. This reading must be measured with 'flowing' gas.

The **manifold** gas pressure is measured at the manifold pressure tap as indicated.

IRI Equipped Models – Cont.

1. The System Controller (i.e. tank temperature control, room thermostat, etc.) closes "calling for heat." If the water temperature is below the OPERATING CONTROL setting, its contacts remain closed.

Note: In absence of a System Controller, the Operating Control will act as a substitute (on constant pumping applications only).

2. This powers the "J2-9" contacts on the Ignition Module which in turn powers the "J1-1" contacts. The coil (1 R) in the 120 VAC DPST relay is now energized which closes its contacts to the Circulating Pump and the Blower. Both Blower and Circulating Pump come on [pre-purge cycle begins].
3. With the Blower and Pump operational, the Air Flow Switch and Water Flow Switch contacts close. The Low Water Cutoff contacts are closed if the boiler is full of water.
4. If the circulating water temperature is below the High Limit Control setting, its contacts remain closed.
5. When the gas supply pressure rises above the Low Gas Pressure Switch setting, the contacts close. The High Gas Pressure Switch contacts are normally closed. If the gas valve outlet pressure rises above the set point, the switch contacts will open.
6. The Blocked Flue Switch contacts are normally closed. If the exhaust pipe vent is blocked, the switch contacts will open.
7. With all switches closed, the "J2-6" contacts on the ignition module is powered.
8. Once the pre-purge cycle ends, the Ignitor is energized and the proving period begins (the Ignitor should begin to glow).
9. After the Ignitor current reaches a preset amperage, the "J1-3" contacts and the flame rectification circuit in ignition module are energized. The Gas Valves are now powered. The position indicator switches on the gas valves change states and the "J2-7" contacts are energized. The proving period ends and Trial For Ignition (TFI) begins.
10. The Ignitor ignites the incoming gas mixture. Upon proof of flame, the ignitor is shut-off and it will now act as a flame sensor, monitoring the continued presence of flame.
 - A. If the flame is sensed by the Ignitor, power to the Ignitor is disconnected, the glow diminishes and the flame remains on.

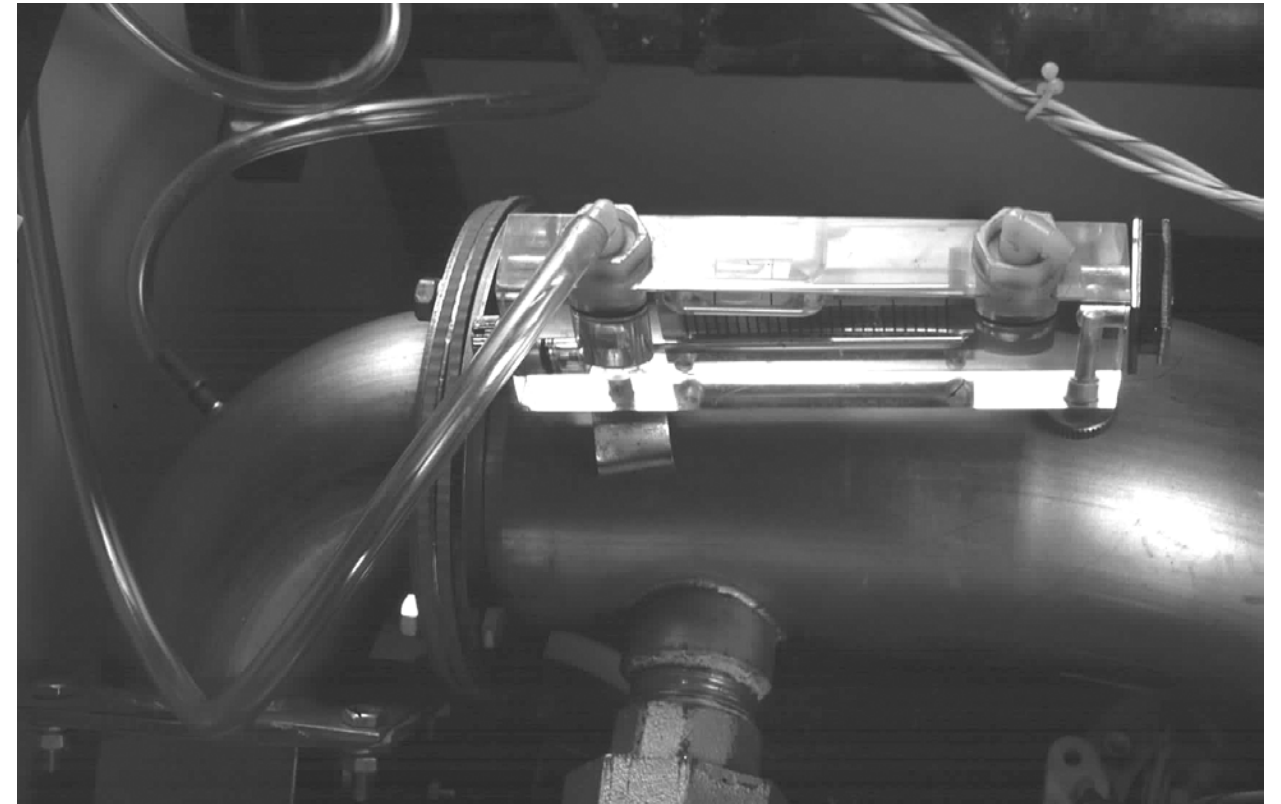
14. The High Limit may be checked by, noting all temperature settings, changing the settings, changing the system controller and operating control to a higher set point than the limit itself and running the boiler. Allow the boiler to shut down on High Limit. This can be accomplished quicker by having the High Limit set just above the actual outlet temperature indicated on the LED. After shut down, the boiler should not fire up until the manual reset button is depressed and power to the unit is reset. The operating control and the system controller may be tested in a similar fashion but a shut down on either will not require the power to the boiler to be reset. Return all temperature settings to the original positions upon completion of tests.
15. Safety valves may be checked for proper closure upon loss of flame. The valves should positively stop the flow of gas to the burner within 5 seconds of being de-energized. The voltage to the valve terminals may be checked for loss of power when a flame failure occurs by closing the manual test firing valve just ahead of the gas orifice location. Plugged leak test valves have been provided on the downstream side of both safety shut-off valves. The leak test valve for the second safety shut-off valve is located in the gas piping between the safety shut-off valve and the manual shut-off valve. The plug may be removed to allow a pressure gauge to be inserted to verify proper closure of the valves. The first safety shut-off valve may be checked by energizing the vent valve solenoid to close it and closing the manual shut-off valve. The safety shut-off valve should close and the pressure should stabilize. The second safety shut-off valve may be checked while the manual shut-off valve is closed. De-energize the vent valve second safety shut-off valve and the manual shut-off and verify that the pressure is stabilized between the valve. The pressure should not drop to ensure positive closure. In either case, if a steady increase in pressure is indicated, the valve under test should be replaced.
16. The dirt leg and gas strainer (if required) should be inspected periodically for accumulation of foreign debris that could cause blockage. Gas should be shut off ahead of the particular device to be cleaned or inspected to prevent gas leakage.

OPERATING SEQUENCE

The IRI version of the RAM Ignition Module provides for a single ignition trial or a single flame failure condition before a lockout occurs. An alarm is sounded in the event of a lockout condition. A lockout requires that the power to the boiler be manually reset. Once the ON/OFF switch closes, the "POWER" on the DIA-SCAN lights up and uninterrupted power is applied to:

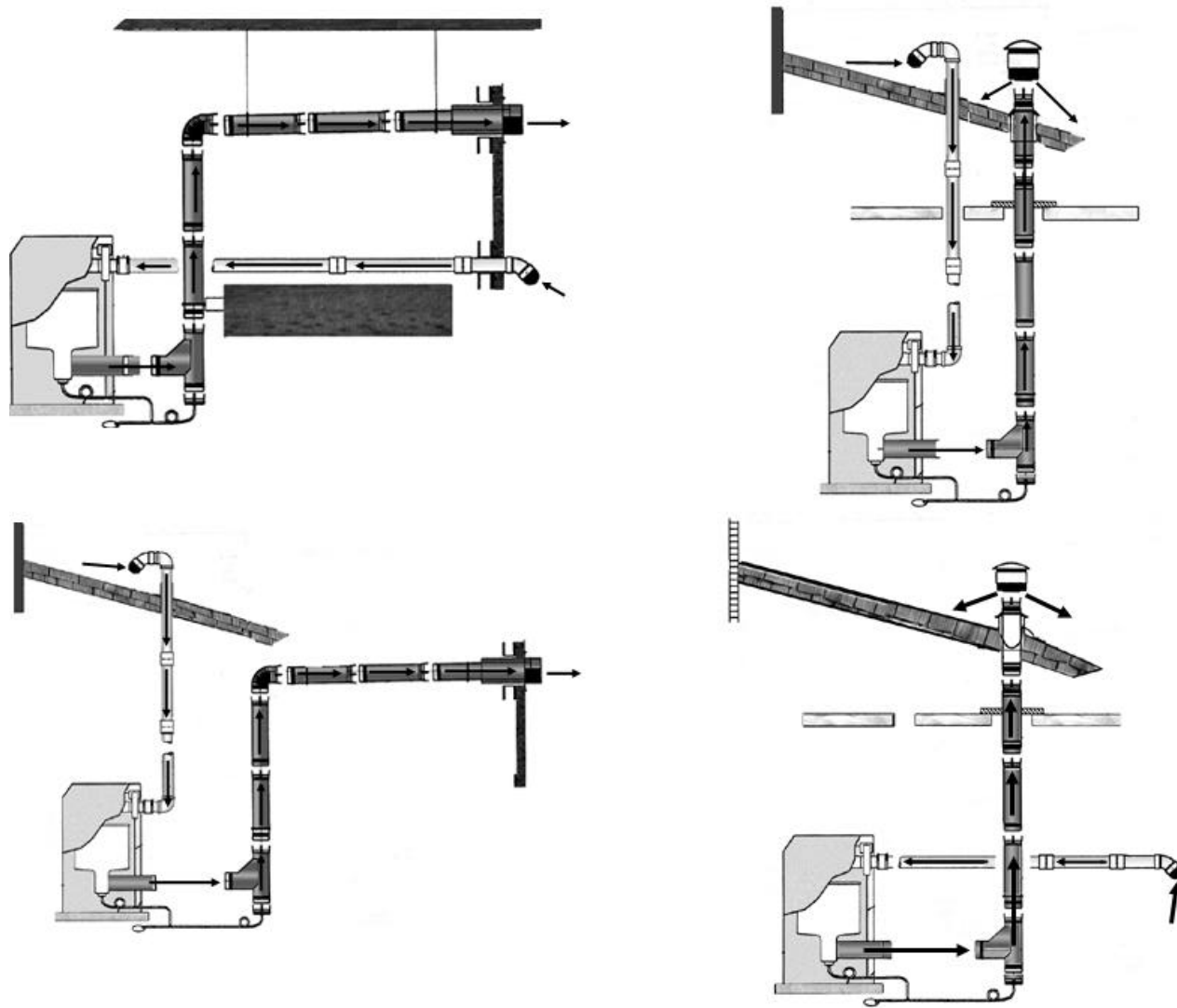
- A) 120/24 VAC Transformer (LINE)
- B) "J1-2" on RAM Ignition Module (LINE)
- C) "J2-8" on RAM Ignition Module (24 VAC)

AIR PRESSURE CHECK WITH DRAFT GAUGE



Only the LW/LB-1000 has an adjustable air shutter. Typically, the service agent will adjust this air shutter for a 4.5-5.0" positive w.c. air pressure reading at the blower outlet for smoothest ignition. Note: (The models 500 and 750 have a blower rheostat to allow adjustment for smooth ignition.)

VENTING OPTIONS



Outside air intake and exhaust terminations should be located so exhausted flue gas moisture will not condense and freeze over the air intake or cause a nuisance or hazard to pedestrians or the equipment. (Ref: NFPA 54, ANSI Z223. 1, for complete Guidelines).

Direct Venting: Maximum 60 equivalent feet exhaust and 60 equivalent feet intake air vent.

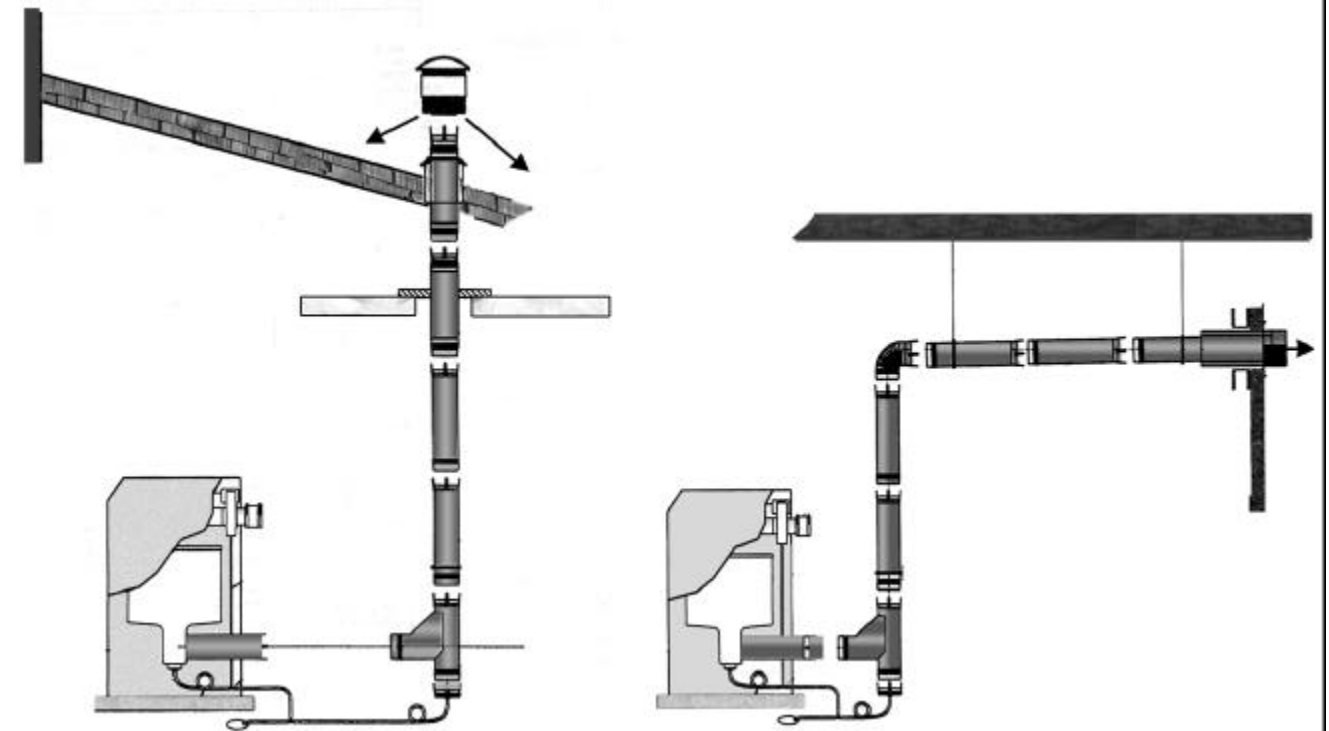
TABLE 1 PERIODIC TESTING RECOMMENDATIONS FOR IRI
EQUIPPED MODELS

Item	Frequency	Accomplished By	Remarks
1. Gages and Indicators	Daily	Operator	Visually inspect, log observations
2. Burner Flame	Daily	Operator	Visually inspect for uniform blue flames
3. Flame Signal Strength	Weekly	Operator	Check flame signal strength with meter and log
4. Flame Failure Detection	Weekly	Operator	Close Manual Shutoff Valve, check safety shutdown time, log
5. Gas Valves	Weekly	Operator	Open Operating Control, listen for valve closure, check for voltage
6. Flow Switch/ Low Water cutoff	Weekly	Operator	See detailed instructions
7. Vent System	Monthly	Operator	See Operating Manual
8. Condensate Drains	Monthly	Operator	See Operating Manual
9. Blocked flue and blower	Monthly	Operator	See detailed instructions
10. Gas pressure switches	Monthly	Operator	See detailed instructions
11. Burner components	Semiannually	Service Technician	See detailed instructions
12. Transformer	Semiannually	Service Technician	Check primary & secondary voltage, log
13. High Limit and Operating Control	Annually	Service Technician	See detailed instructions
14. Safety Valves	As Required	Operator	See detailed instructions
15. Drip Leg and gas strainer	As Required	Operator	See detailed instructions

IRI Equipped Models – Cont.

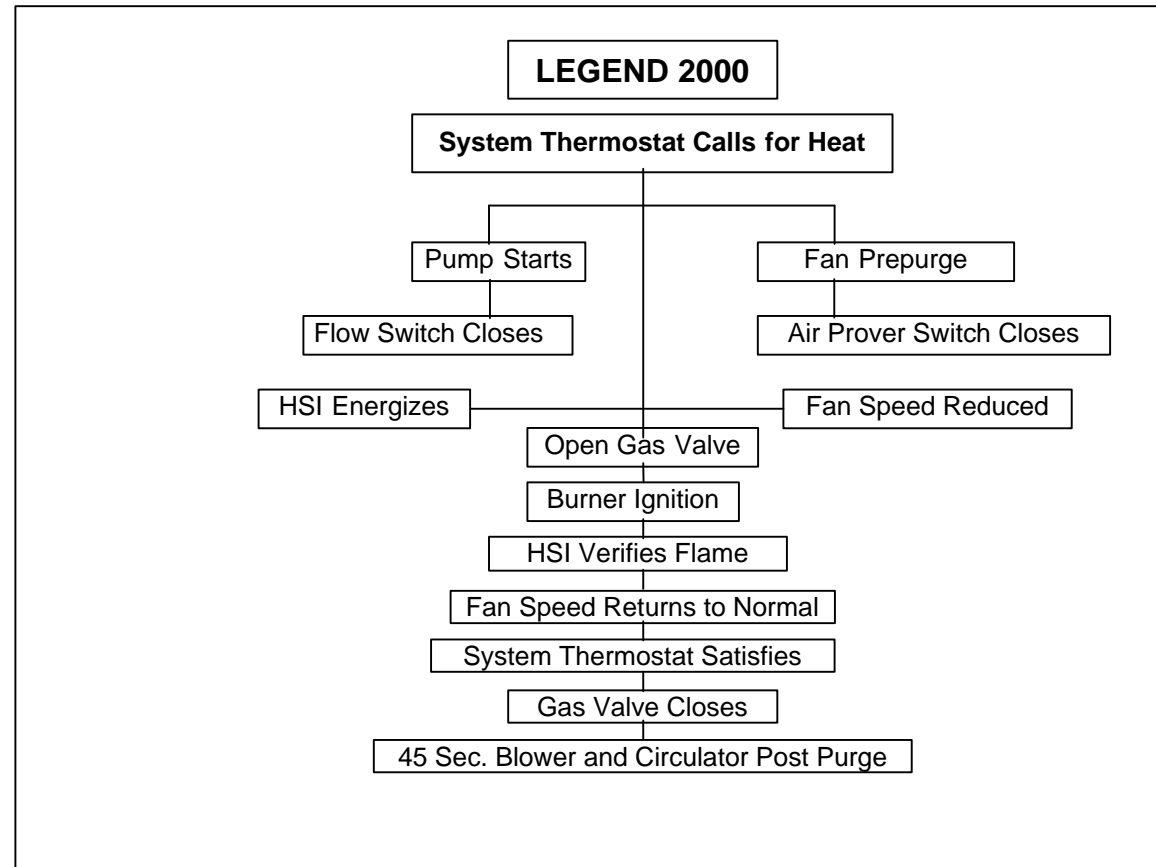
4. or in the range of 40 - 400 Ohms for the LW/LB-500&750 ignitor.
5. If a flame failure is detected the boiler should shut off within one second. This may be accomplished by closing the manual shutoff valve just ahead of the gas orifice, checking for gas valve closure and timing by watching the Dia-Scan indicator or checking voltage at the gas valve.
6. Open the operating control contacts by momentarily turning the dial down until "satisfied". Listen for valve closure and verify no voltage to either valve. Return operating control to its normal setting.
7. The flow switch may be tested by verifying switch position when water is flowing through the system and when flow ceases. With water flowing through the system, the circuit between the red and yellow terminals on the switch will be closed. When water flow drops or ceases in the system, the circuit between the red and yellow terminals will be open. These two conditions may be verified with a continuity meter. The low water cutoff can be tested by checking for continuity between terminals 3 & 4. With no water present there should be no continuity.
8. The vent system shall be maintained per the Venting Maintenance section in the operation manual.
9. The condensate lines shall be maintained per the Condensate Removal System section in the operation manual.
10. The blocked flue switch contacts may be opened by applying a positive pressure greater than 1 " w.c. to the barbed fitting. The boiler will shut down if running or not start up. The blower prover switch may be checked by disconnecting the tube at its barbed fitting. The boiler will shut down if running or not start up. A manual reset of power to the boiler is required to start up again.
11. The low gas pressure switch contacts may be opened by closing the manual shutoff valve in the gas supply to the boiler. The boiler will shut down if running or not start up. The high gas pressure switch requires an increase in gas pressure in order for its contacts to be opened. The boiler will shut down if running or won't start if gas pressure in excess of 1 1/2 times its normal manifold pressure is applied at its connecting port. A shut down on any of the switches in the safety circuit will require a reset of the power to the boiler.
12. The burner should be maintained per the Burner Maintenance Section of the operation manual.
13. The transformer voltages can be checked with a voltmeter and the values recorded.

CONVENTIONAL VENTING



Conventional Venting - May be horizontal or vertical. Maximum of 60 equivalent feet of exhaust vent. (Uses room air for intake.)

LADDER DIAGRAM



SEQUENCE OF OPERATION

To understand Legend water heaters, an examination of their sequence of operation is necessary.

IRI Equipped Models – Cont.

inspection and maintenance may be necessary.

Precautions shall be taken to protect against bodily injury or property damage while tests are being conducted. Cover plates that require removal in order to gain access to items requiring maintenance or testing shall be replaced before the boiler is put back into service.

Operators or maintenance technicians should follow the recommended procedures set forth in the instructions and allow for any additional circumstances that arise based on the particular installation when preparing a maintenance program.

The operator or technician should thoroughly understand the operating procedures and recognize an equipment malfunction. Any defects found should be corrected immediately.

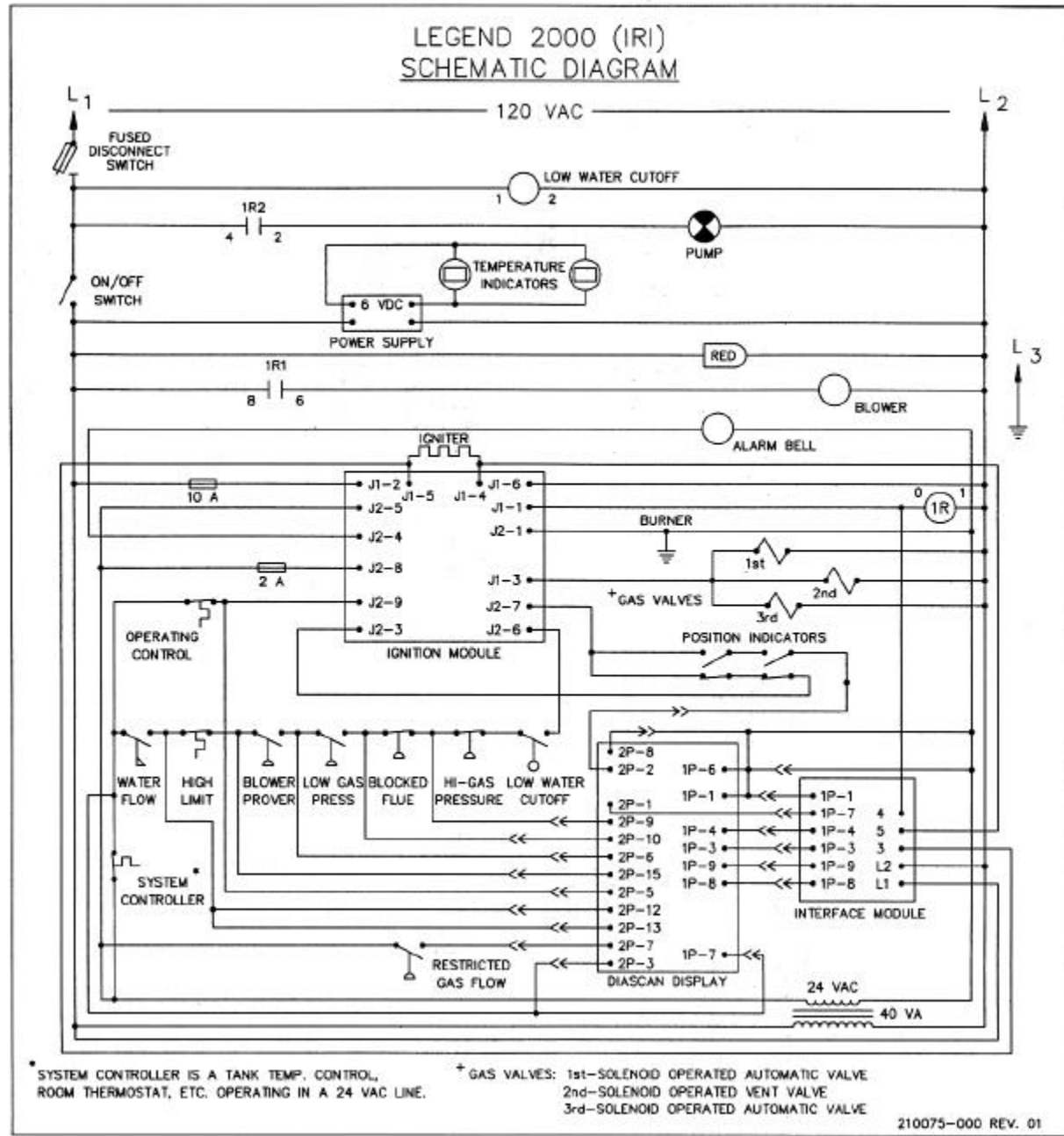
The table provided herein is a recommended guideline to follow for periodic testing of the boilers safety devices and controls. Detailed maintenance procedures are included. The results of the periodic testing should be recorded in a suitable log book at the time of testing.

TESTING AND MAINTENANCE INSTRUCTIONS

1. Dia Scan indicators should be visually inspected on a daily basis for normal operation of the boiler. The temperature indicators should be inspected and the differential temperatures recorded while the boiler is firing. If the temperature differential increases by five degrees from the time the boiler was first put into service, a general deliming of the heat exchanger may be in order. The initial temperature differential should be established per the procedures in the operation manual.
2. Visually inspect the flame through the observation port for a uniform hard blue flame.
3. The flame signal strength may be checked by placing a digital multimeter in series with the sensor lead. The red lead should be unplugged from the ignitor and the meter inserted in series. Once the boiler has established a flame, a signal of at least one microamp should be indicated. If a weaker signal is present, then the flame may not be impinging on the ignitor properly or the ignitor may be at fault. To check for a faulty ignitor the cold resistance is measured by shutting the boiler down and allowing the ignitor to cool to room temperature. The ignitor leads are then disconnected and an Ohm meter is hooked up across the leads. The resistance value should be in the range of 45 - 75 Ohms for the LW/LB-1000 Ignitor

IRI Equipped Models – Cont.

LEGEND 2000 IRI SCHEMATIC DIAGRAM

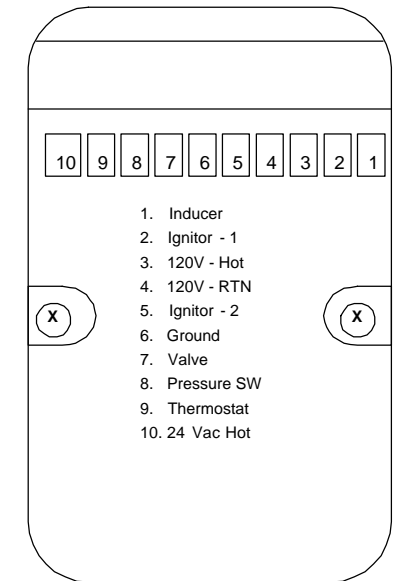


TOUBLESHOOTING LEGEND WATER HEATERS

To troubleshoot a Legend water heater check that:

- 120 VAC is supplied to the heater
- the system is full of water
- gas is supplied to the unit
- the heater is properly grounded
- vent installation is proper
- combustion air is provided
- condensate drain tubes are operational
- on/off switch is "on"

RAM HSI Control



LEGEND OPERATING INFORMATION TABLE

Model Description	Model 500	Model 750	Model 1000
Air Blower	4.5-5.0" w.c. Positive Exhaust Pressure		
Blocked Flue Switch	1.0" w.c. Positive to Close		
Blower Prover Switch	1.0" w.c. Positive to Close		
Low Gas Pressure Switch	5.5" w.c. Supply press to close (Min 7.0" w.c. recommended) - Natural Gas 10.5" w.c. Supply press to close (11.5" w.c. recommended) - Propane Gas		
Restricted Gas Pressure Switch	.15" w.c. Positive to Close		
Manifold Gas Pressure	Approximately 3.5" w.c. - Natural Gas Approximately 10.0" w.c. - Propane Gas		
Water Flow Switch	25 GPH Flow Closes		
Hot Surface Ignitor (HSI) Surface	Cold - 75-400 OHMS		Cold - 40-75 OHMS

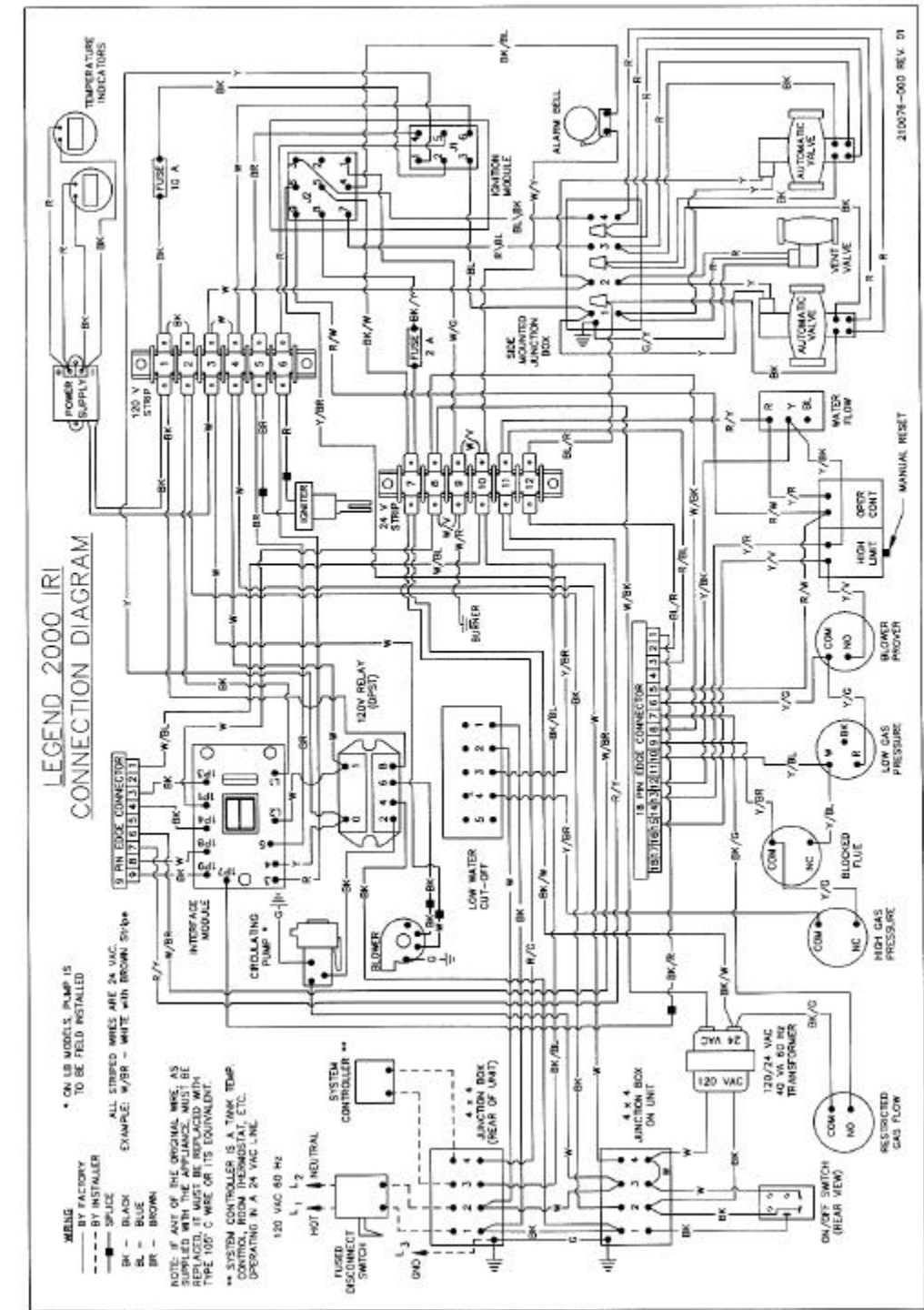
SUPPLY VOLTAGE POLARITY CHECK



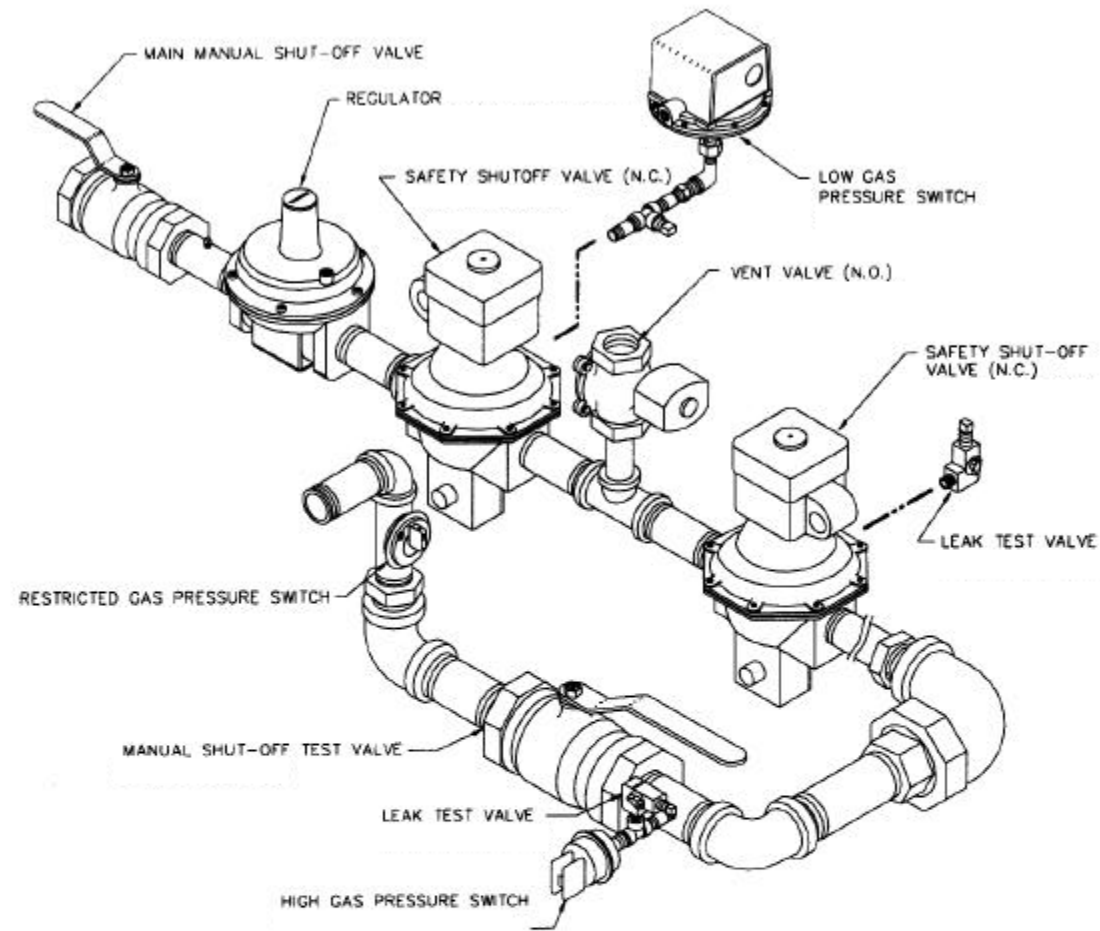
S T E P	1	Supply voltage Polarity Check
	Using a multimeter, check supply black to ground, white to ground and green to ground voltage (in the junction box on the back of the Legend).	

RESULTS	
If the meter:	then
does not read 120 VAC	check supply voltage
does read 120 VAC	go to Step 2.
does not read "0" white to ground	check supply wiring
does read "0" white to ground	go to Step 2.

LEGEND 2000 IRI CONNECTION DIAGRAM



TYPICAL I.R.I. GAS TRAIN *



* NOTE: DETAIL SHOWS MINOR DIFFERENCES IN PIPING LAYOUT FOR LB, LW-500 & -750 MODELS

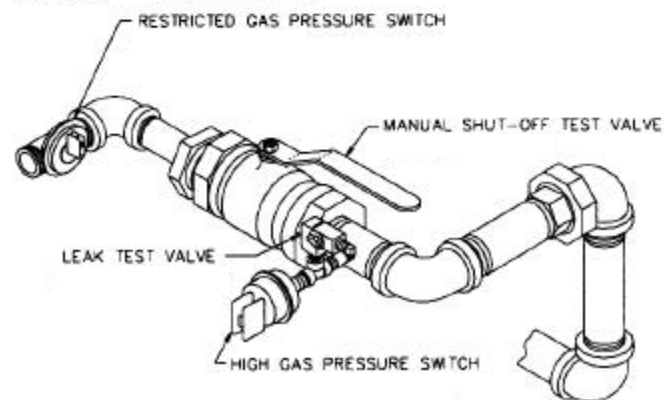


Figure 1

HSI CONTROL SUPPLY VOLTAGE TEST

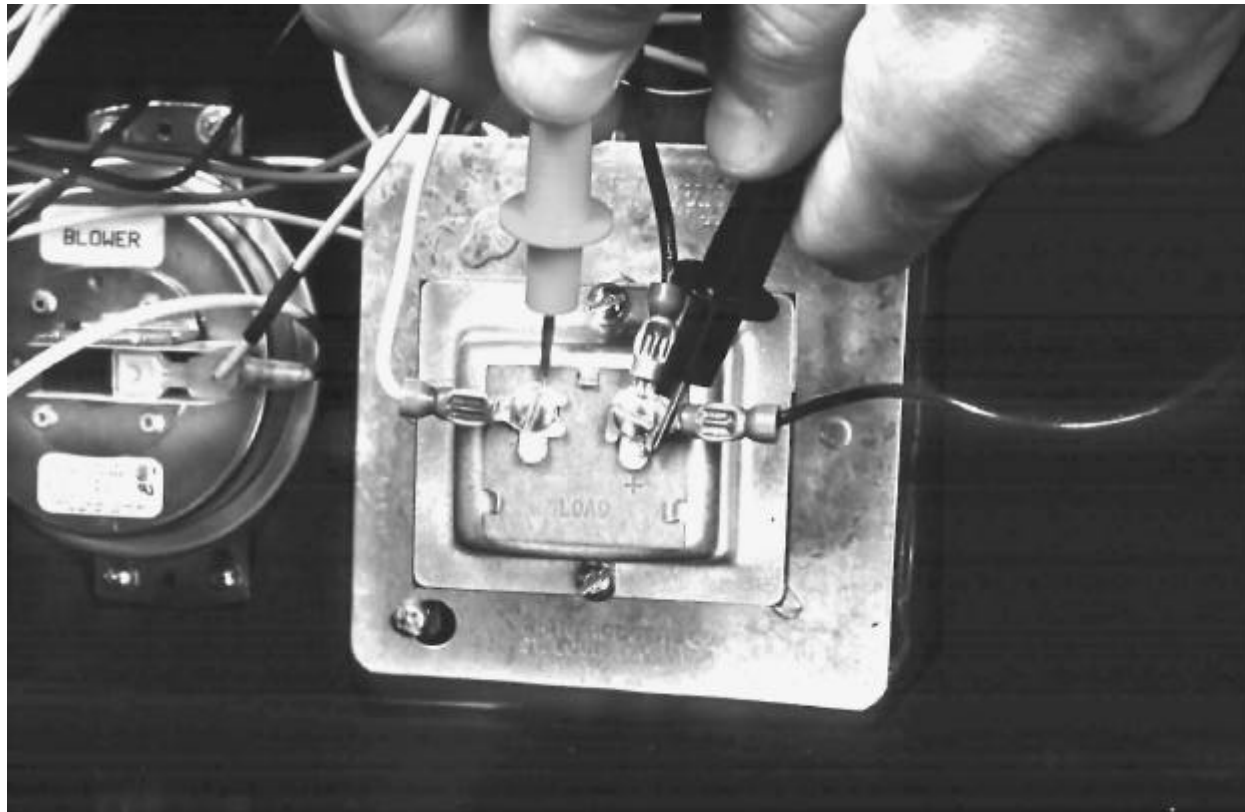


Hot Surface Ignition Control

S T E P	2	HSI Control Supply Voltage Test
		Test for 120 VAC between HSI terminal 3 and ground (terminal 6).

RESULTS	
If the meter:	then
does not read 120 VAC	<ul style="list-style-type: none"> • check wiring to On/Off switch. • check internal 10 amp fuse.
does read 120 VAC	go to step 3.

TRANSFORMER TEST – SECONDARY VOLTAGE



S T E P	3	Transformer Test – Secondary Voltage
		Test for 24 VAC between the two transformer terminals.

RESULTS	
If the meter:	then
does not read 24 VAC	<ul style="list-style-type: none"> • check 120 VAC supply connection to primary side of transformer. (Step 1) • replace transformer.
does read 24 VAC	go to step 4.

single trial version with an alarm contact. Any failure that is sensed by a component in the safety circuit or the gas valve position indicating switches will cause the boiler to simultaneously shut down the gas valves while opening the vent valve, purge the combustion chamber, continuously sound the alarm and lock out. The power to the ignition module must be manually reset to restart the boiler.

INSTALLATION

The gas control train has a main manual gas shutoff valve installed at the factory. A gas service pressure regulator is required to maintain a gas supply pressure below the maximum allowable pressure indicated on the appliance rating plate. A dirt leg shall be provided in the gas piping per the National Fuel Gas Code (NFPA 54).

Vent lines from gas regulators, switches, and any other equipment requiring atmospheric pressure to balance a control diaphragm can be manifolded together. The manifolded line should have a diameter not less than the largest vent line plus 50 % of the area of the additional vent lines. For example, if the largest vent line is 1/4 inch and the vent line from the safety switch is 1/8 inch, the manifolded line should be 5/16 inch minimum. These vent lines **should not** be manifolded to the following: Vent lines between the two safety shut-off valves.

Vent lines from the pressure relief valve if provided.

Vent lines from the ignition or main burner systems.

Vent lines from other boilers.

Vent lines between the two safety shut-off valves on the individual burner lines and the vent lines from the pressure relief valve, if provided, can be manifolded together. The diameter of the manifolded line must not be less than the largest vent line plus 50% of the area of the additional vent lines. These vent lines **should not** be manifolded to the following:

Vent lines from ignition or main burner systems.

Vent lines from other boilers.

A permanent means for making periodic tightness tests of the safety shut-off valves is provided for with the appropriate leak test valves located on the downstream side of each safety shut-off valve.

The boiler shall not be released for operation before the installation, checkout and start-up has been performed according to the installation, operation and maintenance manual, the LEGEND 2000 start- up procedures and this insert sheet.

TESTING AND MAINTENANCE

The effective operation of all safety and control devices depends upon their ability to respond to their activating impulses, therefore it is important that they remain in proper operating condition at all times. An inspection and maintenance schedule should be established and performed on a periodic basis. During initial operation, more frequent

A.O. SMITH COMMERCIAL COPPER HYDRONIC BOILERS
LEGEND 2000 SERIES I. R. I. MODELS

GENERAL

The LEGEND 2000 series of boilers, when constructed, installed, operated and maintained in accordance with the provisions set forth in this Insert along with the standard Instruction Manuals, is said to be in compliance with the Industrial Risk Insurers (IRI) position for a water tube boiler. The boiler is built in accordance with the ASME boiler and pressure vessel code and the IRI IM.4.1.1 information which references and modifies sections of the ANSI/NFPA 8501 Standard for single burner boilers and furnaces. This insert sheet is intended to supplement the Instruction Manuals set supplied with the boiler.

The importance of a well-maintained boiler installation is recognized by insurance companies. Where a plant does not have a sufficient staff trained in the complete maintenance of its boiler, a maintenance contract should be established with the boiler company or an organization which is knowledgeable regarding the boiler and all subsystems associated with it. Operation, maintenance and inspection should be in accordance with the National Boiler Inspection Code unless otherwise superseded by local codes.

Figure 1 shows a typical IRI gas control train for Legend 2000 models. The major components are identified with a description and part number. Note that the gas trains are similar with the exception of the gas pressure regulator, the high gas pressure switch, the ball valve and the piping layout as shown in the figure. The gas control train uses two solenoid operated gas valves with position indicating switches and a separate gas pressure regulator to control the flow of gas to the main burner. The gas manifold pressure is taken at the restricted gas flow switch location. The position indicating switches are monitored by the ignition module. A third solenoid valve located between the two larger valves is called a bleed or vent valve. The vent valve relieves any leakage through the seat of the first safety valve and prevents the development of pressure upon the seat of the second safety valve. This provides for additional security against fuel leakage into the combustion chamber when the burner is off. The vent valve is normally open and must be vented to the atmosphere according to the INSTALLATION instructions.

Figure 2 and 3 are the connection diagram and the schematic respectively. These models have additional safety features in the circuit as compared to standard models. The primary differences are the addition of the high gas pressure switch and the low water cutoff to the circuit. The Dia-Scan module does not indicate the high gas pressure switch or the low water cutoff, however the ignition module will energize an alarm bell in the event of a failure. The boilers operating sequence is controlled by the ignition module. The operating sequence, included, is similar to that of a standard LEGEND 2000 boiler but does not reduce blower speed at start up. The module is a

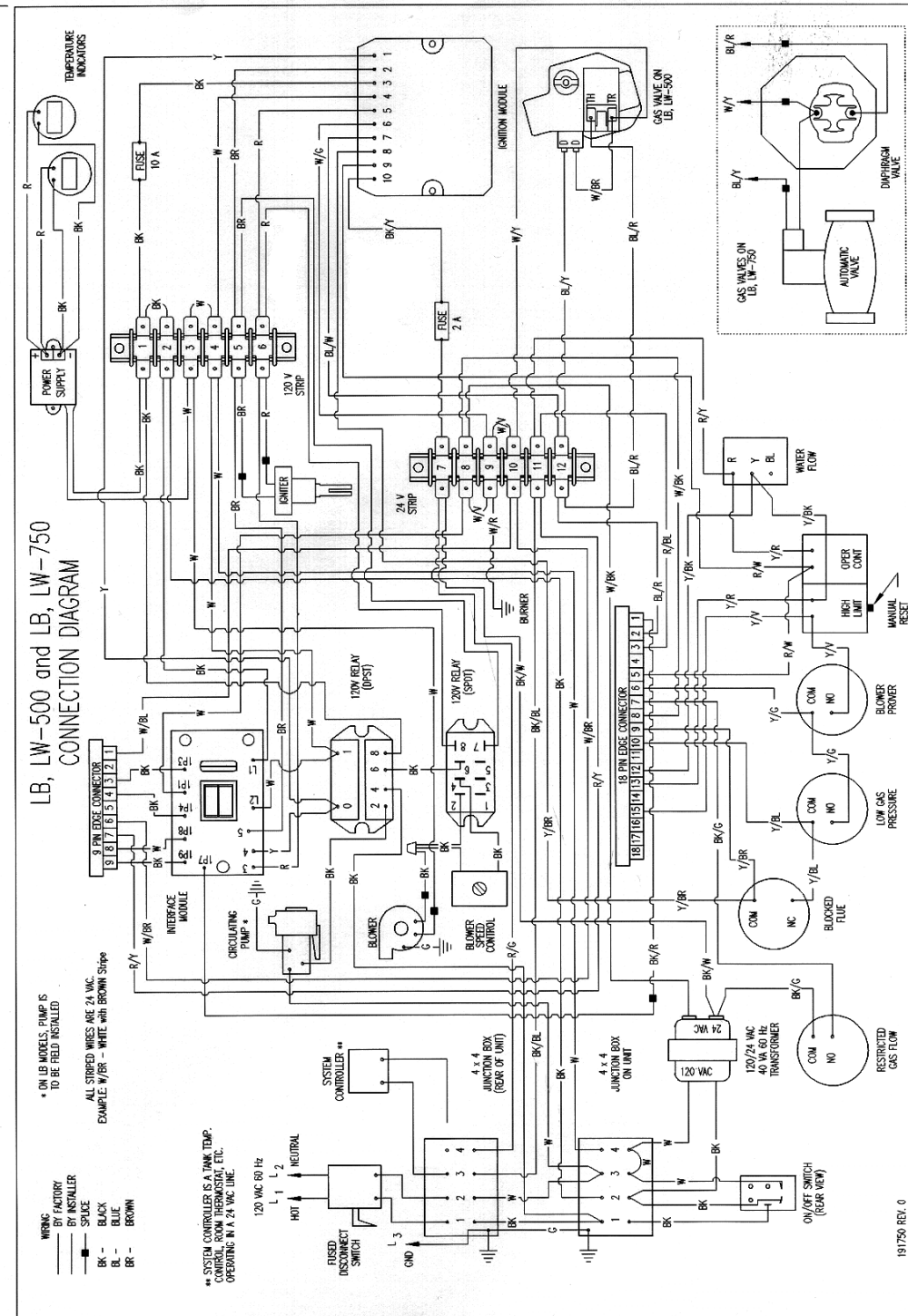
HSI CONTROL TEST (TERMINAL 10)



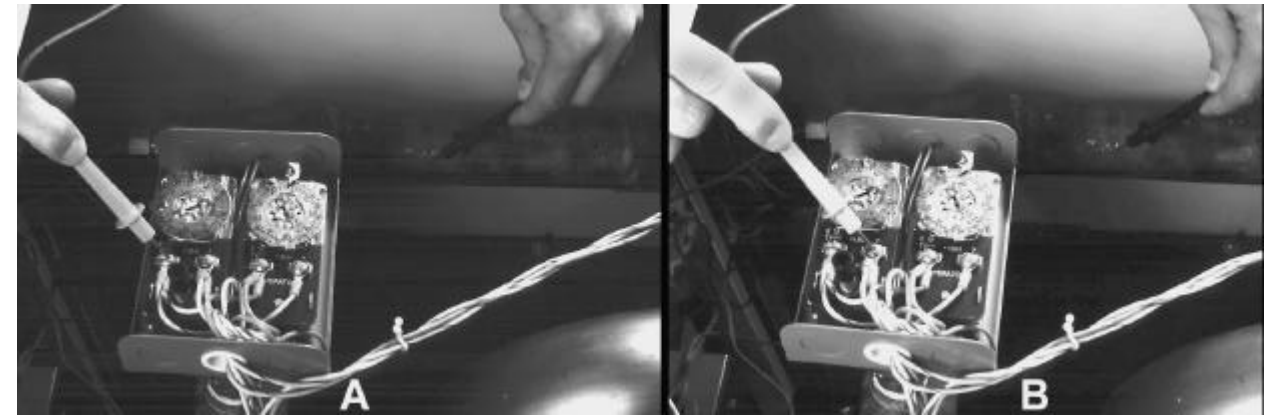
S T E P	4	HSI Control Test (Terminal 10)
		Test for 24 VAC between the Ram HSI control terminal 10 and ground (terminal 6).

RESULTS	
If the meter:	then
does not read 24 VAC	<ul style="list-style-type: none"> • check wiring to transformer. • check internal 2 Amp fuse.
does read 24 VAC	go to step 5.

CONNECTION WIRING DIAGRAM FOR LW/LB 500 AND 750



OPERATING CONTROL TEST



S T E P	6	Operating Control Test (This is the automatic reset high limit on domestic water applications.)
		Test for 24 VAC between each terminal of the operating control and ground.

RESULTS	
If the meter:	then
does not read 24 VAC from either terminal to ground	check wiring to system control.
does read 24 VAC to only one terminal and ground	<ul style="list-style-type: none"> first check temperature setting on control – (set at least 30° higher than system control (tank temperature control) setting and retest. if still no voltage, replace the control.
does read 24 VAC from each terminal to ground	go to 7.

HSI CONTROL TERMINAL 9 TEST



S T E P	7	HSI Control Terminal 9 Test
		Test for 24 VAC between Ram HSI control terminal 9 and ground (terminal 6).

RESULTS	
If the meter:	then
does not read 24 VAC	check wiring to operating control.
does read 24 VAC	go to Step 8.

TABLE FOR STEP 29

Gas Valve Coil – OHMS Resistance Table

LEGEND MODEL	GAS TYPE	#1 GAS VALVE MODEL	#1 GAS VALVE COIL OHMS*	#2 GAS VALVE MODEL	#2 G.V. COIL OHMS
LW/B-500	NG and LPG	Robertshaw 7000-DERHC-STA	69 (TH-TR)	—	14 (Safety Gas Value)
LW/B-750	NG	WR-2509-258	64	HNWL-V8843N1006	64
	LPG	HNWL-V88A1626	64	HNWL-V88A1626	64
LW/B-1000	NG	ITT-K3AF671S	5000	HNWL-V8843N1022	64
LW/B-1000	LPG	HNWL-V88A1626	64	HNWL-V88A1626	64

*Volts divided by AMPS = OHMS Resistance

Legend Gas Valve Table

Legend Model	Type Gas	Type Valve
500 for USA and Canada	Nat/Propane	Dual Solenoid
750 USA	Natural	Diaphragm Solenoid
	Propane	Diaphragm
USA & Canada	Natural	Diaphragm Solenoid
	Propane	Diaphragm Solenoid
1000 USA and Canada	Natural	Diaphragm Solenoid
	Propane	

MISCELLANEOUS INFORMATION ON LEGEND 2000

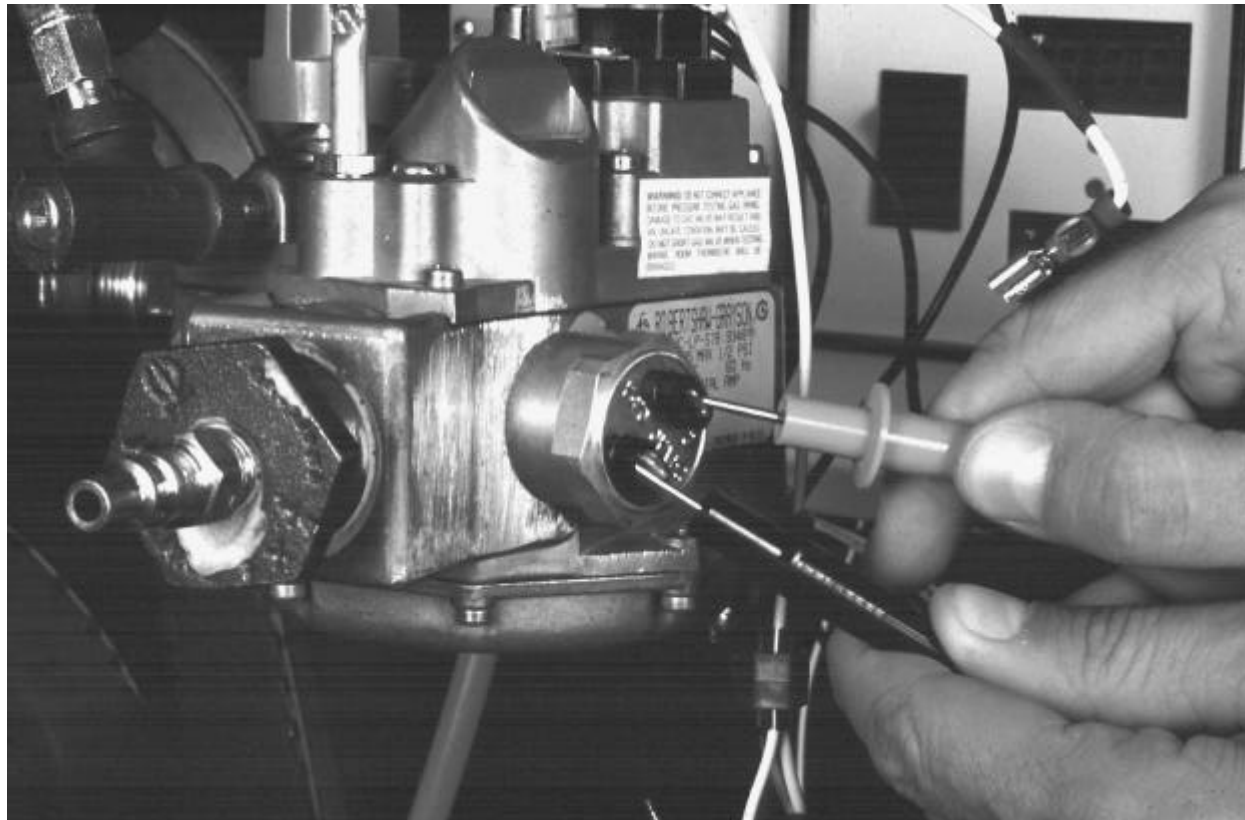
LW Circulator Information

Heater Model	Water GPM @ 20°TR	Pressure Drop thru Heater	Circulator HP	Circulator Motor
LW-500	44	12.5 ft. hd.	1	B&G 3531
LW-750	66	17.76 ft. hd.	1	B&G 3531
LW-1000	88	8.8 ft. hd.	1	TACO 1935

AMP DRAW TABLE

Heater Model	Blower Amp	Pump Amp	Ignition System
LW-500	120V; 3.5A	120V; 10.4FLA	120V; 5A Max
LW-750	120V; 3.5A	120V; 14.0FLA	120V; 5A Max
LW-1000	120V; 3.5A	120V; 15.4FLA	120V; 5A Max

GAS VALVE COIL(S) - CONTINUITY CHECK



- Power supply on/off switch is off
- Disconnect white (neutral) leads from gas valve(s)
- Multimeter set to 200 scale and batteries good

S T E P	29	Gas Valve Coil(s) – Continuity Check
		Test for coil resistance (OHMS) through each gas valve coil. See table (page 55) for proper reading.

RESULTS	
If the meter: reads "1" or "0"	then replace the gas valve.
reads more than +7.5% of value listed in table (next page)	replace the gas valve.
does read within +7.5% of value listed in table (next page)	gas valves should open and burner ignite.

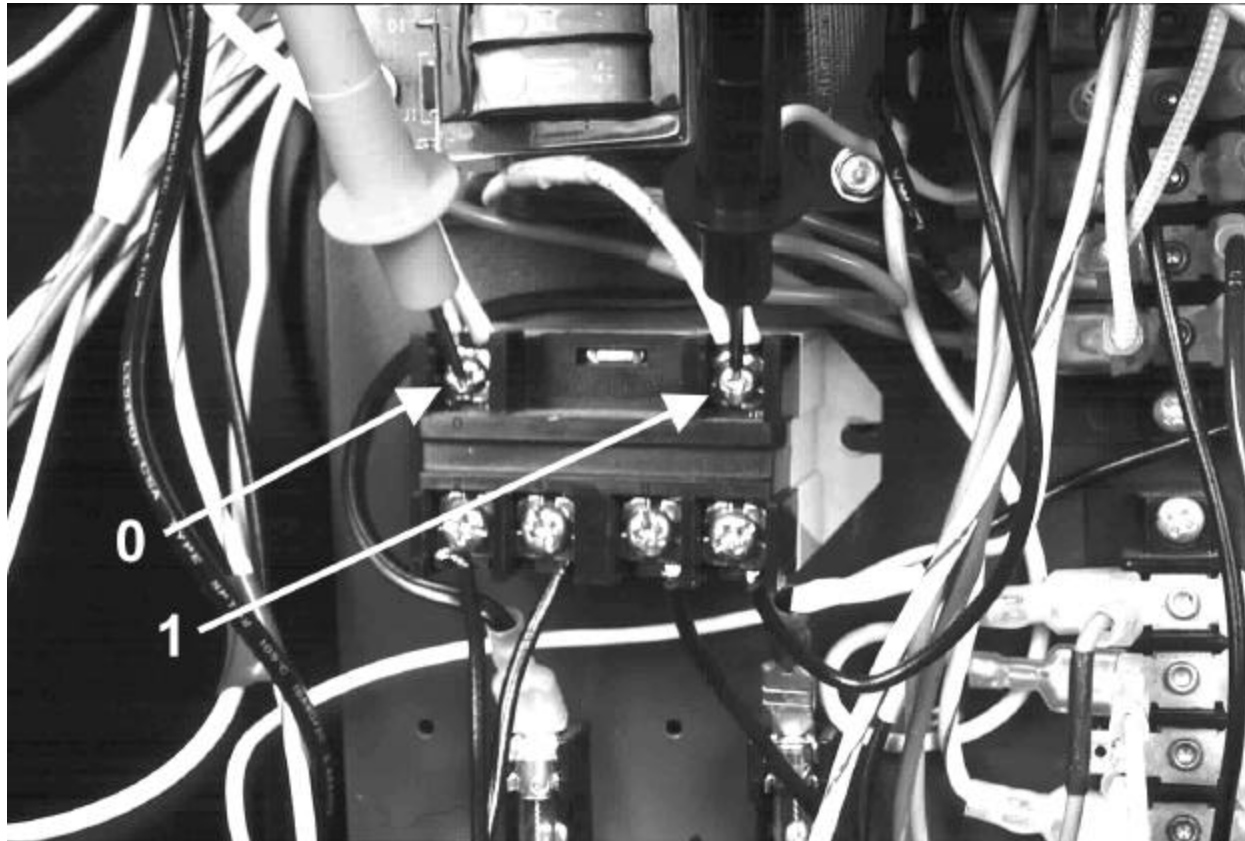
HSI CONTROL TERMINAL 1 TEST



S T E P	8	HSI Control Terminal 1 Test
		Test for 120 VAC between Ram HSI control terminal 1 and ground (terminal 6).

RESULTS	
If the meter: does not read 120 VAC	then replace Ram HSI Control.
does read 120 VAC	go to Step 9.

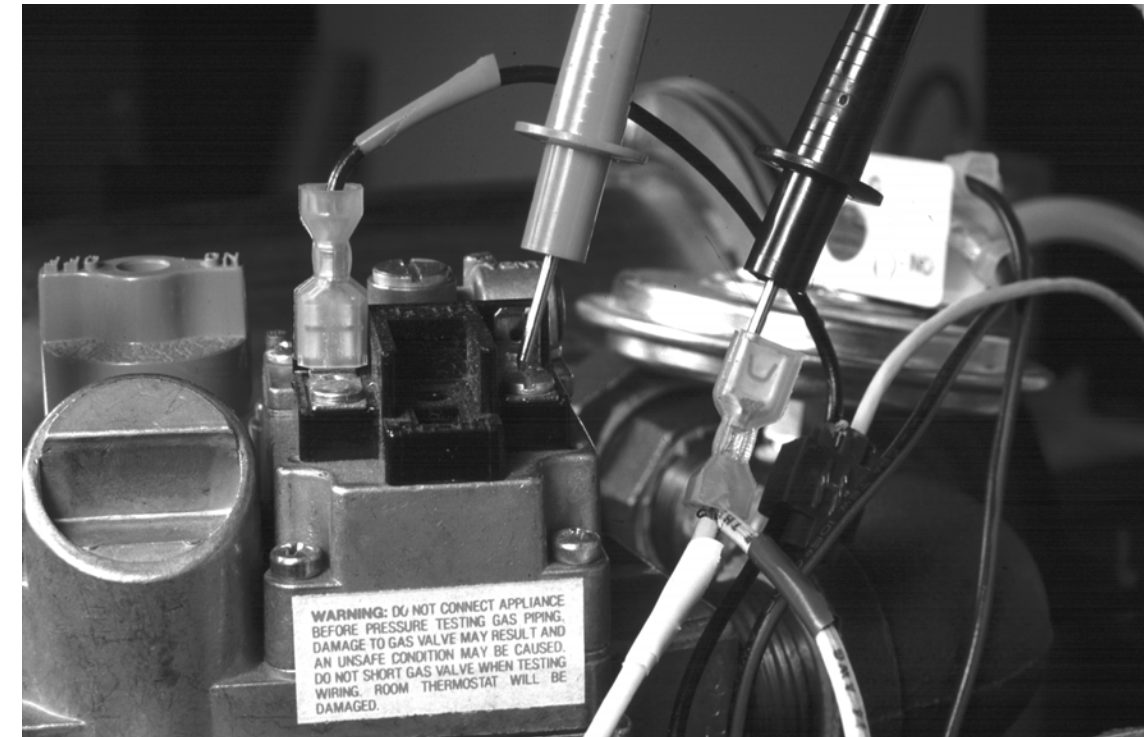
TEST OF 1R (DPST) RELAY – POWER SUPPLY



S T E P	9	Test of 1R (DPST) Relay - Power Supply
		Test for 120 VAC between terminals 0 and 1 on DPST Relay.

RESULTS	
If the meter:	then
does not read 120 VAC	check wiring to Ram HSI control terminal 1 and relay terminal 1.
does read 120 VAC	go to Step 10.

GAS VALVE(S) 24 VAC CHECK

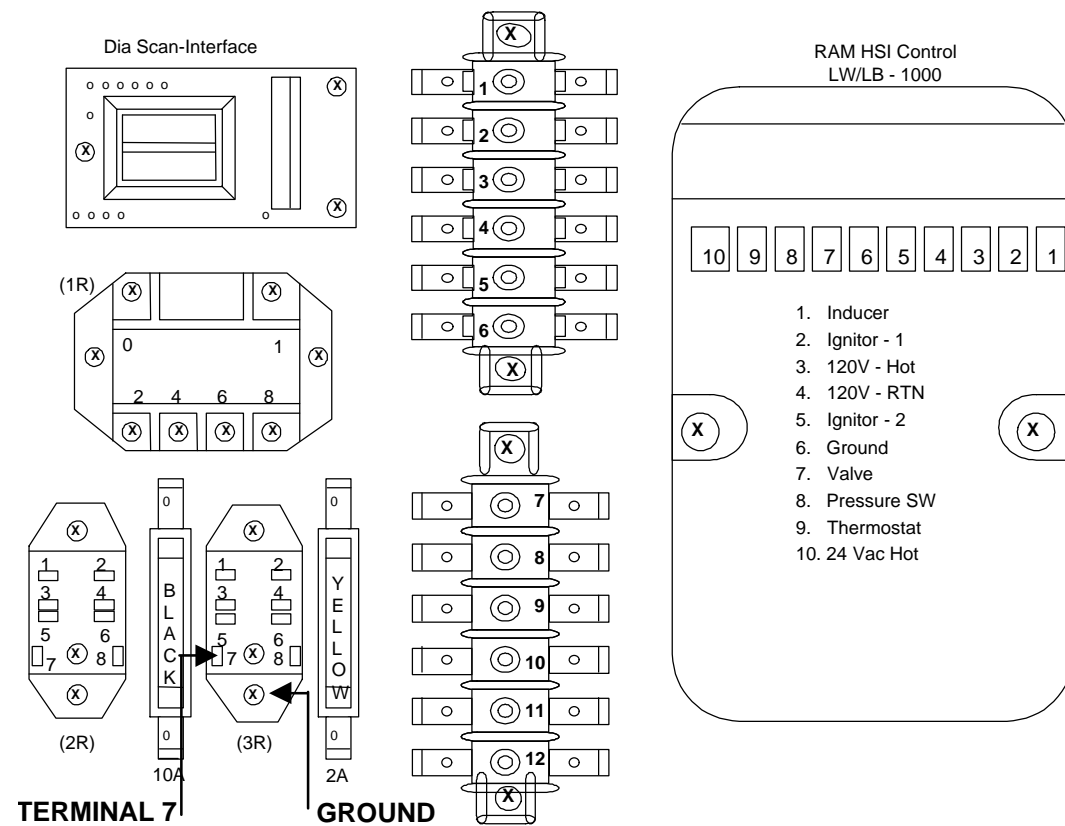


During 4 Second Trial for Ignition. Ref: Pages 57 and 58 Wiring Diagram

S T E P	28	Gas Valve(s) 24 VAC Check.
		Test For 24 VAC between ground and gas valve BL/Y connection and then ground and gas valve BL/R connection.

RESULTS	
If the meter:	then
does not read 24 VAC between the gas valve BL/Y wire connection and ground	correct wiring connections from RAM HSI control terminal 7 to lower (24V) terminal strip-terminal 12 to gas valve BL/Y wire terminal.
does not read 24 VAC between the gas valve BL/R wire connection and ground	correct wiring from RAM 7 to lower (24V) terminal strip - terminal 12 - to gas valve BL/R wire terminal.
does read 24 VAC between gas valve connection BL/R and also 24 VAC between gas valve BL/Y wire connection	go to Step 29.

3R RELAY (24V SPDT) TERMINAL 7 AND GROUND CHECK



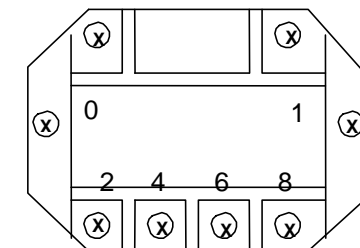
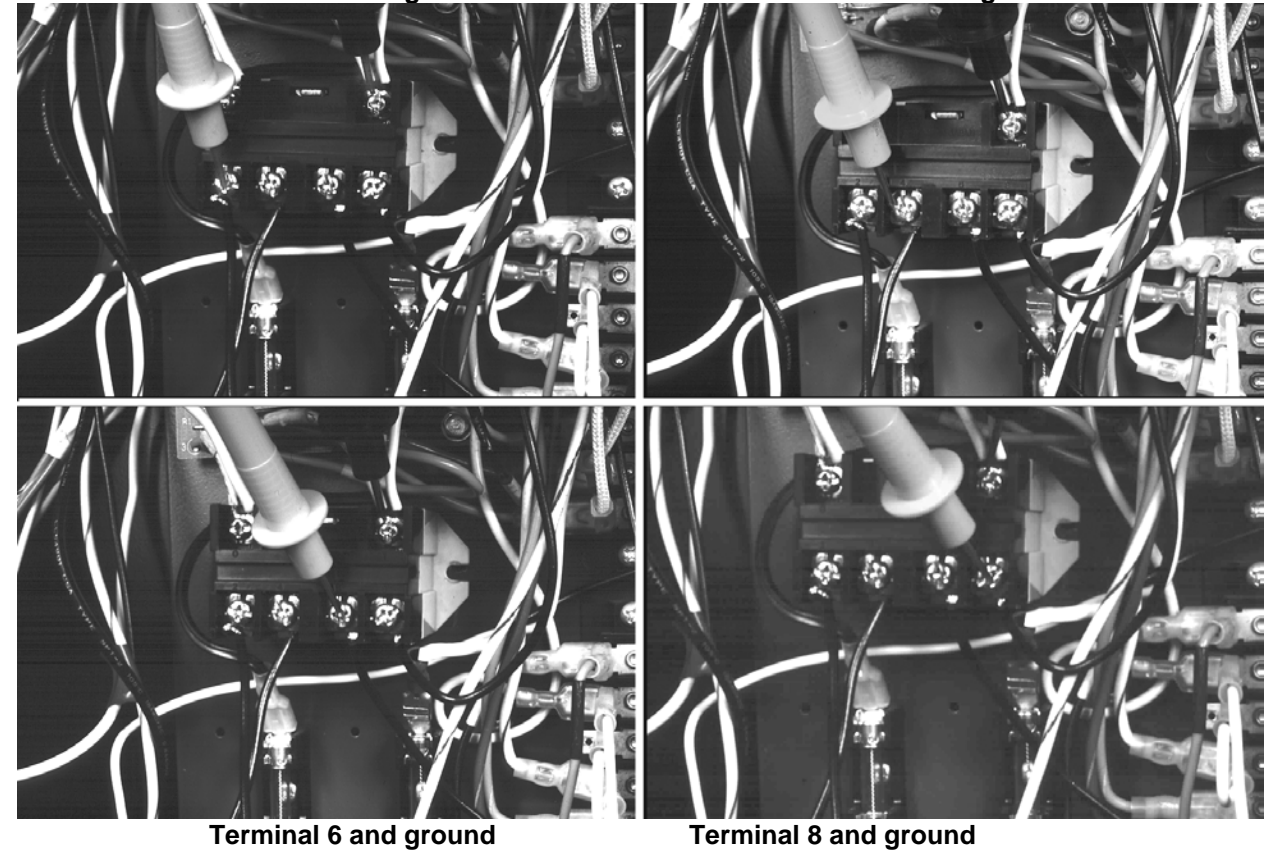
During 4 Second Trial for Ignition

3R Term 5 Still has 120 VAC, Blower Returns to Hi Speed.

S	T 27	E LW/LB	P 1000 only	3R Relay (24V SPDT) Terminal 7 and Ground and 3R Terminal 8 Wire and Ground Check
				Test for 24 VAC between 3R terminal 7 and ground and test for 24 VAC between the disconnected wire from 3R terminal 8 and ground.

RESULTS	
If the meter:	then
does not read 24 VAC from either 7 or the wire off of 8	correct the wire connection between RAM HSI control terminal 7 and 3R relay terminal 7.
reads 24 VAC from only one terminal (7)	replace 3R relay.
does read 24 VAC between 3R terminal 7 and ground and the disconnected wire from 3R terminal 8 and ground	go to Step 28.

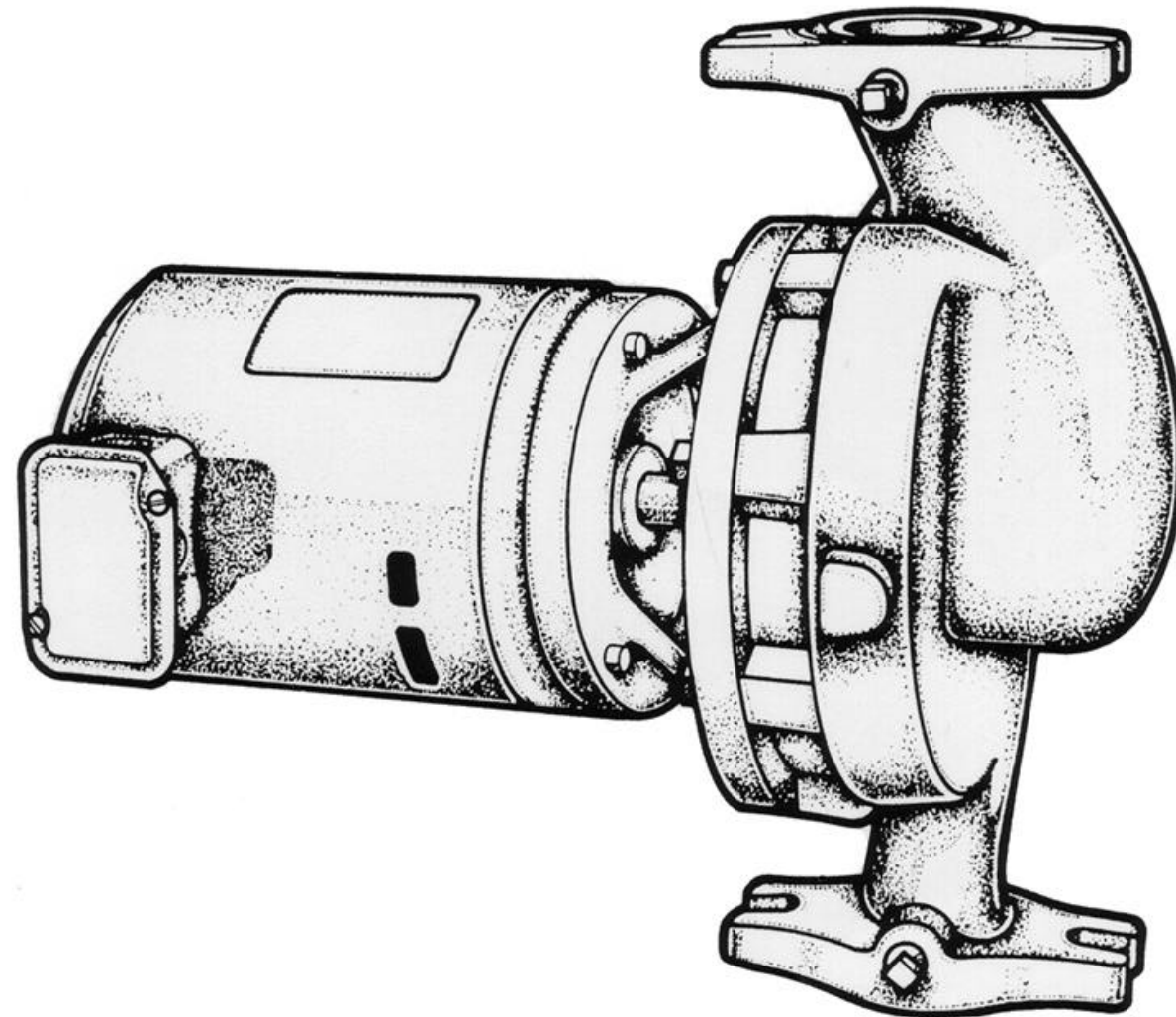
TEST OF 1R (DPST) RELAY – POWER OUTPUT
Terminal 2 and ground Terminal 4 and ground



S	T 10	E	P	Test of 1R (DPST) Relay - Power Output
				Test between ground and terminals 2, 4, 6 and 8 in the DPST relay- Each to Ground (terminal 1).

RESULTS	
If the meter:	then
does not read 120 VAC to each terminal	replace DPST relay.
does read 120 VAC to each terminal	go to Step 11.

TEST OF WATER CIRCULATING PUMP - RUNNING



S T E P	11	Test of Water Circulating Pump - Running
		Listen for Motor Operation

RESULTS		
If the:	and	then
motor is not running	the wiring connection between the pump and 1R (DPST) relay terminal 2 is okay*	replace motor.
motor is running		continue to Step 12.

*For capacitor and parts information see pump manufacturer's literature.

HSI TERMINAL 7 CHECK

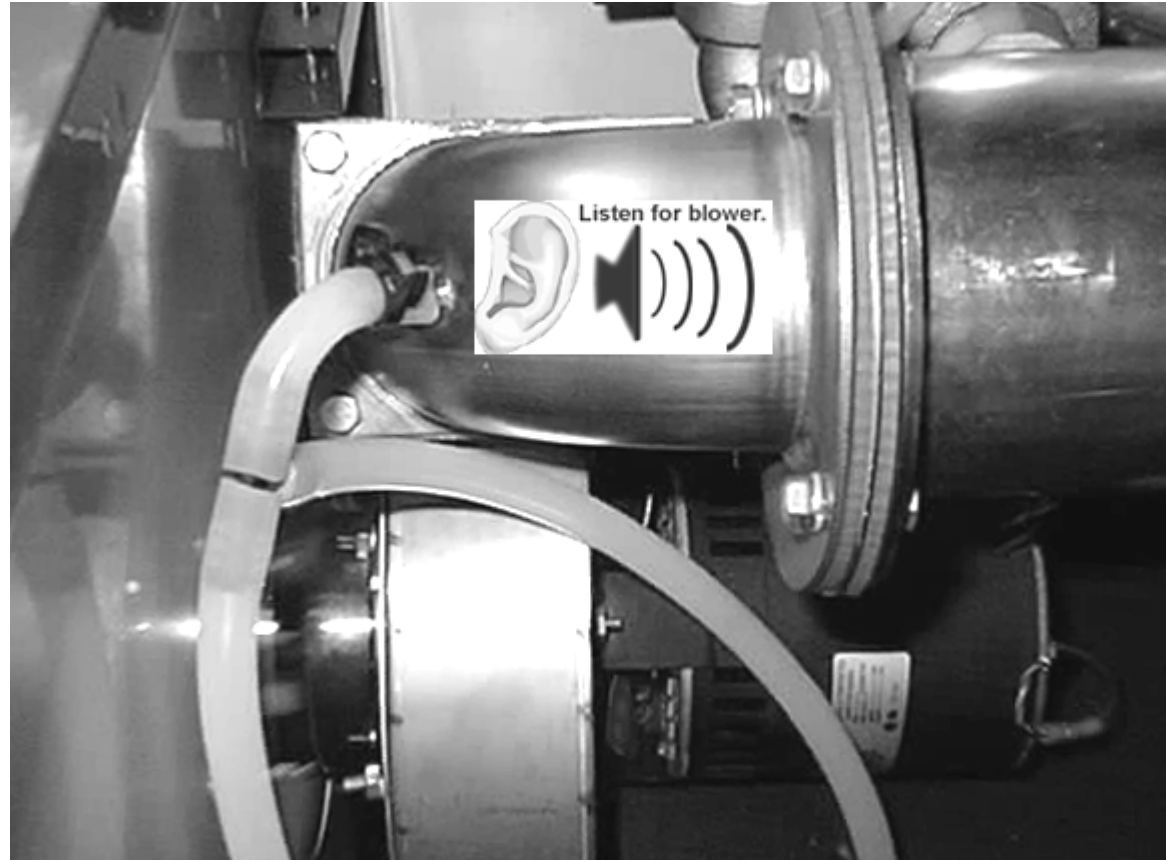


**TRIAL FOR IGNITION - 4 SEC - BEGINS
IGNITOR IS DRAWING AT LEAST 3 AMPS
HSI CONTROL TERM 2 TO GROUND IS 120 VAC**

S T E P	26	HSI Terminal 7 Check
		Test for 24 VAC between RAM HSI control terminal 7 and RAM terminal 6 (ground).

RESULTS	
If the meter:	then
does not read 24 VAC,	replace module.
does reads 24 VAC,	go to Step 27.

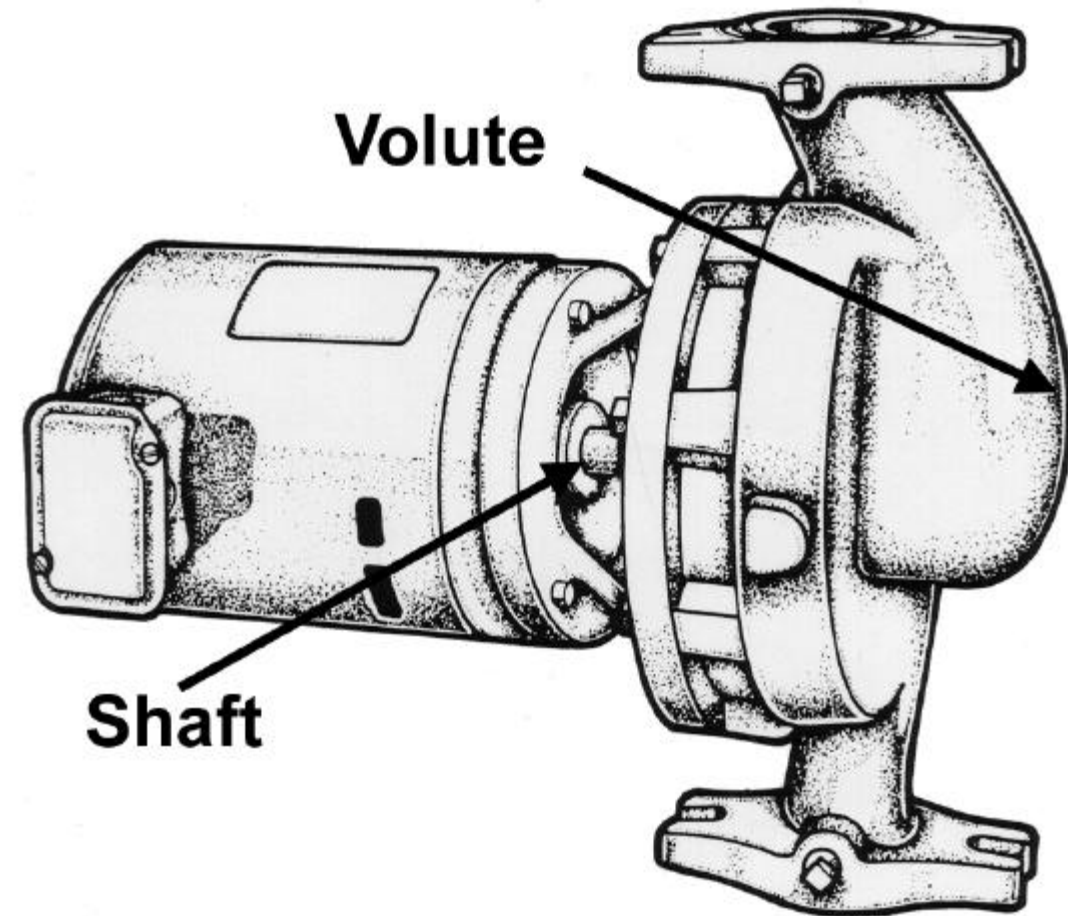
BLOWER SPEED CHECK



S T E P	25d	Blower Speed Check
		Blower should be obviously operating at a low RPM.

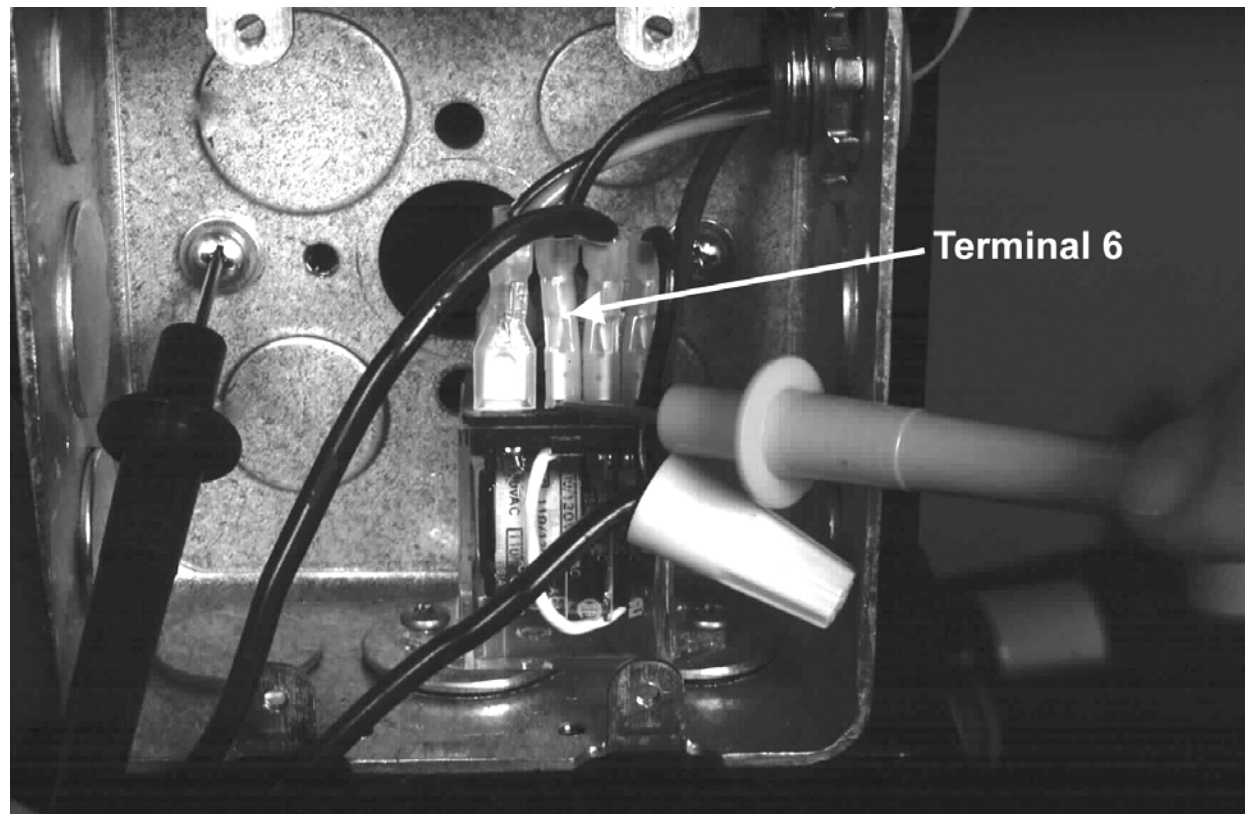
RESULTS		
If the:		then
blower is not operating at a reduced RPM		replace the blower.
blower is operating at a reduced RPM		go to Step 26.

TEST OF WATER CIRCULATING PUMP – MOVING WATER



S T E P	12	Test of Water Circulating Pump - Moving Water
		Visual Check The shaft can be seen through openings in the pump housing to verify that the impeller is turning. To check wear on the impeller requires the pumps removal from the casing.

2R RELAY TEST – SUPPLY POWER

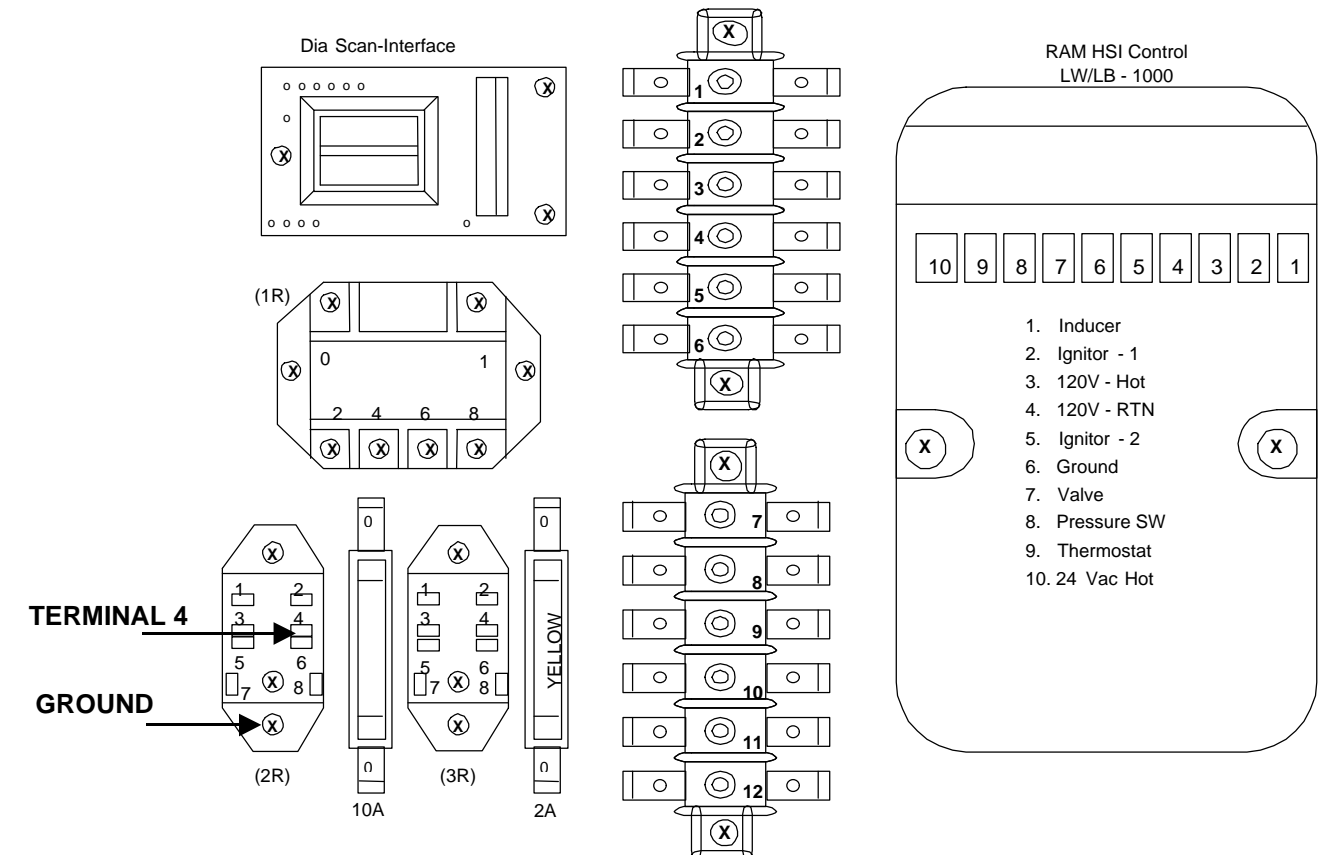


Ref. Wiring Diagrams Pages 57 and 58.

S T E P	13	Test of 2R (120V SPDT) Relay (Located in junction box with Rheostat on 500 and 750 model heaters. Located in the large electrical box on the 1000 models.)
		Test for 120 VAC from Terminal 6 to Ground.

RESULTS		
If the meter:	then	
does not read 120 VAC	check wire connections between terminal 6 on 1R relay and terminal 6 on 2R relay.	
does read 120 VAC	go to Step 14.	

2R RELAY (120V SPDT) TERMINAL 4 CHECK

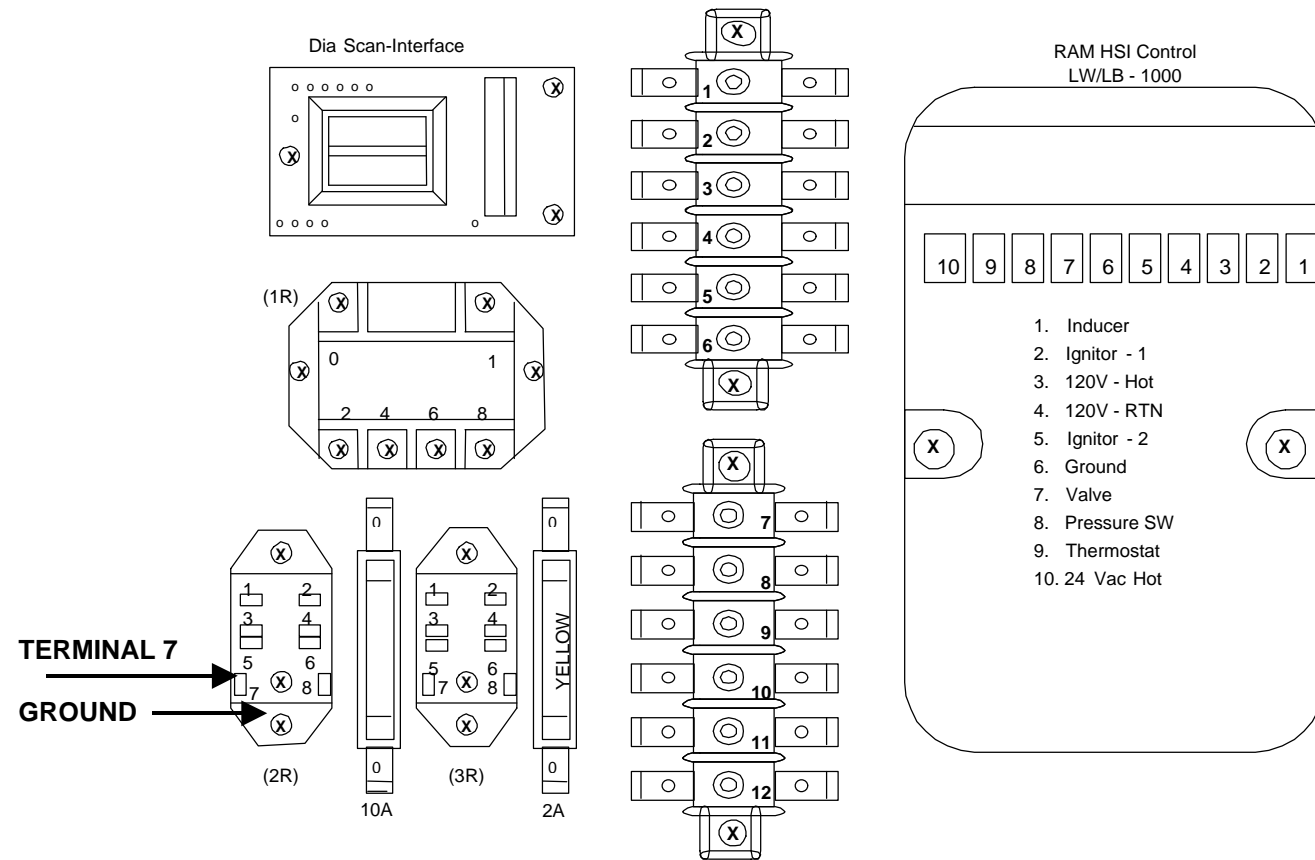


**During 20 Second Proving Period
Ignitor is Heating-Blower is at Slow Speed**

S T E P	25c LW/LB 1000 only	2R Relay (120V SPDT) Terminal 4 Check
		Test for 120 VAC between 2R (120V SPDT) relay terminal 4 and ground.

RESULTS		
If the:	and	then
blower does not read 120 VAC	the wiring connection from the blower red wire to 2R relay term 4 is correct	replace the 2R relay.
does read 120 VAC		go to Step 25d.

RELAY 2R (SPDT) RELAY TERMINAL 7 AND 8 CHECK



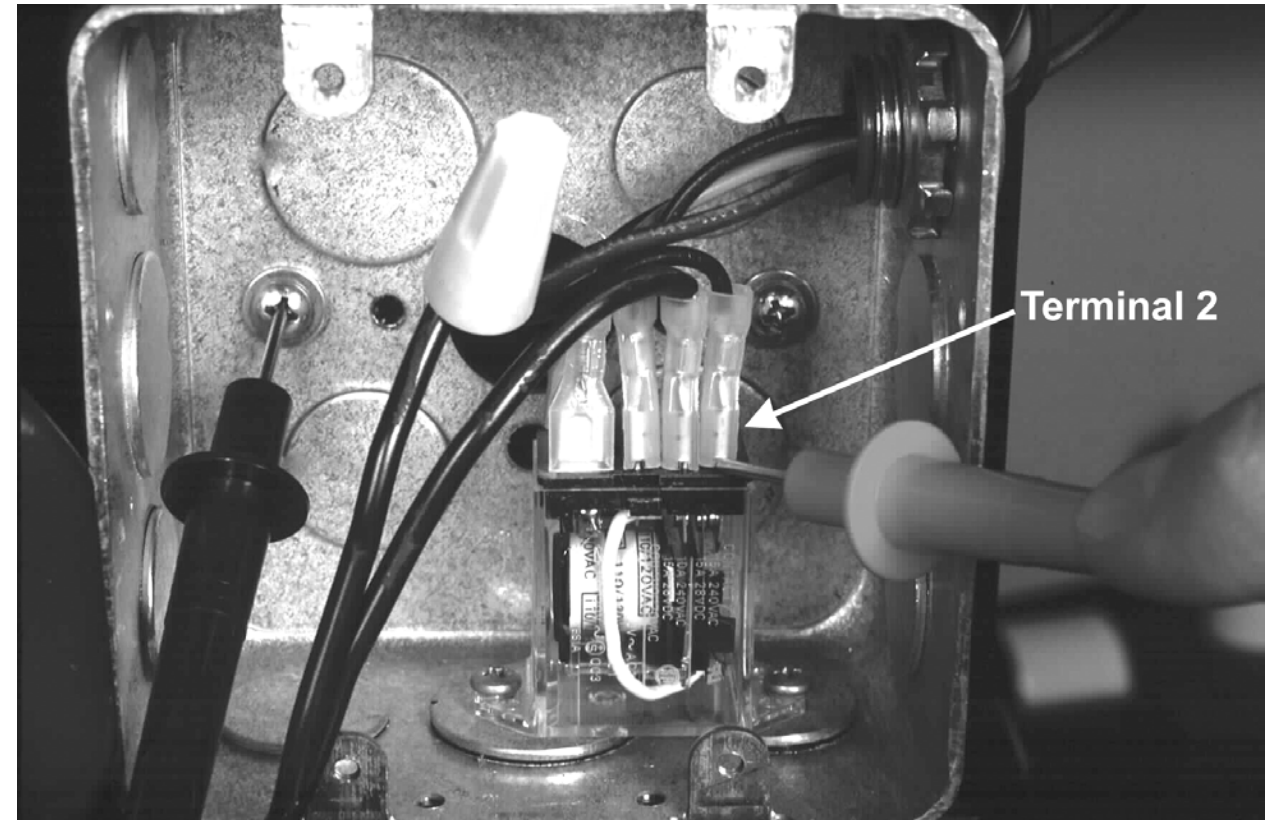
During 20 Second Proving Period
Ignitor is Heating-Blower is at Slow Speed

S T E P	25b	Relay 2R (SPDT) Relay Terminal 7 and 8 Check
	LW/LB 1000 ONLY	Test for 120 VAC between 2R (120V SPDT) relay terminal 7 and ground and then between 2R relay terminal 8 and ground.

RESULTS	
If the meter:	then
does not read 120 VAC from either 7 or 8 to ground	correct wiring connection from 2R relay terminal 7 to 3R relay terminal 1.
reads 120 VAC from only one terminal (7)*	replace the 2R relay.
does read 120 VAC to each terminal	go to Step 25c.

*2R terminal 8 returns to ground. The wire must be removed from 8 to show 120 VAC terminal 8 to neutral. It may be easier to disconnect the wire from 2R term 8 at the upper terminal strip terminal 6 and take a voltage reading from the end of the loose wire to ground.

TEST OF 2R RELAY – BLOWER POWER

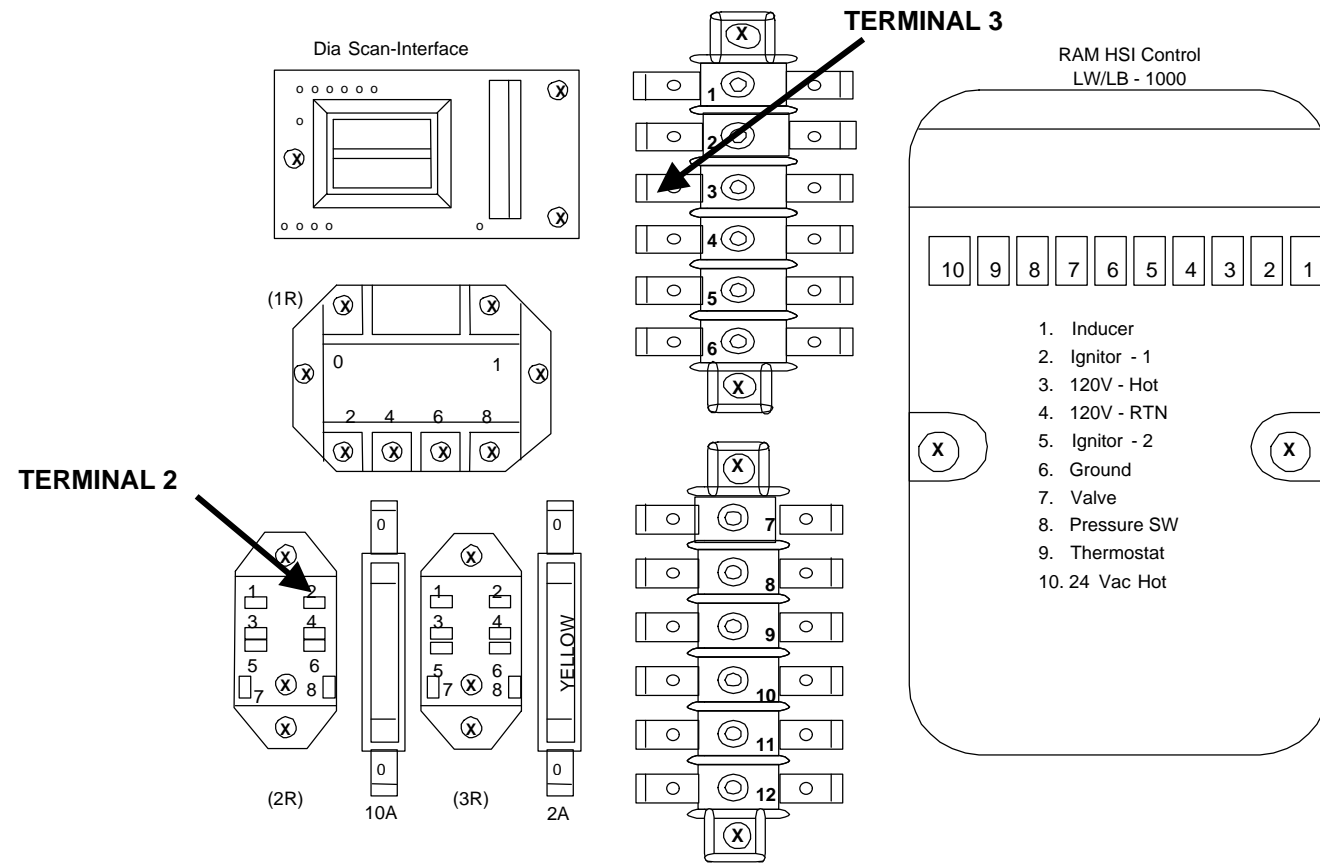


S T E P	14	Test of 2R (120V SPDT) Relay - (continued)
		Test for 120 VAC between terminal 2 on the 2R relay and ground.

RESULTS	
If the meter:	then
does not read 120 VAC	replace relay.
does read 120 VAC	go to Step 15.

Note: Testing between 2R terminals 7 or 8 to ground may read 40-80 VAC, disregard this reading.

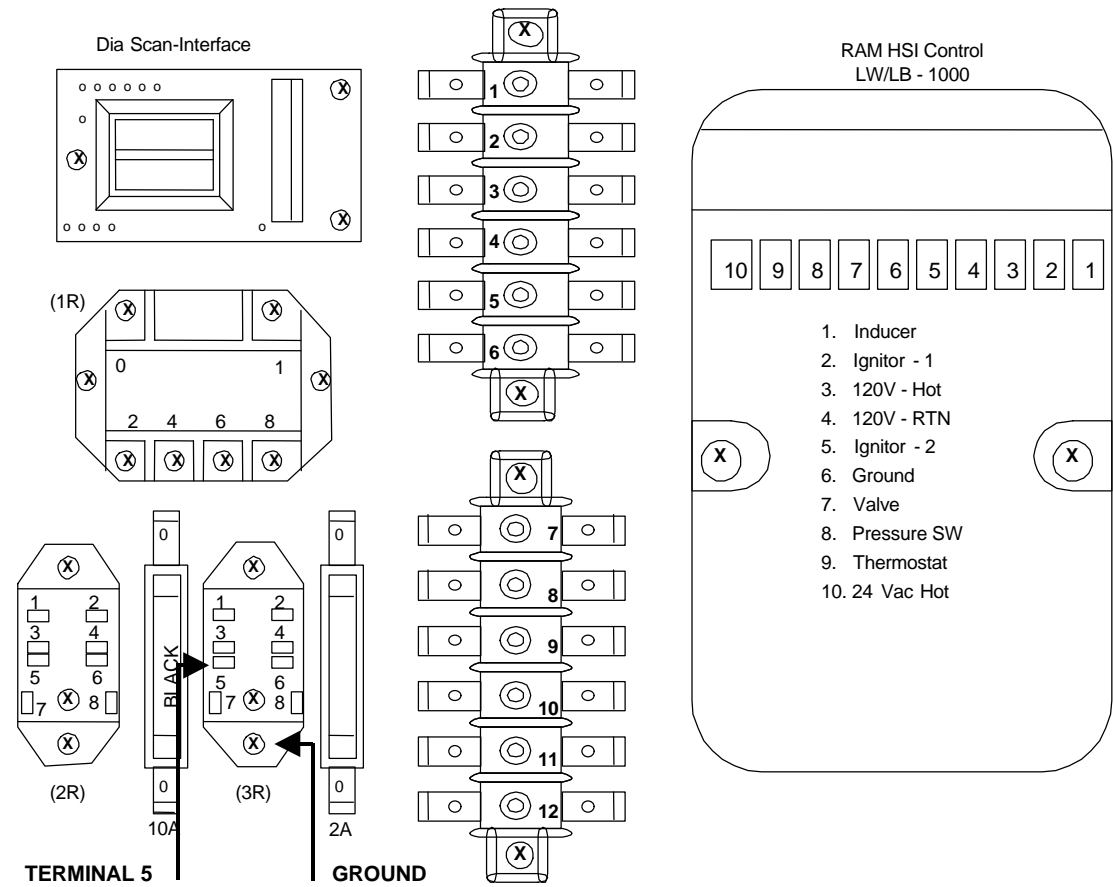
BLOWER TEST



S T E P	15	Blower Test
		Blower should be running at full RPM

RESULTS	
If the:	then
blower is not operating	<ul style="list-style-type: none"> check blower wiring to 2R terminal 2 and white wire to terminal 3 of upper terminal strip. replace blower.
blower is operating correctly	go to Step 16.

RELAY 3R (24 VAC SPDT) CHECK



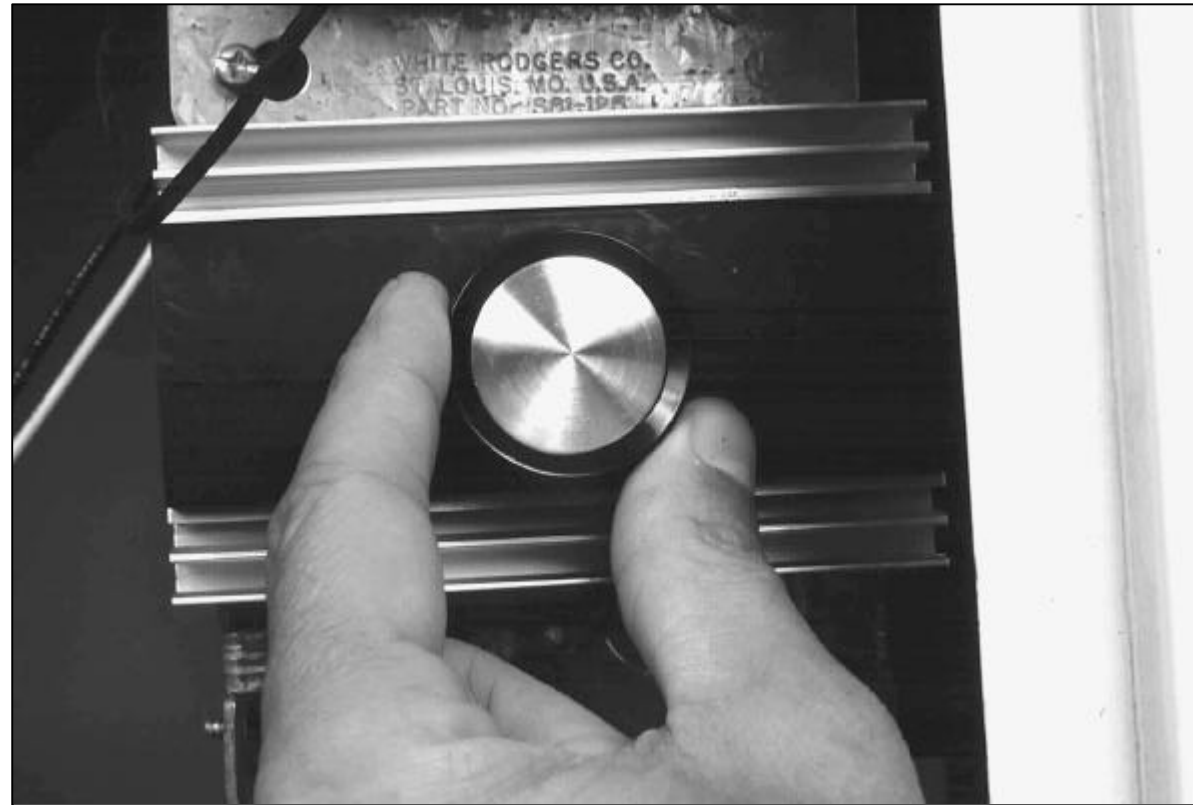
Ref: Page 58 Wiring Diagram

**During 20 Second Proving Period
Ignitor Is Heating**

S T E P	25a	Relay 3R (24 VAC SPDT) Check
	LW/LB 1000	Test for 120 VAC 3R relay terminal 5 to ground.

RESULTS	
If the meter:	then
does not read 120 VAC	check wiring to HSI control terminal 2.
does read 120 VAC	go to Step 25b.

RHEOSTAT CHECK

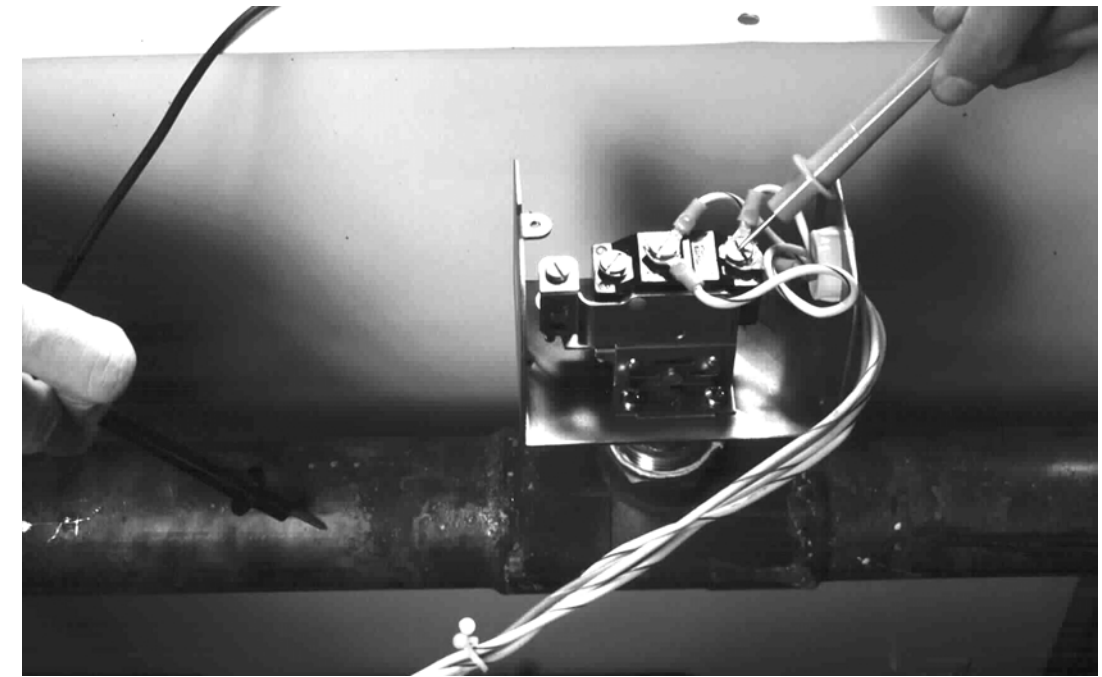


S T E P	24c	Rheostat Check
		Blower should be running at reduced speed. Turning adjustment knob clockwise reduces blower R.P.M. Begin with knob turned approximately 1" before lowest setting.

RESULTS		
If the:	and	then
blower does not run, blower speed does not adjust,	<ul style="list-style-type: none"> • wiring from blower to rheostat to 2R relay terminal 4 is okay • rheostat knob is "ON" (turn clockwise) 	replace rheostat. replace rheostat *.
blower speed does adjust,		go to Step 26.

*A voltage reading from the wire nut connection, joining the blower black wire to the wire from 2R relay terminal 4, to ground will give a reduced voltage reading depending on the rheostat setting.

WATER FLOW SWITCH TEST



S T E P	16	Water Flow Switch Test
		Test for 24 VAC between flow switch red terminal and ground. Test for 24 VAC between flow switch yellow terminal and ground.

RESULTS		
If the meter:	and you have	then
does not read 24 VAC red to ground		check wire connection between system tank temperature control and red flow switch terminal.
does not read 24 VAC yellow to ground	<ul style="list-style-type: none"> • checked for water flow (26 GPM minimum) • checked flow switch paddle installation • checked flow switch adjustment screw setting 	replace flow switch.
does read 24 VAC to each terminal		go to Step 17

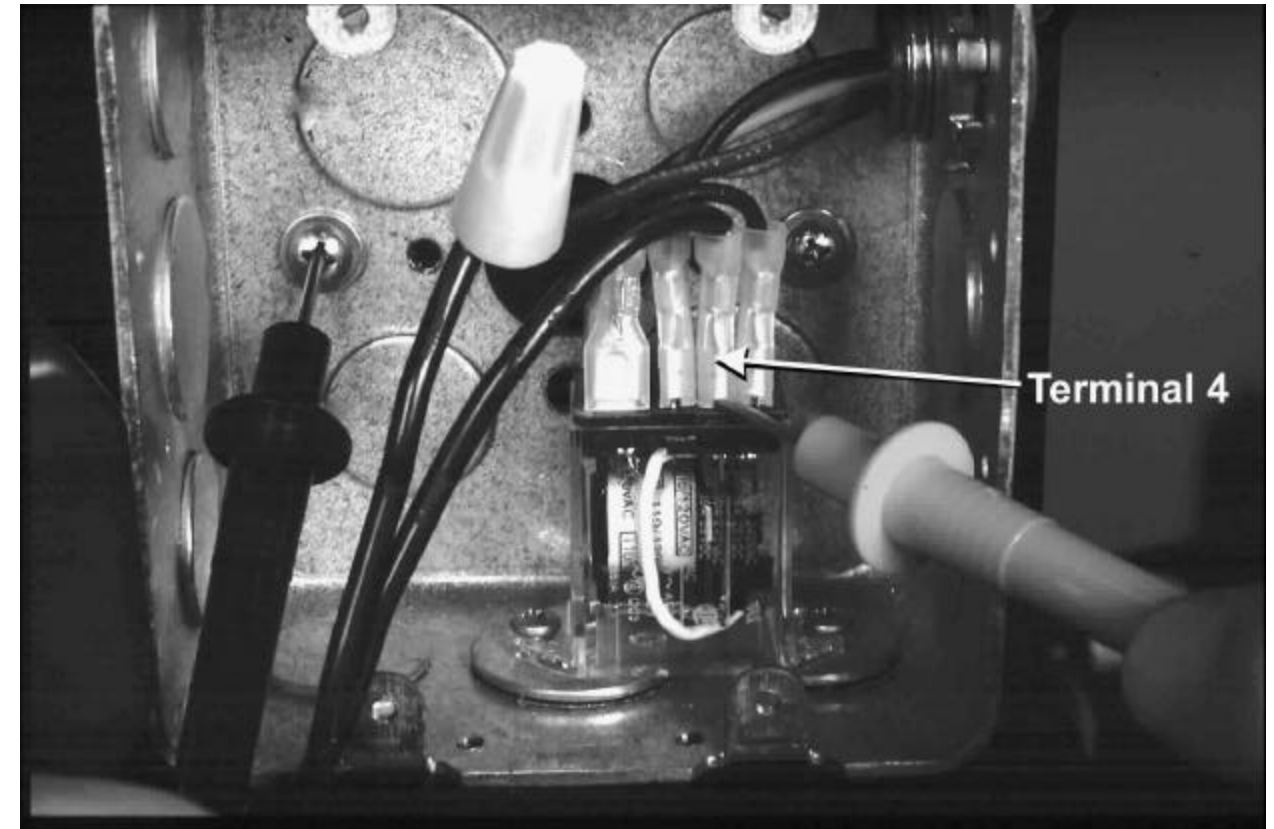
HIGH LIMIT SWITCH TEST



S T E P	17	High Limit Switch Test
	Control should be set at least 30° higher than the tank temperature control setting. Test for 24 VAC from each high limit terminal to ground.	

RESULTS		
If the meter:	and you are	then
does not read 24 VAC either terminal to ground		check wire connection to yellow flow switch terminal.
does read 24 VAC to only one terminal	certain that the control is calling for heat and the reset button has been pushed	replace control.
does read 24 VAC from each terminal to ground		go to step 18.

2R (120V SPDT) RELAY TERM 4 CHECK

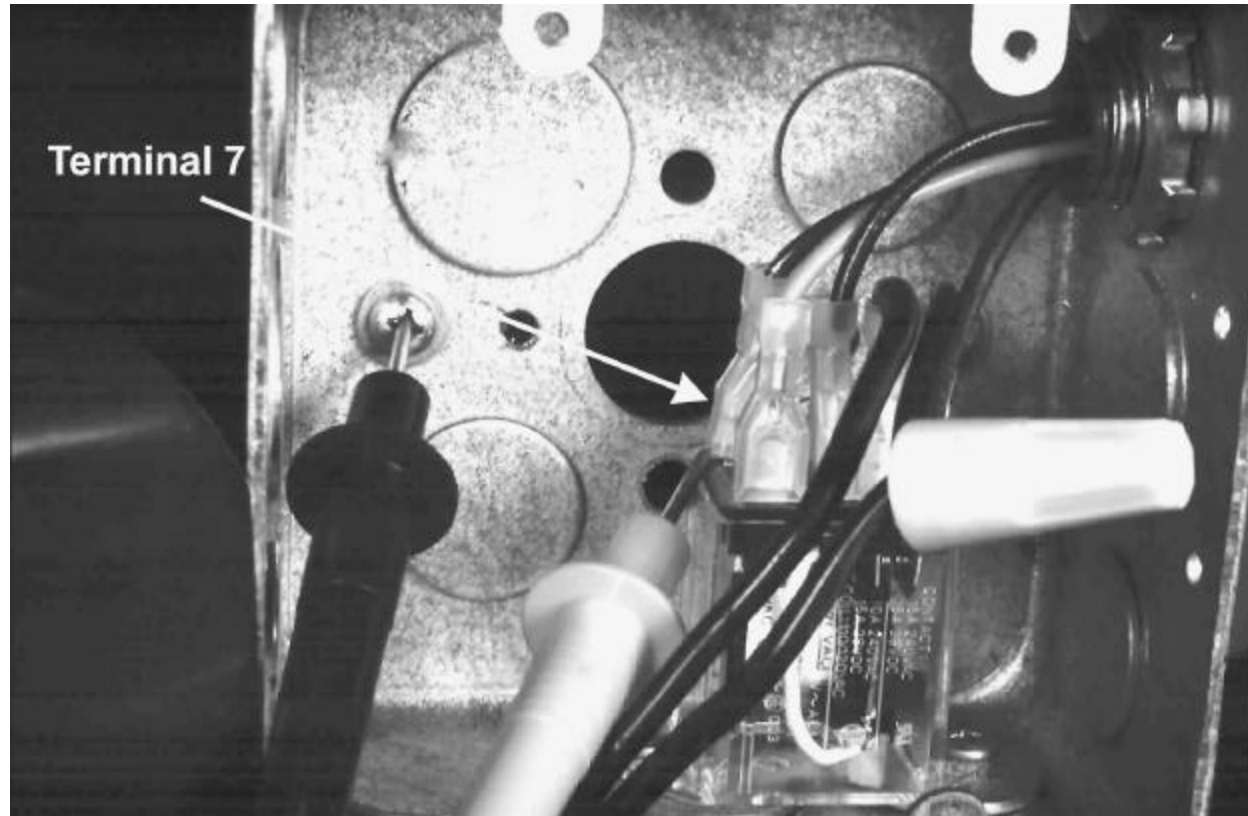


Ignition Proving Period

S T E P	24b	2R (SPDT) Relay Term 4 Check
	LW/LB 500 & 750	Test for 120 VAC 2R relay terminal 4 to ground.

RESULTS	
If the meter:	then
does not read 120 VAC,	replace 2R relay.
does read 120 VAC,	go to Step 24c.

2R (120V SPDT) RELAY TEST



Ignitor Proving Period

S T E P	24a	2R (120V SPDT) Relay Test
	LW/LB 500 & 750	Conduct this test during the 20 sec. period in which the HSI is heating but prior to the 4 second trial for ignition. Test for 120 VAC between 2R relay terminals 7 and ground and then 8 and ground.

RESULTS	
If the meter:	then
does not read 120 VAC from either 7 or 8 to ground	check wiring to Ram terminal 2.
reads 120 VAC from only one terminal (7)*	replace 2R relay.
reads 120 VAC from each terminal,	go to Step 24b.

*See Step 24c comment.

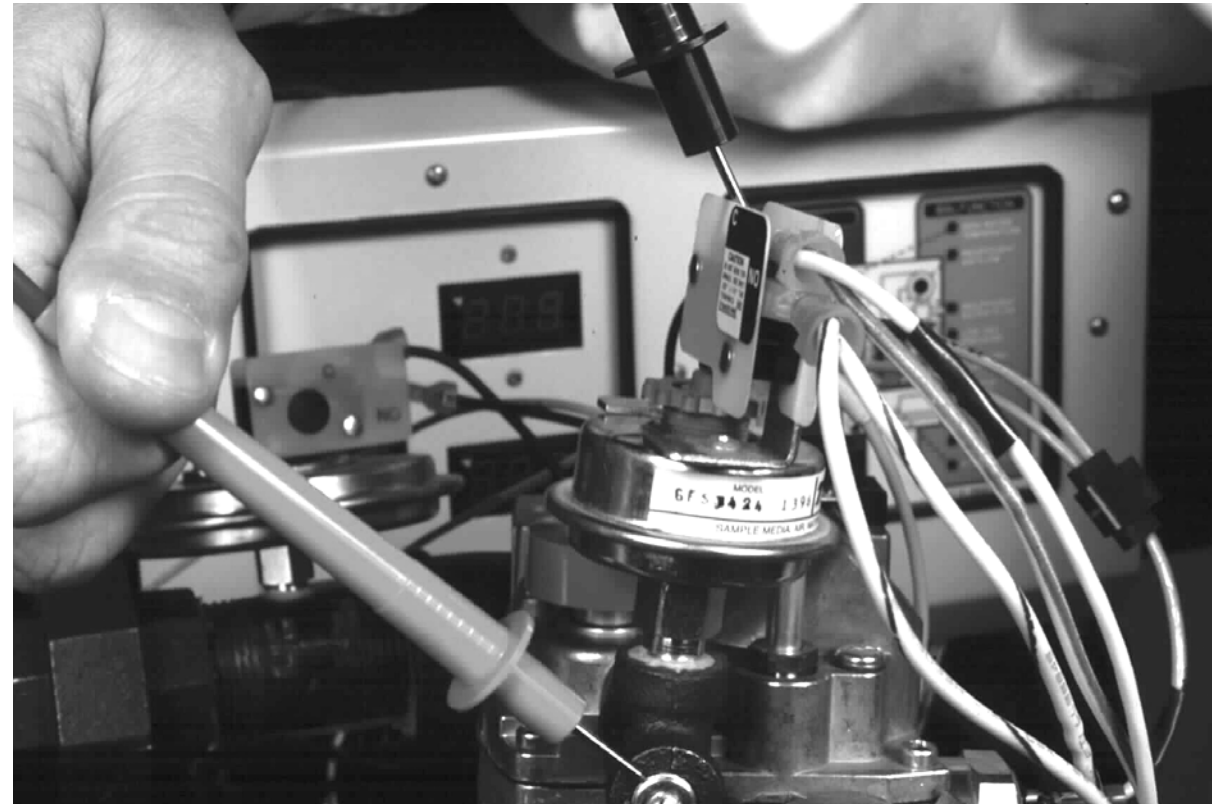
BLOWER PROVER SWITCH TEST



S T E P	18	Blower Prover Switch Test
		1.0" w.c. positive pressure closes this switch. Use a draft gauge or Magnihelic to verify at least 1.0" w.c. positive pressure
		Test for 24 VAC from each terminal to ground.

RESULTS		
If the meter:	and the	then
does not read 24 VAC from either terminal to ground		check wiring to high limit switch.
does read 24 VAC to only one terminal and ground	<ul style="list-style-type: none"> tube connections are tight draft pressure is okay (typical reading will be 4.5" to 5.0" positive press.) 	replace switch.
does read 24 VAC from each terminal to ground		go to step 19.

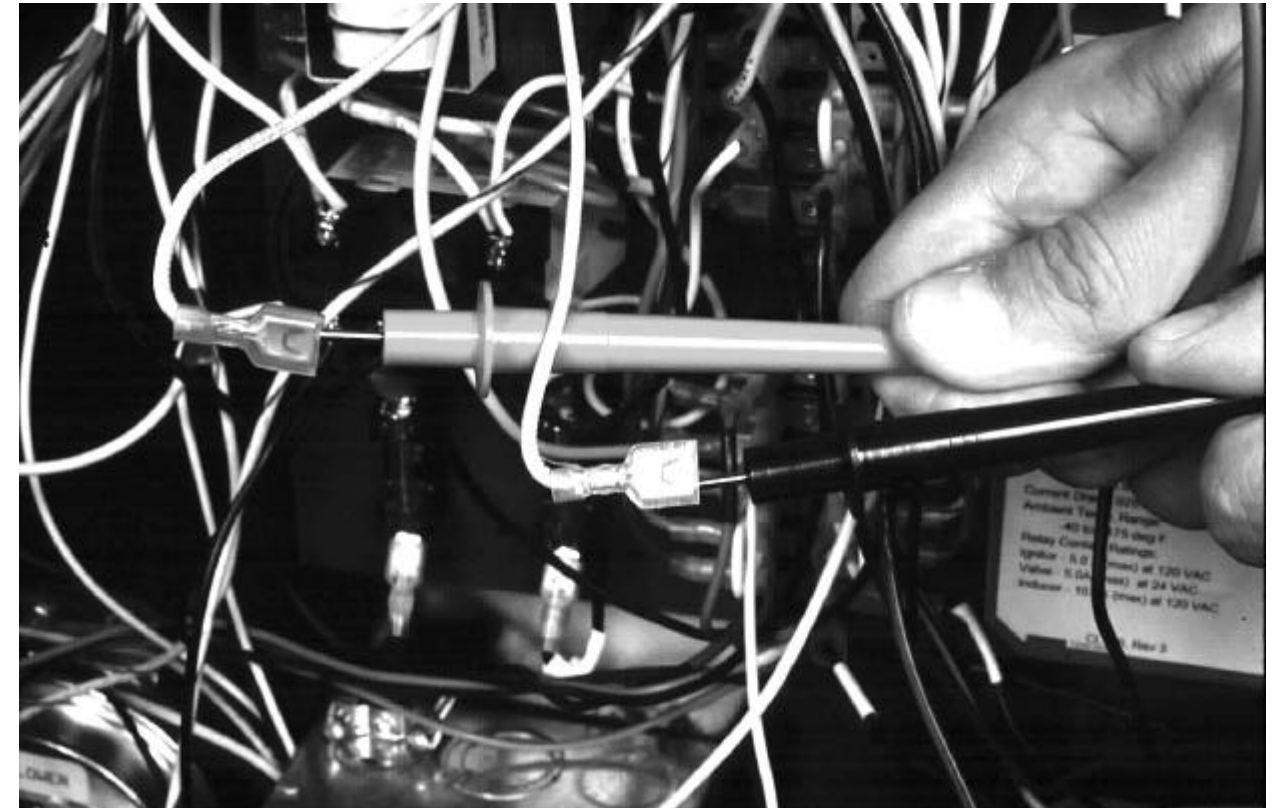
LOW GAS PRESSURE SWITCH TEST



S T E P	19	Low Gas Pressure Switch Test
		This switch closes at 5.5" w.c. positive gas pressure on Natural gas, 10.5" w.c. on Propane gas.
		Test for 24 VAC from each terminal to ground

RESULTS		
If the meter:	and	then
does not read 24 VAC from either terminal to ground		check wire connections between low gas pressure switch and blower prover switch.
reads 24 VAC from only one terminal and ground	you have checked for proper gas pressure	replace switch.
does read 24 VAC from each terminal to ground		go to step 20.

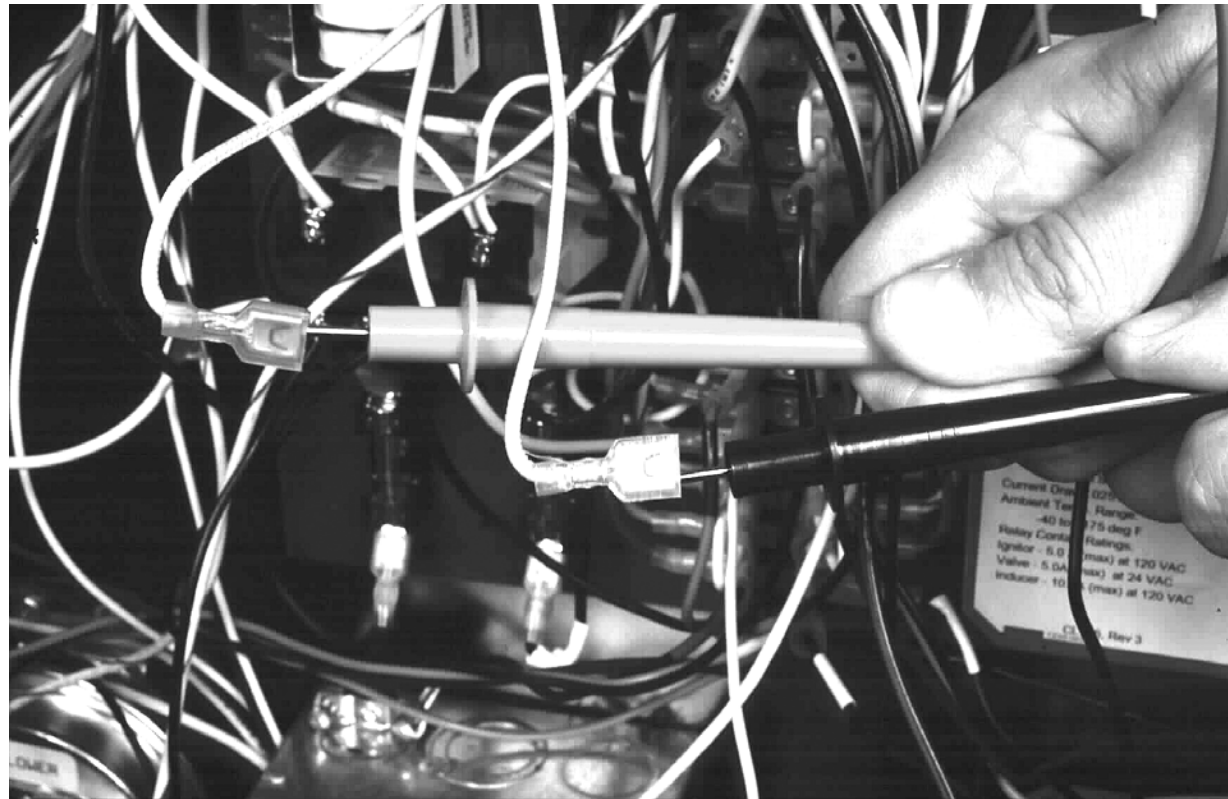
CHECK OF IGNITOR



S T E P	23a	Check of Ignitor
		LW/LB
		1000
Test for 40-70 ohms resistance through the ignitor's detached wires from the upper terminal strip terminals 5 and 6. Ignitor is cold.		

RESULTS	
If the meter:	then
does not read between 45 and 75	replace the ignitor.
does read between 45 and 75 ohms	go to Step 25a.

CONTINUITY CHECK OF IGNITOR

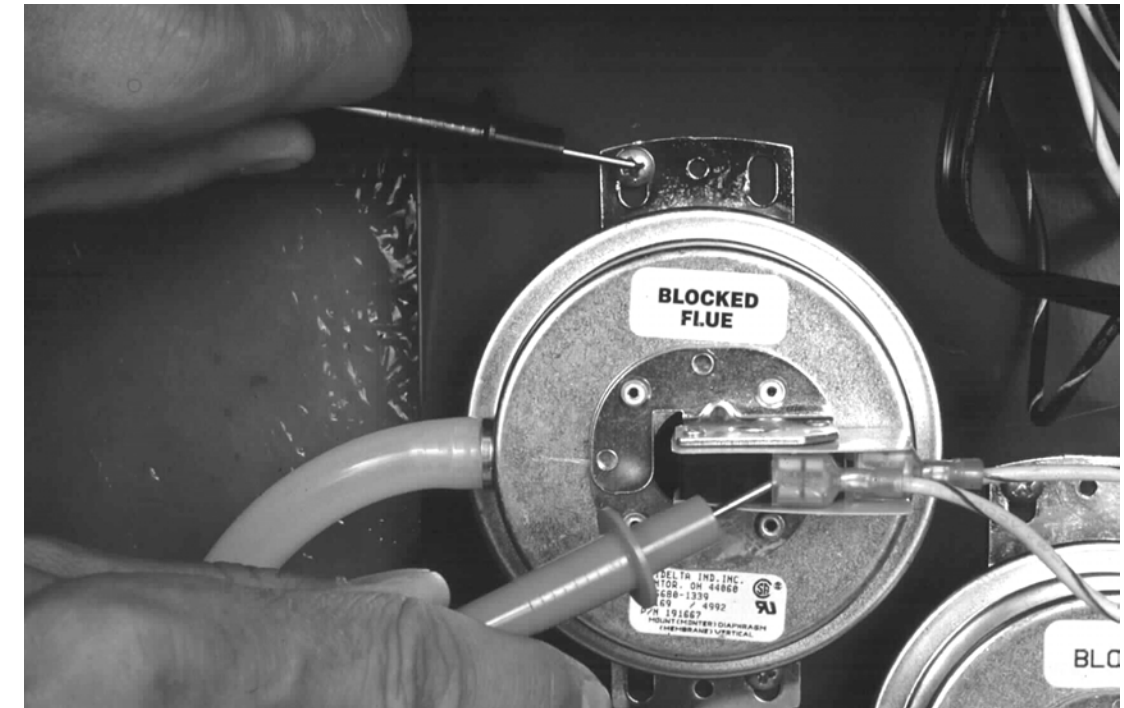


Ref: Page 57 & 58 For Wiring Diagrams

S T E P	23	Continuity Check of Ignitor <ul style="list-style-type: none"> • Power supply off • Ignitor is cold • Detach HSI ignitor wires from the upper terminal strip terminals 5 and 6. Set multimeter to continuity check position-2000 scale. Test for ohms resistance of 75 to 400 ohms .
	LB/LW 500 & 750	

RESULTS	
If the meter:	then
does not read between 75 and 400	replace ignitor.
does read between 75 and 400 ohms	go to Step 23a.

BLOCKED FLUE SWITCH TEST



S T E P	20	BLOCKED FLUE SWITCH TEST	
		This switch opens at 1.0" w.c. positive pressure.	
		Test for 24 VAC from each terminal to ground.	

RESULTS		
If the meter:	and	then
does not read 24 VAC from either terminal to ground		check wire connection from low gas pressure switch to the blocked flue switch.
reads 24 VAC from only one terminal and ground,	you have <ul style="list-style-type: none"> • checked for proper exhaust vent installation. • checked for blockage in the exhaust vent. 	replace switch.
reads 24 VAC from each terminal and ground to ground,		go to step 21.

HSI CONTROL TERMINAL 8 VOLTAGE CHECK



S T E P	21	HSI Control Terminal 8 Voltage Check
		Test for 24 VAC between RAM terminal 8 and ground (terminal 6).

RESULTS	
If the meter:	then
does not read 24 VAC,	check the wire connection to the blocked flue switch.
does reads 24 VAC,	go to step 22.

HSI CONTROL TERMINAL 2 AND 5 TEST



S T E P	22	HSI Control Terminal 2 and 5 Test
		Test for 120 VAC between HSI Control terminal 2 and ground. Test for 120 VAC between the wire terminal detached from Ram 5 and ground. Note that this is the ignitor circuit. Conducting this voltage test whenever the ignitor is acting as a flame sensor (any time power is on except during this ignitor heat up period) voltage readings of from 40 to 80 VAC will be noted. Note 2: Ignitor will become red at this point.

RESULTS	
If the meter:	then
does not read 120 VAC from 2 to ground,	replace Ram module.
does not read 120 VAC from end of wire, detached from Ram 5 to ground,	replace ignitor.
reads 120 VAC to each term,	go to Step 23 or 24.