



**MODELS:
LB/LW-500, 750 AND 1000
SERIES 400/401**

**GAS-FIRED POWER BURNER COPPER BOILERS
FOR HYDRONIC HEATING AND HOT WATER SUPPLY**

• INSTALLATION • OPERATION • MAINTENANCE • LIMITED WARRANTY



WARNING: If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

- Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.
- **WHAT TO DO IF YOU SMELL GAS:**
 - Do not try to light any appliance.
 - Do not touch any electrical switch; do not use any phone in your building.
 - Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
 - If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency or the gas supplier.



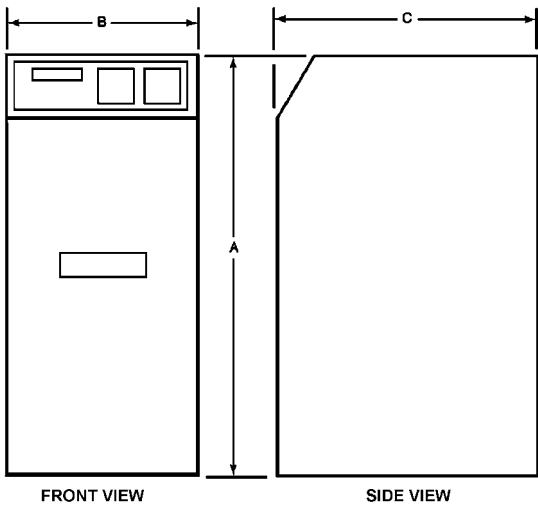
TEXT IN BLACK BOLD TYPE OR UNDERLINED CONTAINS INFORMATION RELATIVE TO YOUR SAFETY. PLEASE READ THOROUGHLY BEFORE INSTALLING AND USING THIS APPLIANCE.

**A. O. SMITH
WATER PRODUCTS
COMPANY**

A DIVISION OF A. O. SMITH CORPORATION
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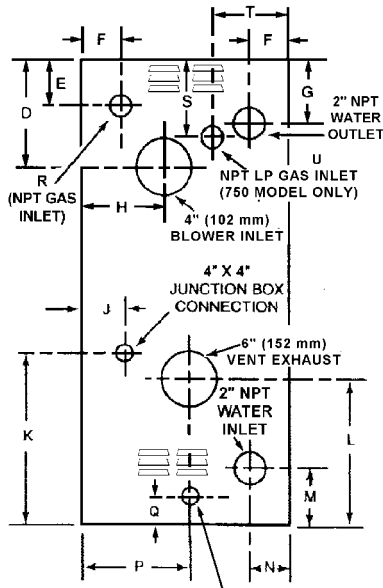
PLACE THESE INSTRUCTIONS ADJACENT TO BOILER AND
NOTIFY OWNER TO KEEP FOR FUTURE REFERENCE

ROUGH-IN DIMENSIONS

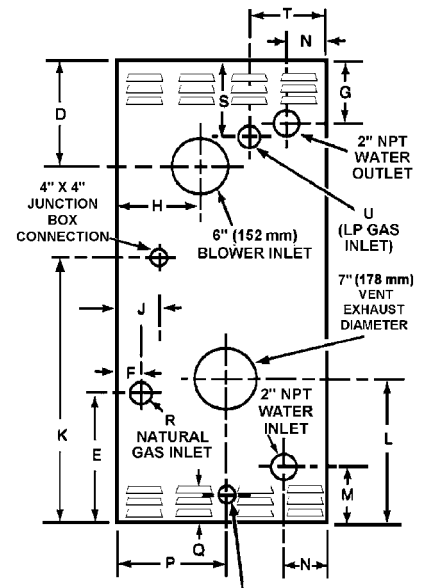


Minimum clearances to combustibles:

- 4" (102 mm) rear
- 0" (0 mm) top & sides
- 6" (152 mm) vent



MODELS LB/LW - 500, 750 (BACK VIEW)



MODEL LB/LW - 1000 (BACK VIEW)

TABLE 1, GAS AND ELECTRICAL CHARACTERISTICS

Model	Manifold Pressure			Maximum Supply Pressure		Electrical Characteristics	
	Type of Gas	Inches W.C.	kPa	Inches W.C.	kPa	Volts/Hz	Amperes
LB/LW-500, 750, 1000	NATURAL	3.5	0.87	13.8	3.44	120/60	30
LB/LW-500, 750, 1000	PROPANE	10	2.49	13.8	3.44	120/60	30

Minimum Supply Pressure, Natural Gas: 7.0 inches W.C. (1.74 kPa)

Minimum Supply Pressure, Propane Gas: 11.0 inches W.C. (2.74 kPa)

Minimum Pressures must be maintained under both load and no load (static and dynamic) conditions.

TABLE 2, ROUGH-IN DIMENSIONS

Models Gas Type Dimensions	LB/LW-500		LB/LW-500		LB/LW-750		LB/LW-750		LB/LW-1000		LB/LW-1000	
	Natural Gas		Propane Gas		Natural Gas		Propane Gas		Natural Gas		Propane Gas	
	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
Exhaust Vent Diam.	6	152	6	152	6	152	6	152	7	178	7	178
Blower Inlet Diam.	4	102	4	102	4	102	4	102	6	152	6	152
A	53	1346	53	1346	53	1346	53	1346	60 1/2	1537	60 1/2	1537
B	23	584	23	584	23	584	23	584	27 1/8	689	27 1/8	689
C	32	813	32	813	32	813	32	813	38 3/16	970	38 3/16	970
D	13 1/2	343	13 1/2	343	13 1/2	343	13 1/2	343	13 3/4	349	13 3/4	349
E	4 3/8	111	4 3/8	111	4 3/8	111	-	-	15 1/2	394	-	-
F	3 1/4	83	3 1/4	83	3 1/4	83	-	-	3 1/4	83	-	-
G	6 3/8	162	6 3/8	162	6 3/8	162	6 3/8	162	8 1/8	206	8 1/8	206
H	7 1/2	191	7 1/2	191	7 1/2	191	7 1/2	191	8 1/4	210	8 1/4	210
J	3 1/2	89	3 1/2	89	3 1/2	89	3 1/2	89	3 1/2	89	3 1/2	89
K	19	483	19	483	19	483	19	483	36	914	36	914
L	14 1/2	359	14 1/2	359	11 1/4	286	11 1/4	286	12	318	12	318
M	5	127	5	127	5	127	5	127	6 3/4	171	6 3/4	171
N	5 1/4	133	5 1/4	133	5 1/4	133	5 1/4	133	4 1/8	105	4 1/8	105
P	11 1/2	292	11 1/2	292	11 1/2	292	11 1/2	292	13 3/8	340	13 3/8	340
Q	2	51	2	51	2	51	2	51	2 1/4	57	2 1/4	57
R	1	NPT	1	NPT	1	NPT	-	-	1 1/4	NPT	-	-
S	-	-	-	-	-	-	11 3/4	298	-	-	11 7/8	302
T	-	-	-	-	-	-	6 1/2	165	-	-	7 5/8	194
U	-	-	-	-	-	-	1	NPT	-	-	1 1/4	NPT
Approx. Shipping Weight	425 lbs	193 Kg.	425 lbs	193 Kg.	528 lbs	240 Kg.	528 lbs	240 Kg.	934 lbs	424 Kg.	934 lbs	424 Kg.

ROUGH-IN DIMENSIONS (Continued)

TABLE 3, RECOVERY CAPACITIES

MODEL	GAS TYPE	INPUT BTUH	KW	U.S. Gallons/Hr and Litres/Hr at TEMPERATURE RISE INDICATED											
				F°	18F°	20F°	30F°	36F°	40F°	50F°	54F°	60F°	70F°	72F°	
				C°	10C°	11C°	17C°	20C°	22C°	28C°	30C°	33C°	39C°	40C°	
LB/LW-500	Natural	500,000		GPH	3030	2727	1818	1515	1364	1091	1010	909	779	758	
			146	LPH	11471	10324	6882	5735	5162	4129	3824	3441	2950	2868	
LB/LW-500	Propane	450,000		GPH	2727	2455	1636	1364	1227	982	909	818	701	682	
			132	LPH	10324	9291	6194	5162	4646	3716	3441	3097	2655	2581	
LB/LW-750	Natural	750,000		GPH	4545	4091	2727	2273	2045	1636	1515	1364	1169	1136	
			220	LPH	17206	15485	10324	8603	7743	6194	5735	5162	4424	4301	
LB/LW-750	Propane	675,000		GPH	4091	3682	2455	2045	1841	1473	1364	1227	1052	1023	
			198	LPH	15485	13937	9291	7743	6968	5575	5162	4646	3982	3871	
LB/LW-1000	Natural	1,000,000		GPH	6061	5455	3636	3030	2727	2182	2020	1818	1558	1515	
			293	LPH	22941	20647	13765	11471	10324	8259	7647	6882	5899	5735	
LB/LW-1000	Propane	860,000		GPH	5212	4691	3127	2606	2345	1876	1737	1564	1340	1303	
			252	LPH	19729	17757	11838	9865	8878	7103	6576	5919	5073	4932	

MODEL	GAS TYPE	INPUT BTUH	KW	U.S. Gallons/Hr and Litres/Hr at TEMPERATURE RISE INDICATED									
				F°	80F°	90F°	100F°	108F°	110F°	120F°	126F°	130F°	140F°
				C°	44C°	50C°	56C°	60C°	61C°	67C°	70C°	72C°	78C°
LB/LW-500	Natural	500,000		GPH	682	606	545	505	496	455	433	420	390
			146	LPH	2581	2294	2065	1912	1877	1721	1639	1588	1475
LB/LW-500	Propane	450,000		GPH	614	545	491	455	446	409	390	378	351
			132	LPH	2323	2065	1858	1721	1689	1549	1475	1429	1327
LB/LW-750	Natural	750,000		GPH	1023	909	818	758	744	682	649	629	584
			220	LPH	3871	3441	3097	2868	2816	2581	2458	2382	2212
LB/LW-750	Propane	675,000		GPH	920	818	736	682	669	614	584	566	526
			198	LPH	3484	3097	2787	2581	2534	2323	2212	2144	1991
LB/LW-1000	Natural	1,000,000		GPH	1364	1212	1091	1010	992	909	866	839	779
			293	LPH	5162	4588	4129	3824	3754	3441	3277	3176	2950
LB/LW-1000	Propane	860,000		GPH	1173	1042	938	869	853	782	745	722	670
			252	LPH	4439	3946	3551	3288	3228	2959	2818	2732	2537

TABLE 4, HEAD LOSS at FLOW RATES/MINUTE and TEMPERATURE RISE SHOWN

MODEL	INPUT		F°	18F°	20F°	HEAD LOSS		Boiler Inlet & Outlet
	BTUH	KW	C°	10C°	11.1C°	Feet	Metres	
LB/LW-500 Natural	500,000		GPM	50	45	10		2" NPT
		146	LPM	189	172		3.0	
LB/LW-500 Propane	450,000		GPM	45	41	8.4		2" NPT
		132	LPM	170	155		2.6	
LB/LW-750 Natural	750,000		GPM	75	68	10.1		2" NPT
		220	LPM	284	258		3.1	
LB/LW-750 Propane	675,000		GPM	67	61	8.7		2" NPT
		198	LPM	255	232		2.7	
LB/LW-1000 Natural	1,000,000		GPM	100	91	8.9		2" NPT
		293	LPM	378	344		2.7	
LB/LW-1000 Propane	860,000		GPM	86	78	6.7		2" NPT
		252	LPM	325	296		2.0	

The ideal flow rate through the Legend models is considered to be the flow rate that results in a 20 F° temperature rise across the unit. Table 4, shows head loss through units at flow rate resulting in 20 F° rise. For head loss at other flow rates see sheet E202.2 in A.O. Smith Architect's & Engineer's Manual.

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FOREWORD

This design complies with the latest edition of the ANSI Z21.13 - CSA 4.9 low-pressure boiler standard.

Compliance under this standard implies that when the boiler underwent test, the gas manifold and control assembly provided on the boiler met safe lighting and other performance criteria.

Detailed installation diagrams are found in this manual. These diagrams will serve to provide the installer a reference for the materials and methods of piping necessary. It is essential that all water, gas piping and wiring be installed as shown on the diagrams. You should thoroughly read and understand this manual before installation and/or operation of this boiler.

The factory warranty will be void if the boiler(s) have been improperly installed or operated.

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In addition to these instructions, the boiler(s) shall be installed in accordance with those installation regulations in force in the local area where the installation is to be made. These shall be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

In the absence of local codes, the installation must comply with the latest editions, as follows:

In the United States:

The National Fuel Gas Code, ANSI Z223.1/NFPA 54 and the National Electric Code, NFPA 70.

In Canada:

The installation Code CAN/CSA B149.1-00 and the Canadian Electric Code, CSA C22.2.

These are available from the Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131, USA, or, Canadian Gas Association Laboratories, 55 Scarsdale Road, Don Mills, Ontario M3B 2R3, Canada.

GROUNDING INSTRUCTIONS

This boiler must be grounded in accordance with the National Electrical Code and/or local codes. Boiler is polarity sensitive, correct wiring is imperative for proper operation.

This boiler must be connected to a grounded metal, permanent wiring system, or an equipment grounding conductor must be run with the circuit conductors and connected to the equipment grounding terminal or lead on the boiler.

INLET WATER CONSIDERATIONS

To minimize the amount of condensate, a minimum inlet water temperature to the heat exchanger of 140°F (60°C) shall be maintained. This temperature can be acquired by returning 140°F (60°C) water from the remote storage tank to the boiler or by incorporating a by-pass loop between the boiler's inlet and outlet connections.

Circulating water through the boiler and to the remote storage tank (if applicable) is accomplished by a built-in pump on LW models only. For hot water heating systems using the LB model, the circulating pump is NOT provided and must be field installed.

CORRECT GAS

MAKE SURE THE GAS ON WHICH THE BOILER WILL OPERATE IS THE SAME AS THAT SPECIFIED ON THE BOILER RATING PLATE. DO NOT INSTALL THE BOILER IF EQUIPPED FOR A DIFFERENT TYPE OF GAS — CONSULT YOUR SUPPLIER.

PRECAUTIONS

IF THE UNIT IS EXPOSED TO THE FOLLOWING, DO NOT OPERATE UNTIL ALL CORRECTIVE STEPS HAVE BEEN MADE BY A QUALIFIED SERVICEMAN:

1. EXPOSURE TO FIRE.
2. IF DAMAGED.
3. FIRING WITHOUT WATER.
4. SOOTING.

IF THE BOILER HAS BEEN EXPOSED TO FLOODING, IT MUST BE REPLACED.

LIQUID PETROLEUM MODELS

Boilers for propane or liquefied petroleum gas (LPG) are different from natural gas models. A natural gas boiler will not function safely on LP gas and no attempt should be made to convert a boiler from natural gas to LP gas.

LP gas must be used with great caution. It is highly explosive and heavier than air. It collects first in the low areas making its odor difficult to detect at nose level. If LP gas is present or even suspected, do not attempt to find the cause yourself. Leave the building, leaving doors open to ventilate, then call your gas supplier or service agent. Keep area clear until a service call has been made.

At times you may not be able to smell an LP gas leak. One cause is odor fade, which is a loss of the chemical odorant that gives LP gas its distinctive smell. Another cause can be your physical condition, such as having a cold or diminishing sense of smell

with age. For these reasons, the use of a propane gas detector is recommended.

IF YOU EXPERIENCE AN OUT OF GAS SITUATION, DO NOT TRY TO RELIGHT APPLIANCES YOURSELF. Call your local service agent. Only trained LP professionals should conduct the required safety checks in accordance with industry standards.

HIGH ALTITUDE INSTALLATIONS



INSTALLATIONS ABOVE 2000 FEET (600 M) REQUIRE REPLACEMENT OF THE BURNER ORIFICE IN ACCORDANCE WITH SECTION 8.2.1 OF THE NATIONAL FUEL GAS CODE (ANSI Z223.1). FAILURE TO REPLACE THE ORIFICE WILL RESULT IN IMPROPER AND INEFFICIENT OPERATION OF THE APPLIANCE RESULTING IN THE PRODUCTION OF INCREASED LEVELS OF CARBON MONOXIDE GAS IN EXCESS OF SAFE LIMITS WHICH COULD RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Ratings specified by manufacturers for most appliances apply for elevations up to 2000 feet (600 m). For elevations above 2000 feet (600 m), ratings must be reduced at the rate of 4% for each 1000 feet (300 m) above sea level. For example, if a boiler is rated at 500,000 Btu/hr. at sea level, to rate the boiler at 4000 feet (1200 m), the original rating is reduced by 16 percent (4 x 4%) to a rating of 420,000 Btu/hr.

The input reduction is primarily achieved by reducing the size of the main burner orifice. To do this, the main burner orifices require replacement with an orifice sized for the particular installation elevation. Part number for gas orifices for altitudes up to 4000 feet (1220 m) are given in Table 5. Orifices for higher altitudes are special order and may be obtained from A. O. Smith Water Products Company. When ordering, be sure to state the model number and the altitude of the location where the boiler is installed.

TABLE 5. LEGEND 2000 ORIFICE TABLE

Model	Natural Gas Part No.	Propane Part No.	Size (In.)	Elevation (Ft.)
LB/LW-500	*191884-0	—	0.391	0-2000
LB/LW-500	191884-1	—	0.384	2001-3000
LB/LW-500	191884-2	—	0.374	3001-4000
LB/LW-500	—	192741-0	0.229	0-2000
LB/LW-500	--	192741-1	0.226	2001-3000
LB/LW-500	--	192741-2	0.223	3001-4000
LB/LW-750(USA)	*191884-3	--	0.484	0-2000
LB/LW-750(USA)	191884-5	--	0.469	2001-3000
LB/LW-750 USA	191884-7	--	0.461	3001-4000
LB/LW-750 CAN	*191884-11	--	0.464	0-2000
LB/LW-750 CAN	191884-12	--	0.450	2001-3000
LB/LW-750 CAN	191884-13	--	0.443	3001-4000
LB/LW-750	--	192741-3	0.286	0-2000
LB/LW-750	--	192741-4	0.282	2001-3000
LB/LW-750	--	192741-6	0.278	3001-4000
LB/LW-1000	*192222-0	--	0.555	0-2000
LB/LW-1000	192222-1	--	0.537	2001-3000
LB/LW-1000	192222-2	--	0.533	3001-4000
LB/LW-1000	--	*192739-0	0.333	0-2000
LB/LW-1000	--	192739-1	0.329	2001-3000
LB/LW-1000	--	192739-2	0.325	3001-4000

*Factory installed orifice.

Upon completion of derating of the boiler, adjustment to the gas pressure regulator may be required. See GAS PRESSURE REGULATORS in this manual for inlet and manifold pressure requirements.

Also, due to the input rating reduction required at high altitudes, the output rating of the appliance is also reduced and should be compensated for in the sizing of the equipment for applications.

NOTE: Some gas utility companies derate their gas for altitude, making it unnecessary to install high altitude orifices. Call the local gas utility company to verify BTU content.

FIELD INSTALLED COMPONENTS

When installing the boiler, the following components **MUST** be used, if applicable:

- 1) Circulating Pump (Hydronic)
- 2) Tank Temperature Control (Hot Water Supply)
- 3) Loop Temperature Control (Hydronic)
- 4) Low Water Cutoff Device
- 5) Relief Valve
- 6) Pressure Gauge
- 7) Manual Gas Shutoff Valve (Supply)

Check the **FEATURES AND CONTROLS** section for further information.

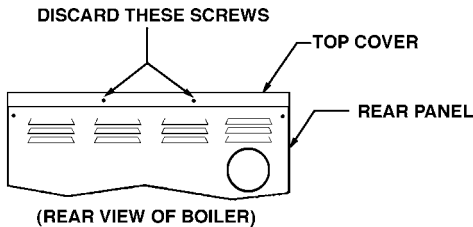


FIGURE 1.

PANELS AND COVERS

All panels and covers (e.g. control and junction box covers; front, side and rear panels of boiler) **MUST** be in place after service and/or before operation of the boiler. This will ensure that all gas ignition components will be protected from water.

NOTE: Remove the two (2) sheet metal screws from the rear of the top cover and discard them, see fig 1. This will allow removal of the top cover without the use of tools. Also, remove the sheet metal screw from the bottom of the front panel.

FEATURES/CONTROLS

The Legend 2000® is a low-pressure boiler (Category IV) to be used as either hot water supply (domestic/commercial water heating) or hot water heating (hydronic) application. Category IV boilers operate with a positive vent pressure and with a vent gas temperature less than 140°F (60°C) above its dew point. Category IV appliances are often termed “High Efficiency” appliances.

This high efficiency is obtained from a unique heat exchanger design consisting of multiple integral high-finned copper tubes brazed in parallel into two brass manifolds. The condensate from the heat exchanger flows downward into the vent collector housing then into the plastic condensate drain and through the attached flexible hose which must terminate at a suitable floor drain.

ELECTRONIC IGNITION CONTROL

The Legend 2000® is controlled by the WHC 1502 ignition system, fig. 2. The WHC 1502 is a solid-state ignition control that ignites the main burner by energizing the Hot Surface Ignitor, fig. 3. The ignition control system continuously monitors the current of the ignitor and will not allow gas to enter the main burner until current flow reaches the preset ignition temperature threshold. Once the ignition threshold has been reached, the control system will open the gas valve(s). After the main burner ignites, the control

system monitors the burner flame through the principle of flame rectification. If a flame is not verified, the gas valve is immediately closed.

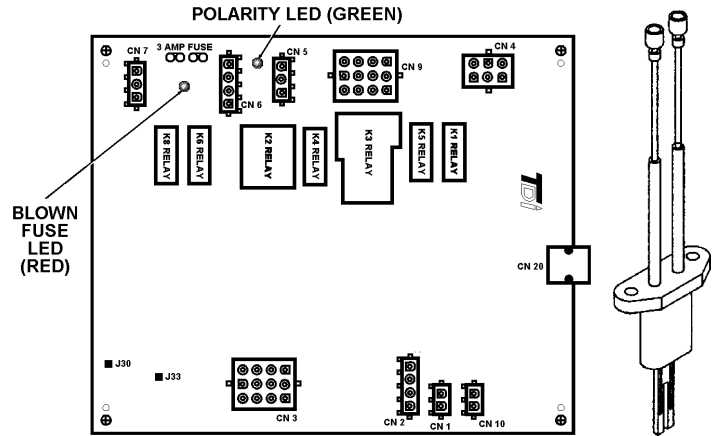


FIGURE 2.

FIGURE 3.

The control board provides a pre-purge period of twenty (20) seconds and a post-purge period of twenty-five (25) seconds. The flame establishing period is four (4) seconds.

This control is non-adjustable. Any attempts to modify the performance, other than those listed in this manual, voids the control warranty.

The 24 VAC circuitry of the ignition control system is protected with a 3-amp fuse. If the fuse opens, a red LED located near the fuse will light.

HOT SURFACE IGNITOR

The Hot Surface Ignitor, fig. 3, is a device that ignites the main burner by high temperature (>1800°F) [982°C]. The igniter is made of recrystallized silicon carbide, and when 120 VAC is applied to the igniter, sufficient heat is generated to ignite the main burner. Although improvements have been made to strengthen the igniter, it is still fragile and care must be taken in handling the igniter to prevent breakage.

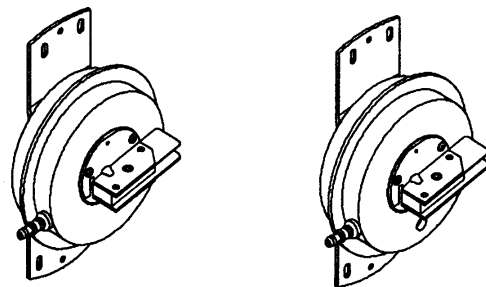


FIGURE 4.

BLOCKED FLUE SWITCH

The Blocked Flue Switch (BFS) fig. 4, is a single-pole, normally closed pressure switch that will open its contacts when a rising positive pressure of 1.0 in. w.c. (0.25 kPa) is encountered. The contacts will close when the pressure falls below the fixed set point of 1.0 in. w.c. (0.25 kPa). The BFS monitors the pressure inside the venting system. If the venting system is blocked in such a way that the build up in pressure exceeds the setting of

the BFS, the main burner is extinguished (if boiler is running) or the boiler will not start up.

BLOWER PROVER SWITCH

The Blower Prover Switch (BPS) fig. 4, is similar in construction to the BFS. It is a single-pole, normally open pressure switch that will close its contacts when a rising positive pressure of 1.0 in. w.c. (0.25 kPa) is encountered. The contacts will open when the pressure falls below the fixed set point of 1.0 in. w.c. (0.25 kPa) The BPS monitors the pressure inside the blower elbow. If the blower is not operating at a sufficient blowing capacity, the main burner is extinguished (if boiler is running) or the boiler will not start up.

LOW GAS SWITCH

The Low Gas Switch (LGS) fig. 5, is a single-pole, normally open pressure switch that will close its contacts when a rising pressure of 5.0 in. w.c. (1.24 kPa) is encountered. The contacts will open when the pressure falls below the fixed set point of 5.0 in. w.c. (1.24 kPa) The LGS monitors the gas supply pressure to the boiler. If the gas supply falls below 5.0 in. w.c. (1.24 kPa), the main burner is extinguished (if boiler is running) or the boiler will not start up.

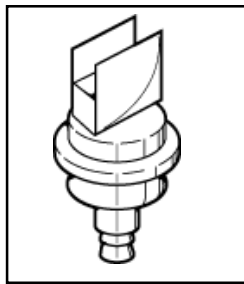


FIGURE 5. LOW GAS SWITCH (LGS)

WATER FLOW SWITCH

The Water Flow Switch (WFS) fig. 6, is installed at the boiler water outlet to prevent main burner operation in the event of inadequate water flow through the boiler. The WFS is a single-pole, normally open switch that will close its contacts when an increasing water flow rate of approximately 25 GPM (1.61 lps) is encountered. The contacts will open when the flow rate drops below this setting, extinguishing the main burner flames (if boiler is running) or the boiler will not start up.

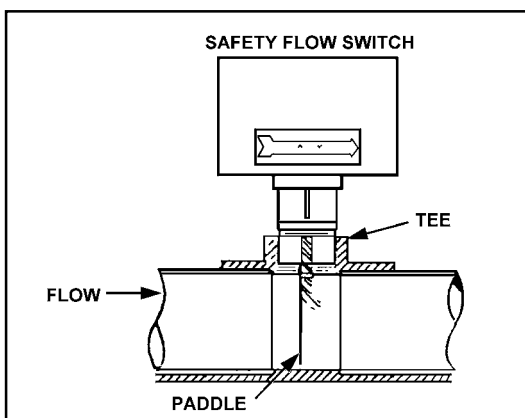


FIGURE 6. WATER FLOW SWITCH (WFS)

AIR SHUTTER

The blower is equipped with an air shutter assembly for fine adjustment of the air to gas ratio. The assembly consists of a shutter flange and the air shutter. The shutter may require adjustment to achieve ideal start-up characteristics when fine tuning the boiler for correct combustion specifications. Refer to the Start-Up Procedures, part number 192077 Rev. 1, for the proper combustion specifications and limits. If necessary, the shutter may be adjusted by loosening the two nuts used to hold the shutter and blower adapter assembly in place on the inlet of the blower. Once the unit is set to the specifications called for in the Start-Up Procedures, tighten the nuts to lock the shutter in place.

BLOWER SPEED CONTROL

The Blower Speed Control (BSC) permits variation of speed of the blower during boiler (LB/LW-500 only) start-up. When the 1502 Control Board energizes the igniter, the BSC will lower the speed (RPM) of the blower to a preset level. This lower speed will be maintained until the igniter is de-energized by the Control Board. Then, the blower will return to its normal operating speed.

COMBINATION GAS CONTROL

The Combination Gas Control (CGC) is a gas valve or valves that controls the supply of gas to the main burner during operation of the boiler. The CGC includes a manual main shutoff valve, two (2) automatic valves and a pressure regulator, see figure 15.

The two-position gas control knob has "ON" and "OFF" positions that allows or prevents the flow of gas to the main burner, respectively. The first automatic valve is solenoid operated and opens and closes when the main valve terminal on the Control Board is energized or de-energized, respectively. The second automatic valve is diaphragm operated and opens under control of the pressure regulator and closes if gas or power supply is interrupted. The pressure regulator is adjustable and maintains an almost constant gas outlet pressure under wide fluctuations in gas supply pressure.

MANUAL RESET LIMIT (E.C.O)

This device prevents the water temperature from exceeding 250°F (121°C). It is located in the outlet waterway within the outlet temperature sensing device and is monitored by the Control Board. Commonly referred to as the "emergency cut out", it is a manually resettable control. The "ADJUST", "SELECT" or "ENTER/RESET" button on the display board must be depressed to reset the unit if the water temperature reaches this limit. See figure 20.



CAUTION
LIMIT CONTROLS ARE NOT TO BE USED AS A THERMOSTAT OR OPERATING CONTROL.

AUTOMATIC RESET LIMIT

This limit is a safety device in series with the ignition system. Set the limit control to a minimum of 30°F (16°C) above the maximum designed system temperature. If the boiler outlet water temperature should exceed the automatic reset limit setting, the main gas valves will close. The automatic reset limit control is factory set at 180°F (82°C) and has an adjustable range from 110 to 240°F (43° to 116°C). The operating differential is also adjustable from 5 to 50°F (3° to 28°C).

ON/OFF SWITCH

The ON/OFF Switch is a single-pole, single-throw rocker switch. This switch provides 120V from the line source to the boiler.

CIRCULATING PUMP

HOT WATER SUPPLY SYSTEMS, the circulating pump is integral to the LW models. This pump has been lubricated at the factory, and future lubrication should be in accordance with the motor manufacturer's instructions provided as a supplement to this manual.

FOR HOT WATER HEATING SYSTEMS-LB MODELS, the circulating pump is NOT provided and must be obtained and installed in the field.

NOTE: If a system pump is to be installed on a Legend LB model, the maximum rating of the pump motor must not exceed 1 hp.

TANK TEMPERATURE CONTROL

A tank probe is provided with LW models to be used for tank temperature regulations. The temperature setting for the tank is set through the display.

Refer to figs. 7, 13, 14 and 16 for connecting the tank probe to the boiler.

See TEMPERATURE SET POINT ADJUSTMENT PROCEDURE for further instructions.

FOR HOT WATER SUPPLY SYSTEMS, the boiler is supplied with a Tank Probe to be field installed in the storage tank. Alternate methods of temperature control, if desired, must be supplied by the installer.

A change in water temperature in the storage tank lower than the Tank Temperature Control setting will cause the sensor to close its contacts and consequently, energize the boiler.

If the Tank Probe or Temperature Control is out of calibration, replace it with a new one; do not attempt to fix this control.

NOTE: If you are using an LW model in a hydronic (space heating) application, do not use the tank probe as a loop temperature regulation device. The tank probe's maximum setting is 190°F (88°C). Therefore, 24 VAC connections (red/green wires) are provided in the rear junction box for an alternate device. The J33 board jumper must be removed to use a 24 VAC temperature regulation device (See figures 21 and 22).

LOW WATER CUTOFF (Not Supplied)

If low water protection is required by the authorities having jurisdiction, a low water cutoff switch should be installed next to the boiler in the outlet water line as shown in figure 12. The switch should receive periodic (every six months) inspection to assure proper operation. A Low Water Cutoff device of the float type should be flushed every six months.

DRAIN VALVE

A drain valve is factory installed in the heat exchanger manifold. This will help to drain the heat exchanger.

Additional drain valves must be obtained and installed on each boiler and tank for draining purposes, see figures 12, 13 and 14.

SAFETY RELIEF VALVE

Your local code authority may have other specific safety relief valve requirements not covered below.

WARNING

THE PURPOSE OF A SAFETY RELIEF VALVE IS TO AVOID EXCESSIVE PRESSURE OR TEMPERATURE INTO THE STEAM RANGE WHICH MAY CAUSE SCALDING AT FIXTURES, TANK EXPLOSION, SYSTEM OR BOILER DAMAGE.

TO AVOID SCALDING OR WATER DAMAGE, A DRAIN LINE MUST BE CONNECTED TO A SAFETY RELIEF VALVE TO DIRECT DISCHARGE TO A SAFE LOCATION. A DRAIN LINE MUST NOT BE REDUCED FROM THE SIZE OF THE VALVE OUTLET AND IT MUST NOT CONTAIN ANY VALVES BETWEEN THE BOILER AND THE RELIEF VALVE OR THE RELIEF VALVE AND THE DRAIN EXIT. IN ADDITION, THERE SHOULD NOT BE ANY RESTRICTIONS IN A DRAIN LINE NOR SHOULD IT BE ROUTED THROUGH AREAS WHERE FREEZING CONDITIONS MIGHT OCCUR. DO NOT THREAD OR CAP THE DRAIN LINE EXIT. RESTRICTING OR BLOCKING A DRAIN LINE WILL DEFEAT THE PURPOSE OF THE SAFETY RELIEF VALVE AND MAY CREATE AN UNSAFE CONDITION. INSTALL A DRAIN LINE WITH A DOWNWARD SLOPE SUCH THAT IT WILL NATURALLY DRAIN ITSELF.

If any pressure relief valve is replaced, the replacement valve must comply with the latest version of the ASME Boiler and Pressure Vessel Code, Section IV ("HEATING BOILERS").

Select a relief valve with a discharge rating **NOT LESS** than the boiler input, and a set pressure **NOT EXCEEDING** the working pressure of any component in the system.

FOR HOT WATER SUPPLY SYSTEMS, the boilers are shipped with a 125 psi (860 kPa) pressure relief valve that must be installed in the water outlet as near to the boiler as possible.

This ASME-rated valve has a discharge capacity that exceeds the maximum boiler input rating and a pressure rating that does not exceed the maximum working pressure shown on the boiler rating plate.

In addition, a CSA design-certified and ASME-rated temperature and pressure (T & P) relief valve must be installed on each and every water storage tank in the hot water supply system.

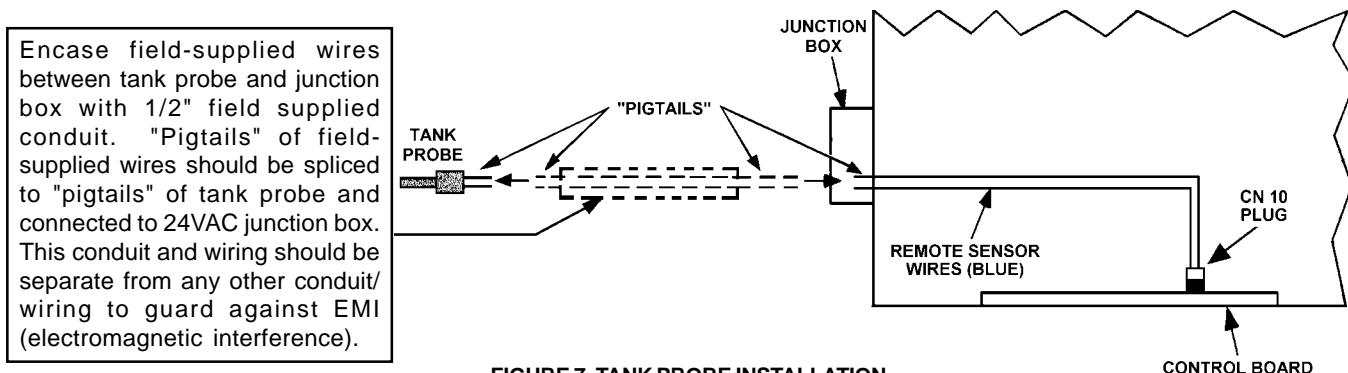


FIGURE 7. TANK PROBE INSTALLATION

The T & P relief valve must comply with the applicable construction provisions of the Standard for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22-1999 or CAN/CSA-B149.1-00, or most recent edition. The T & P relief valve must be of the automatic reset type and not embody a single-use type fusible plug, cartridge or linkage.

The T & P relief valve should have a temperature rating of 210°F (99°C), a pressure rating **NOT** exceeding the lowest rated working pressure of any system component, and a discharge capacity exceeding the total input of the water boilers supplying water to the storage tank.

Locate the T & P relief valve (a) in the top of the tank, or (b) in the side of the tank on a centerline within the upper 6 inches (152 mm) of the top of the tank. See figures 13 and 14. The tapping shall be threaded in accordance with the latest edition of the Standard for Pipe Threads, General Purpose (inch), ANSI/ASME B1.20.1. The location of, or intended location for, the T & P relief valve shall be readily accessible for servicing or replacement.

FOR HOT WATER HEATING SYSTEMS, the boilers are shipped with a 50 psi (345 kPa) pressure relief valve. This relief valve must be installed in the water outlet as near to the boiler as possible.

INSTALLATION INSTRUCTIONS

REQUIRED ABILITY

INSTALLATION OR SERVICE OF THIS BOILER REQUIRES ABILITY EQUIVALENT TO THAT OF A LICENSED TRADESMAN IN THE FIELD INVOLVED. PLUMBING, AIR SUPPLY, VENTING, GAS SUPPLY AND ELECTRICAL WORK ARE REQUIRED.

LOCATION

When installing the boiler, consideration must be given to proper location. The location selected should provide adequate air supply and be as centralized with the piping system as possible.

THE BOILER MUST NOT BE INSTALLED ON CARPETING.

THE BOILER SHOULD NOT BE LOCATED IN AN AREA WHERE IT WILL BE SUBJECT TO FREEZING.

LOCATE IT NEAR A FLOOR DRAIN. THE BOILER SHOULD BE LOCATED IN AN AREA WHERE LEAKAGE FROM THE BOILER OR CONNECTIONS WILL NOT RESULT IN DAMAGE TO THE ADJACENT AREA OR TO LOWER FLOORS OF THE STRUCTURE.



WARNING

THERE IS A RISK IN USING FUEL BURNING APPLIANCES SUCH AS BOILERS IN ROOMS OR AREAS WHERE GASOLINE, OTHER FLAMMABLE LIQUIDS OR ENGINE DRIVEN EQUIPMENT OR VEHICLES ARE STORED, OPERATED OR REPAIRED. FLAMMABLE VAPORS ARE HEAVY AND TRAVEL ALONG THE FLOOR AND MAY BE IGNITED BY SPARKS CAUSING FIRE OR EXPLOSION. SOME LOCAL CODES PERMIT OPERATION OF GAS APPLIANCES IF INSTALLED 18 INCHES (457 MM) OR MORE ABOVE THE FLOOR. THIS MAY REDUCE THE RISK IF LOCATION IN SUCH AN AREA CANNOT BE AVOIDED.



WARNING

FLAMMABLE ITEMS, PRESSURIZED CONTAINERS OR ANY OTHER POTENTIAL FIRE HAZARDOUS ARTICLES MUST NEVER BE PLACED ON OR ADJACENT TO THE BOILER. OPEN CONTAINERS OR FLAMMABLE MATERIAL SHOULD NOT BE STORED OR USED IN THE SAME ROOM WITH THE BOILER.

If the boiler is installed above radiation level, a **Low Water Cutoff Device** must be installed in the boiler outlet at the time of installation.

CHEMICAL VAPOR CORROSION

Water boiler corrosion and component failure can be caused by the heating and breakdown of airborne chemical vapors. Spray can propellants, cleaning solvents, refrigerator and air conditioning refrigerants, swimming pool chemicals, calcium and sodium chloride (water softener salt), waxes, and process chemicals are typical compounds which are potentially corrosive. These materials are corrosive at very low concentration levels with little or no odor to reveal their presence.

Products of this sort should not be stored near the boiler. Also, air which is brought in contact with the water boiler should not contain any of these chemicals. If necessary, uncontaminated air should be obtained from remote or outside sources. Failure to observe this requirement will void the warranty.

INSTALLATION CLEARANCES

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

4" (102 mm) Rear; 0" (0 mm) Top and Sides; 6" (152 mm) Vent.

Two inch (51 mm) clearance is allowable from combustible construction for hot water pipes.

Sufficient area should be provided at the front and rear of the unit for proper servicing. Service clearances of 24" (610 mm) in front, rear, top and left side are recommended. In a utility room installation, the door opening shall be wide enough to allow the boiler to enter or to permit the replacement of another appliance such as a water heater.

LEVELING

Each unit should be checked after installation to be certain that it is level.

If the unit is not level, obtain and insert shims under the nylon protective feet at the frame base to correct this condition.

AIR REQUIREMENTS



WARNING

FOR SAFE OPERATION, AN AMPLE SUPPLY OF AIR MUST BE PROVIDED FOR PROPER COMBUSTION AND VENTILATION IN ACCORDANCE WITH SECTION 8.3, AIR FOR COMBUSTION AND VENTILATION, OF THE NATIONAL FUEL GAS CODE, ANSI Z223.1 OR SECTION 7.4 OF CSA-B149.1-00 OR APPLICABLE PROVISIONS OF THE LOCAL BUILDING CODES. AN INSUFFICIENT SUPPLY OF AIR WILL RESULT IN A YELLOW, LUMINOUS BURNER FLAME, CAUSING CARBONING OR SOOTING OF THE FINNED HEAT EXCHANGER AND CREATING A RISK OF ASPHYXIATION. DO NOT OBSTRUCT THE FLOW OF COMBUSTION AND VENTILATION AIR.

UNCONFINED SPACE

In buildings of conventional frame, brick or stone construction, unconfined spaces may provide adequate air for combustion.

If the unconfined space is within a building of tight construction (buildings using the following construction: weather stripping, heavy insulation, caulking, vapor barrier, etc.), air for combustion, ventilation and draft hood dilution must be obtained from outdoors

or spaces freely communicating with the outdoors. The installation instructions for confined spaces in tightly constructed buildings must be followed to ensure adequate air supply.

CONFINED SPACE

A. U.S. INSTALLATIONS

When drawing combustion and dilution air from inside a conventionally constructed building to a confined space, such a space shall be provided with two permanent openings, ONE IN OR WITHIN 12 INCHES (305 MM) OF THE ENCLOSURE TOP AND ONE IN OR WITHIN 12 INCHES (305 MM) OF THE ENCLOSURE BOTTOM. Each opening shall have a free area of at least one square inch per 1000 Btu/hr (2,225 mm² per kw) of the total input of all appliances in the enclosure, but not less than 100 square inches (645 cm²).

If the confined space is within a building of tight construction, air for combustion, ventilation and draft hood dilution must be obtained from outdoors. When directly communicating with the outdoors or communicating with the outdoors through vertical ducts, two permanent openings, located in the aforementioned manner, shall be provided. Each opening shall have a free area of not less than one square inch per 4000 Btu/hr (551 mm² per kw) of the total input of all appliances in the enclosure. If horizontal ducts are used, each opening shall have a free area of not less than one square inch per 2000 Btu/hr (1,101 mm² per kw) of the total input of all appliances in the enclosure.

B. CANADIAN INSTALLATIONS

Ventilation of the space occupied by the boiler(s) shall be provided by an opening for ventilation air at the highest practical point communicating with outdoors. The total cross-sectional area shall be at least 10% of the area of the combustion air opening but in no case shall the cross-sectional area be less than 10 square inches (6500 mm²).

In addition to the above, there shall be permanent air supply opening(s) having a cross-sectional area of not less than 1 square inch per 7,000 BTUH (315 mm²/KW) up to and including 1,000,000 BTUH plus 1 square inch per 14,000 BTU (158 mm²/kW) in excess of 1,000,000 BTUH. This opening(s) shall be located at, or ducted to, a point neither more than 18" (457 mm) nor less than 6 inches (152 mm) above the floor level.

Where power vented equipment is used in the same room as the boiler, sufficient air openings must be supplied.

UNDERSIZED OPENINGS MAY RESULT IN INSUFFICIENT AIR FOR COMBUSTION.

Where an exhaust fan is installed in the same room with the boiler, sufficient openings for air must be provided in the walls. **UNDERSIZED OPENINGS WILL CAUSE AIR TO BE DRAWN INTO THE ROOM THROUGH THE CHIMNEY OR OTHER OPENINGS, CAUSING POOR COMBUSTION. SOOTING MAY RESULT WITH AN INCREASED RISK OF ASPHYXIATION.**

VENTING



WARNING

THE INSTRUCTIONS IN THIS SECTION ON VENTING THE BOILER MUST BE FOLLOWED TO AVOID CHOKED COMBUSTION OR RECIRCULATION OF FLUE GASES. SUCH CONDITIONS CAUSE SOOTING OR RISKS OF FIRE AND ASPHYXIATION.

VENT SIZING, INSTALLATION AND TERMINATION SHALL BE IN ACCORDANCE WITH THIS INSTALLATION MANUAL.

ALL ELECTRICAL POWER AND GAS MUST BE TURNED OFF PRIOR TO ANY INSTALLATION OF THE VENTING SYSTEM.

SPECIAL INSTALLATION CONSIDERATIONS

The Legend 2000® is listed as a Category IV appliance and utilizes a mechanical forced draft system. The vent system shall be designed to prevent leakage of flue gases and condensate. The condensate must be allowed to flow to a suitable drain. Since the condensate is known to be detrimental to conventional vent materials (galvanized steel, some stainless steels), the vent material for the boiler's exhaust shall be approved and certified for the venting of low temperature condensing flue gasses. AL 29-4C® is one such material.

The exhaust gases of this boiler are generally only 15°-20°F (8°C to 11°C) higher than the boiler's operating temperature, much lower than a standard boiler. In cold climates any water vapor remaining in the flue gases will condense into a cloud of vapor at the point where the vent system exits the building. Special

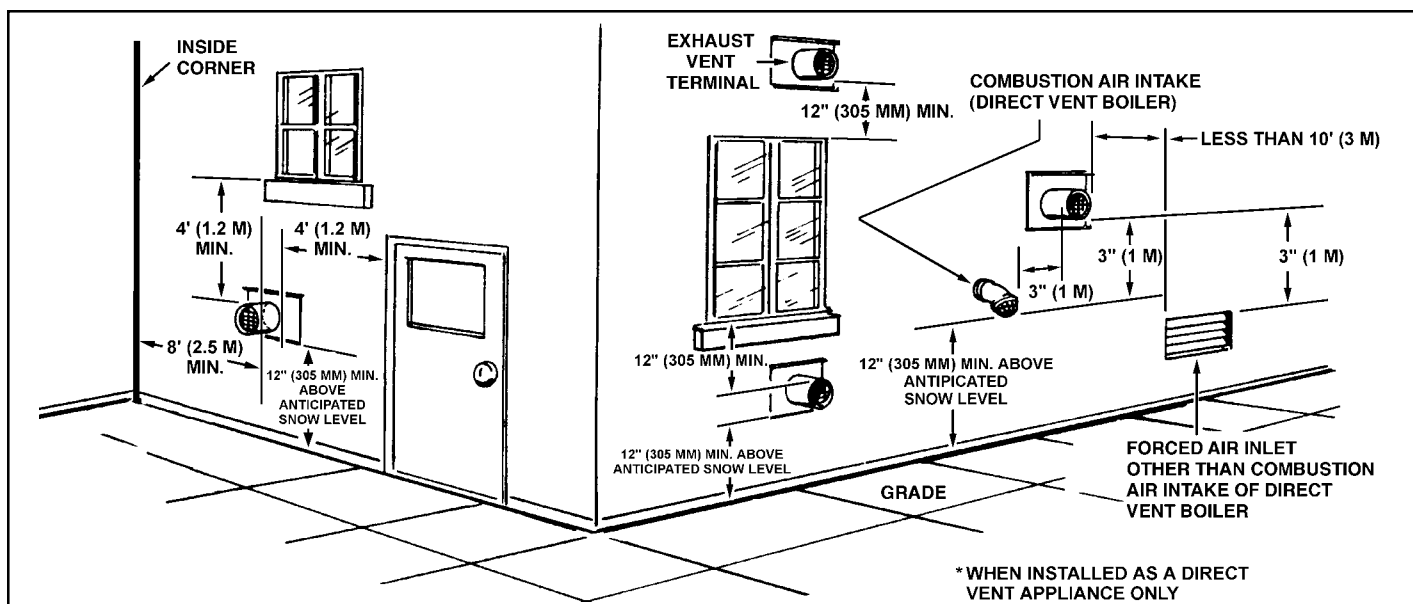


FIGURE 8. SIDEWALL EXHAUST VENTING

consideration is recommended, before locating the vent termination near walkways, windows and building entrances.

Direct venting into dead spaces such as; alleys, atriums and inside corners can cause recirculation of flue gases. Recirculation of flue gases will cause sooting, premature failure of the heat exchanger and icing of the combustion air intake during severe cold weather. To prevent the recirculation of flue gases, maintain as much distance as possible between the combustion air intake and the exhaust vent terminal. Due to large volumes of flue gases, multiple boiler applications also require additional distance between the intake and exhaust terminals.

VENTING SYSTEM USING AL 29-4C®

The LEGEND 2000® may be installed in four separate orientations depending on the requirements of the building and the appliance. The installer must decide which method is most appropriate for each installation. These orientations are:

1. **Vertical Termination** — vertical vent termination through un-enclosed or enclosed areas with roof penetration, see fig. 9.
2. **Through-the-Wall Termination (TWT)** — horizontal vent termination directly through an outside wall, see figure 9A.
3. **Direct Vent** — using TWT to exhaust flue products and PVC piping to bring combustion air to the boiler from the outside, see figures 11 and 11C.
4. **Vertical Direct Vent** — using a vertical vent termination to exhaust flue products and PVC piping to bring combustion air to the boiler from outside, see figures 11A and 11B.

GENERAL INSTALLATION REQUIREMENTS

COMMON VENTING LEGEND BOILERS.

Common venting of multiple Legend boilers are not allowed except with either a U.L. or CSA approved power venter.

- All the vent pipe(s) and power venter must be sized by and installed as per the recommendations of the power venter manufacturer. Please see boiler's wiring label for electrical hook-up of power venter to the ignition control.
- When multiple Legend boilers are connected using a common power venter and common power venter and common vent pipe; the power venter and vent piping should be sized to maintain a -0.0 IWC to -0.04 IWC draft in the common vent downstream of the boilers, when any one of or all boilers are firing. A positive pressure of +.02 IWC to =.05 IWC should be seen 12" above the boot tee of each unit when the unit is firing.
- All Venting material must be AL29-4C venting material.
- A factory start-up of the engineered power venting system must be performed by an authorized factory start-up agent of the power venter system manufacturer.
- To assure proper boiler and power venter operation, both the power venter start-up and A.O. Smith Authorized boiler start-up must be performed simultaneously.

1. Failure to conform with any of these requirements may violate local, state/provincial or federal codes as well as create conditions which may cause catastrophic property damage or personal injury. The vent system must terminate so that proper clearances are maintained as cited in local codes or the latest edition of the National Fuel Gas Code, ANSI Z223.1 or CSA-B149.1-00 and latest addenda. The vent system must not have external runs greater than that allowed by local codes or the National Fuel Gas Code.

2. AL 29-4C® sections and fittings **MUST** be used for the entire length of the exhaust system; alternatives such as galvanized pipe, PVC, CPVC or Type B Vent sections must not be used.
3. Install a AL 29-4C® drain fitting as close as possible to the boiler vent connector outlet. See "CONNECTING VENT TO BOILER" on the installation of this drain fitting.
4. Horizontal runs of vent pipe shall be securely supported by adequately placed (approximately every 6 feet [2 m]) non-combustible hangers and/or slip joints suitable for the weight and design of the material employed to prevent sagging and to maintain a minimum upward slope of 1/4" per foot (21 mm) from the boiler to the vent terminal (see "VENTING SUPPORTS" and figures 9A and 11).

The upward slope allows any build up of condensate to flow back towards the boiler and drain fitting preventing the accumulation of condensate. See "CONNECTING VENT TO BOILER."

EXCEPTION: The vent connector on the boiler is sloped downward to direct condensate towards the "field-installed" drain fitting.

5. All joints in the venting system **MUST** be sealed with RTV 106 or equivalent sealant.
6. **NO** other appliances may be interconnected to any part of this venting system, including vent connectors which serve appliances vented by NATURAL DRAFT.
7. The venting system must be planned so as to avoid possible contact with concealed plumbing or electrical wiring inside walls.
8. The venting system must be planned to maintain an airspace clearance from combustibles of at least 6 inches (152 mm) for any conduit and fittings of single wall AL 29-4C® vent and at least 4 inches (102 mm) for any conduit and fittings of double wall AL 29-4C® vent. Double wall AL 29-4C® vent must be used when penetrating any floors, walls or ceilings and any penetration must be properly fire stopped. All insulation material must be removed from any wall, floor or ceiling cavity for at least 4 inches (102 mm) from the conduit.
9. The venting system in a multi-family structure must be planned to be enclosed when passing through occupied or unoccupied spaces above the connected boiler. This enclosure is to be of materials no less fire resistant than surrounding floors and walls. It is recommended that the system be enclosed whenever passing through occupied spaces.

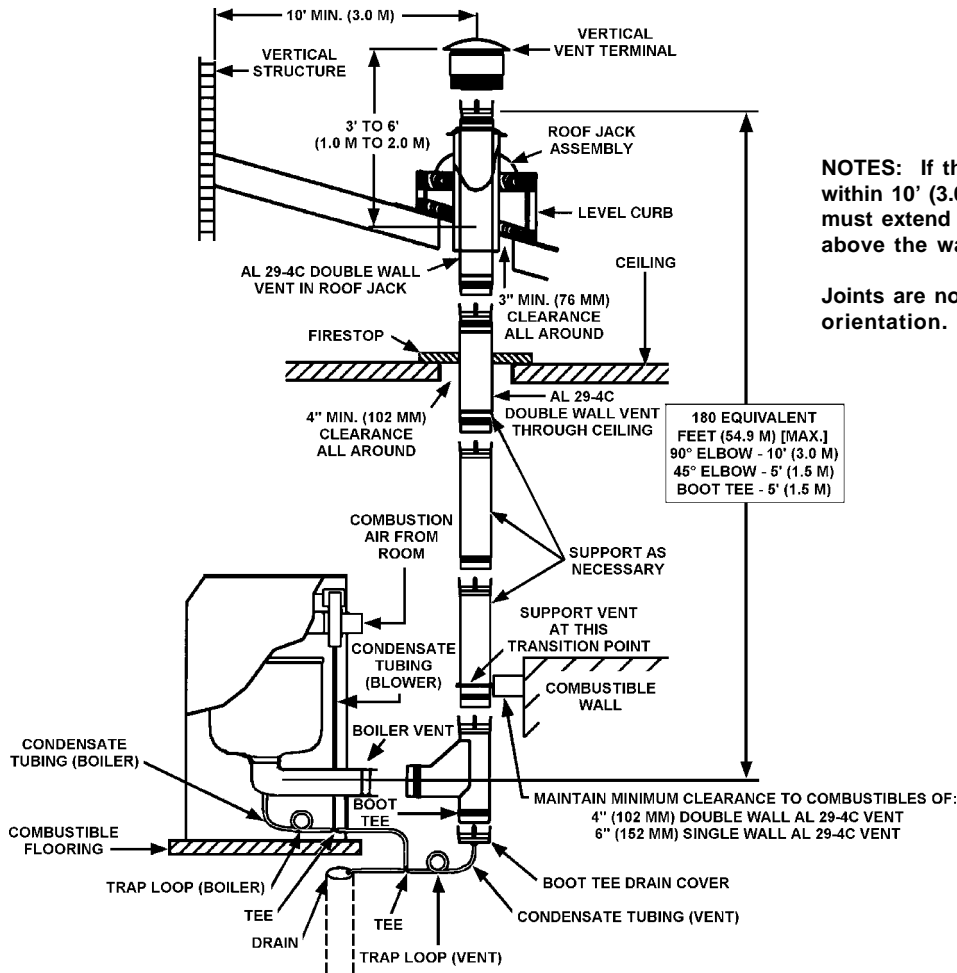
GENERAL EXHAUST VENT INSTALLATION PROCEDURE

Prior to beginning the installation of the vent system, determine and obtain all parts required for the installation. Refer to the DIRECT VENT KIT PARTS LIST (part no. 192109), for a list of the vent sections and fittings.

Proper operation of the boiler and venting system is dependent upon use of all specified parts and installation techniques; both safety and proper performance of the system may suffer if instructions are not followed.

CONNECTING VENT TO BOILER

At the outlet of the boiler vent, see figure 10, the AL 29-4C® Vent Boot-Tee and Boot-Tee Drain Cover must be used as the transition from the horizontal to vertical run. This is where the bottom most support bracket should be located.

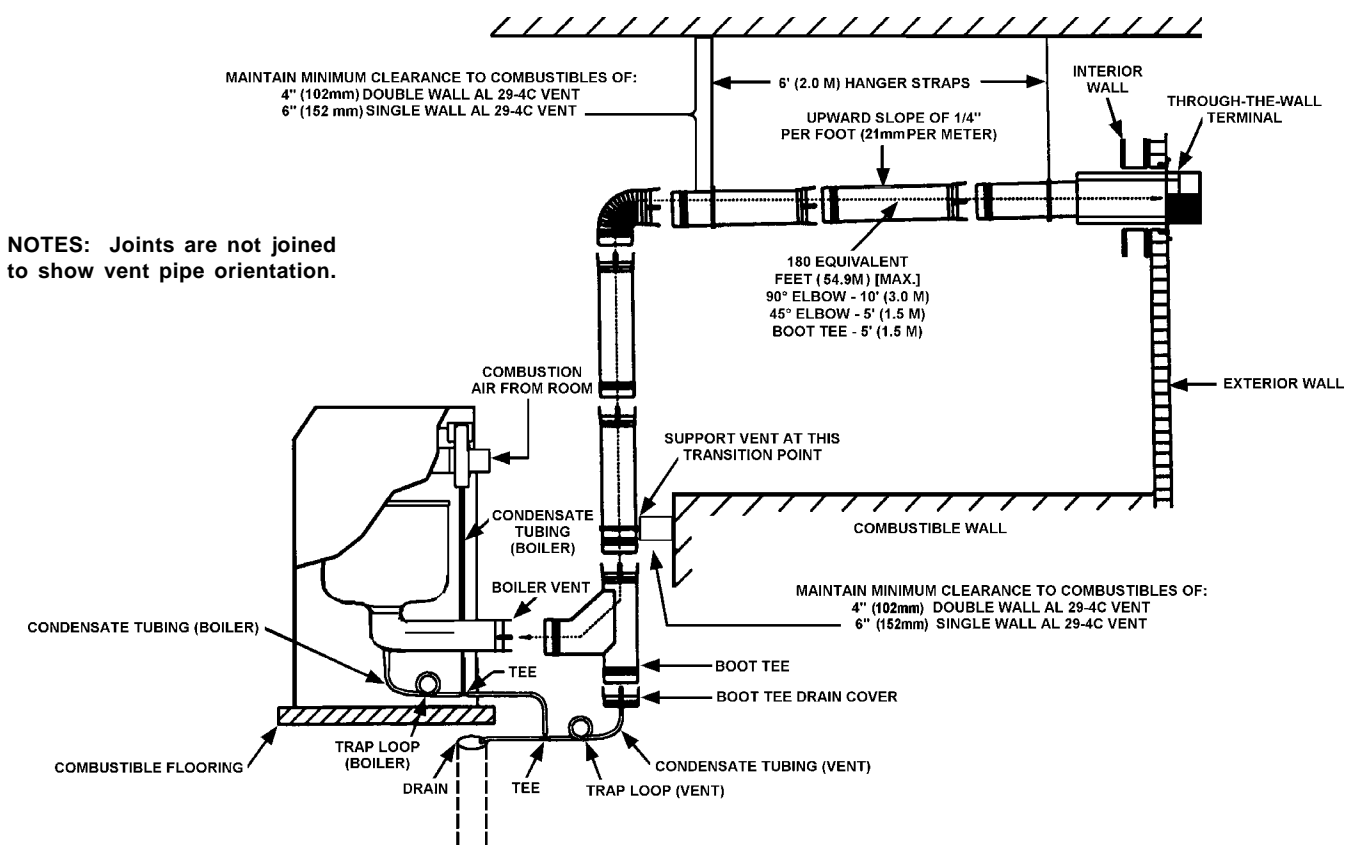


NOTES: If the exhaust vent terminal is within 10' (3.0 m) of a wall or parapet, it must extend a minimum of 2' (610 mm) above the wall or parapet.

Joins are not joined to show vent pipe orientation.

180 EQUIVALENT FEET (54.9 M) [MAX.]
 90° ELBOW - 10' (3.0 M)
 45° ELBOW - 5' (1.5 M)
 BOOT TEE - 5' (1.5 M)

FIGURE 9. VERTICAL TERMINATION



NOTES: Joins are not joined to show vent pipe orientation.

180 EQUIVALENT FEET (54.9M) [MAX.]
 90° ELBOW - 10' (3.0 M)
 45° ELBOW - 5' (1.5 M)
 BOOT TEE - 5' (1.5 M)

FIGURE 9A. THROUGH THE WALL TERMINATION (TWT)

The Boot-Tee Drain Cover is required in order to dispose of the condensate from the venting system. The plastic tube (3/8 [9 mm] ID, 10 feet [3 m] long) needed to route the condensate to a suitable drain is provided with the boiler.

1. Attach the Boot Tee Drain Cover to the appropriate leg of the Boot-Tee, see figure 10.
2. A trap loop must be formed into the drain tube simply by looping the tube to a minimum 3 inch (76 mm) diameter and secure the loop with a cable tie, see figure 10.
3. Prior to final assembly the trap loop must be "primed" by pouring a small quantity of water into the drain hose.
4. Connect the Boot-Tee and Drain Tee assembly to the boiler vent connector, see figure 10.
5. Attach the hose to the drain fitting and run the hose to a sanitary sewer drain maintaining the proper trap loop and following all local, state and federal codes and regulations for draining of acidic effluent (condensate).

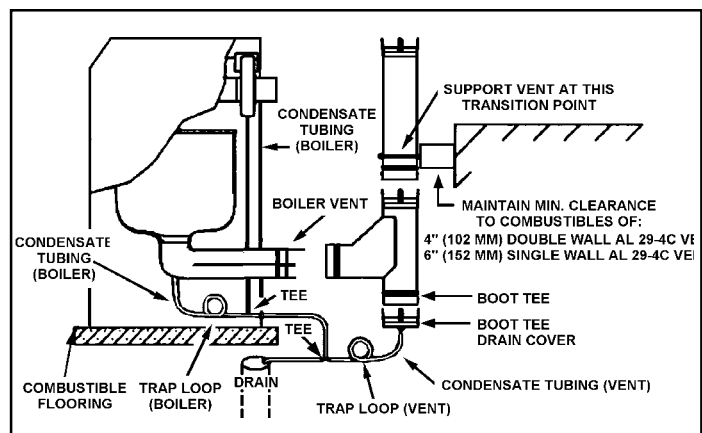


FIGURE 10.

VENTING SUPPORTS

Care must be taken in the installation of the venting system that adequate support is maintained throughout the installation process. When extending more than 10 feet (3.0 m) vertically, vertical support kits are required once every 10 feet (3.0 m) of vertical run. Vertical support is also required immediately after any transition (elbow, tee, etc.) to vertical of over 10 feet (3.0 m) of run and after any offset in the vertical run.

The support bracket (supplied in the Vertical Support Kit) is to be securely fastened to a solid vertical member of the building using the appropriate fasteners; i.e., wood screws for wood framing, machine or tapping screws for structural steel or masonry anchors for solid masonry. The bracket should be located so that it will not interfere with any joints of the venting system. The bottom most support bracket should be located directly above the first transition from horizontal to vertical, see Figure 10. Refer to figures 11, 11A, 11B and 11C.

If a means of support for the bracket is not available and horizontal vent sections are present, install hanger straps (made from non-combustible material) as close to the points of transition as possible. If the horizontal portions of the vent and/or vent connector are longer than 6 feet (2.0 m), then install hanger straps every 6 feet (2.0 m) to support the connector.

DO NOT rivet or screw the straps to the conduit or otherwise puncture the conduit wall. Instead, wrap an extra loop of strap around the conduit to hold it in position, or attach the strap to the center screw of the double wall AL 29-4C® vent coupling, if applicable.

VERTICAL INSTALLATION REQUIREMENTS

1. The vent system must terminate at least three (3) feet [1.0 m] and no more than six (6) feet [2.0 m] above the roof line and no closer than ten (10) feet [3.0 m] from any wall or vertical structure. If the exhaust vent terminal is within 10' (3.0 m) of a wall or parapet, it must extend a minimum of 2' (610 mm) above the wall or parapet. See figures 9 and 11A.
2. For direct vent installations, the total distance of the vent system from the boiler vent connector to the vertical vent termination shall not exceed ninety (90) equivalent feet [27.4 m]. A maximum of three (3) 90° elbows can be used. Minimum vertical vent is nine (9) equivalent feet [2.7 m] for direct vent installations. For standard installations where no air intake piping is included, the total distance can be extended to 180 equivalent feet [54.9 m] with a maximum of five (5) 90° degree elbows. Standard minimum vertical vent length is five (5) feet [1.5 m]. See figures 9, 11A, 11B, and 11C for differences between standard and direct vent installations.
3. An AL 29-4C® Vent Vertical Vent Terminal must be used at the termination.
4. Maintain a minimum of six (6) feet [2.0 m] separation between the air intake and the exhaust terminals.

HORIZONTAL INSTALLATION REQUIREMENTS

1. The vent system must terminate with a AL 29-4C® Vent Through-the-Wall Termination (TWT). Plan the terminal location based on the dimensions given in figure 8. Do not locate the terminal within eight (8) feet (2.5 m) of an inside corner of a building or adjacent to outside walls, shrubs or other such objects that may cause adverse wind conditions in the immediate area.
2. The TWT shall be located not less than 12 inches (305 mm) above grade or, in geographical areas where snow accumulates, no less than 12 inches (305 mm) above the anticipated snow line. Ensure that the TWT is protected against blockage which may occur during ice buildup or snowstorms.

The TWT shall terminate at least three (3) feet [1.0 m] above any forced air inlet within ten (10) feet [3.0 m], except when the forced air inlet is the combustion air intake of a direct vent appliance. The TWT shall terminate at least four (4) feet [1.2 m] below, four (4) feet [1.2 m] horizontally from or one (1) foot [305 mm] above any door, window or gravity air inlet into any building as provided in the latest edition of the NATIONAL FUEL GAS CODE ANSI Z223.1, see figure 8. For Canadian installations consult CSA B149.1-00 (and latest addenda).

In addition, a minimum clearance of four (4) feet (1.2 m) horizontally from, and in NO CASE ABOVE OR BELOW, unless the four (4) feet [1.2 m] of horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

3. For direct vent installations, the total horizontal distance of the vent system from the boiler vent connector to the outside of the

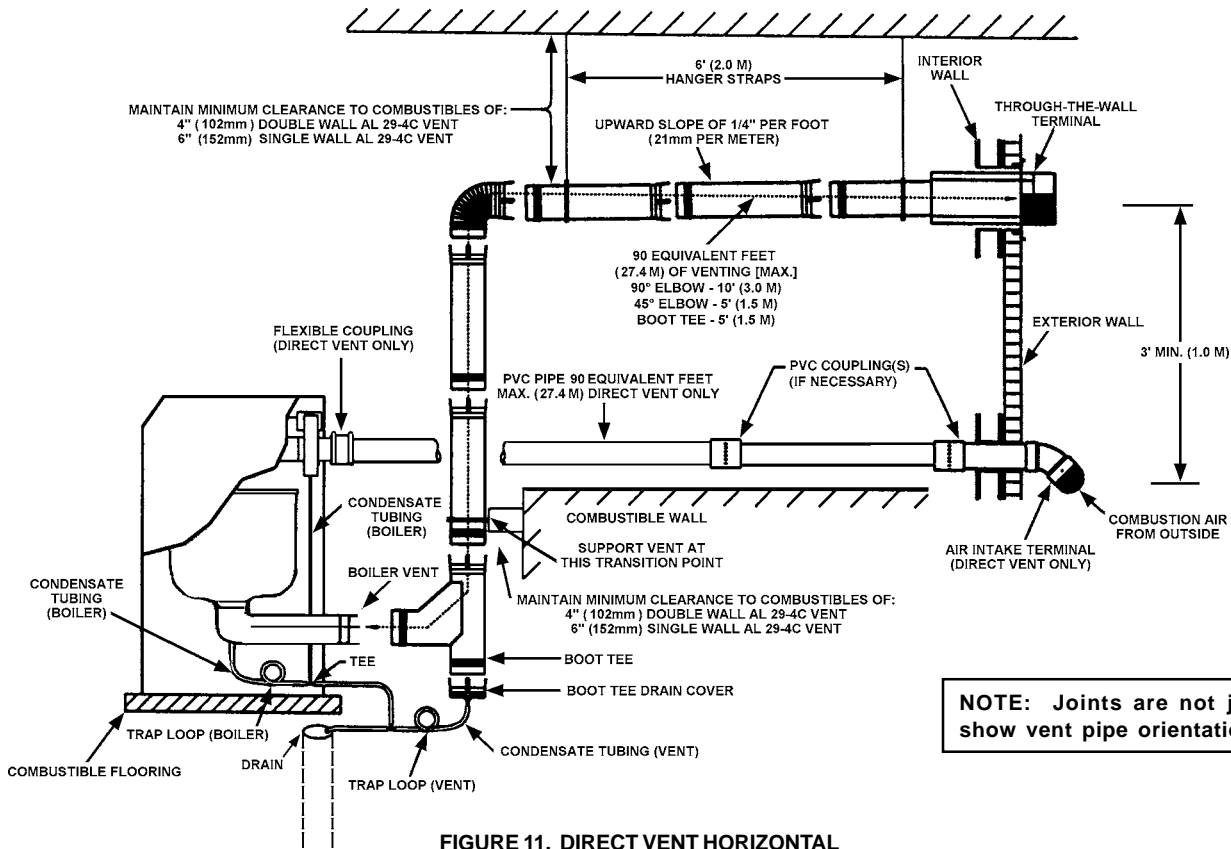


FIGURE 11. DIRECT VENT HORIZONTAL

CAUTION

Direct venting into dead air spaces such as; alleys, atriums and inside corners can cause recirculation of flue gases. Recirculation of flue gases will cause sooting, premature failure of the heat exchanger and icing of the combustion air intake during severe cold weather. To prevent the recirculation of flue gases, maintain as much distance as possible between the combustion air intake and the exhaust vent terminal.

NOTES: If the exhaust vent terminal is within 10' (3.0 M) of a wall or parapet, it must extend a minimum of 2' (610 MM) above the wall or parapet.

Joints are not joined to show vent pipe orientation.

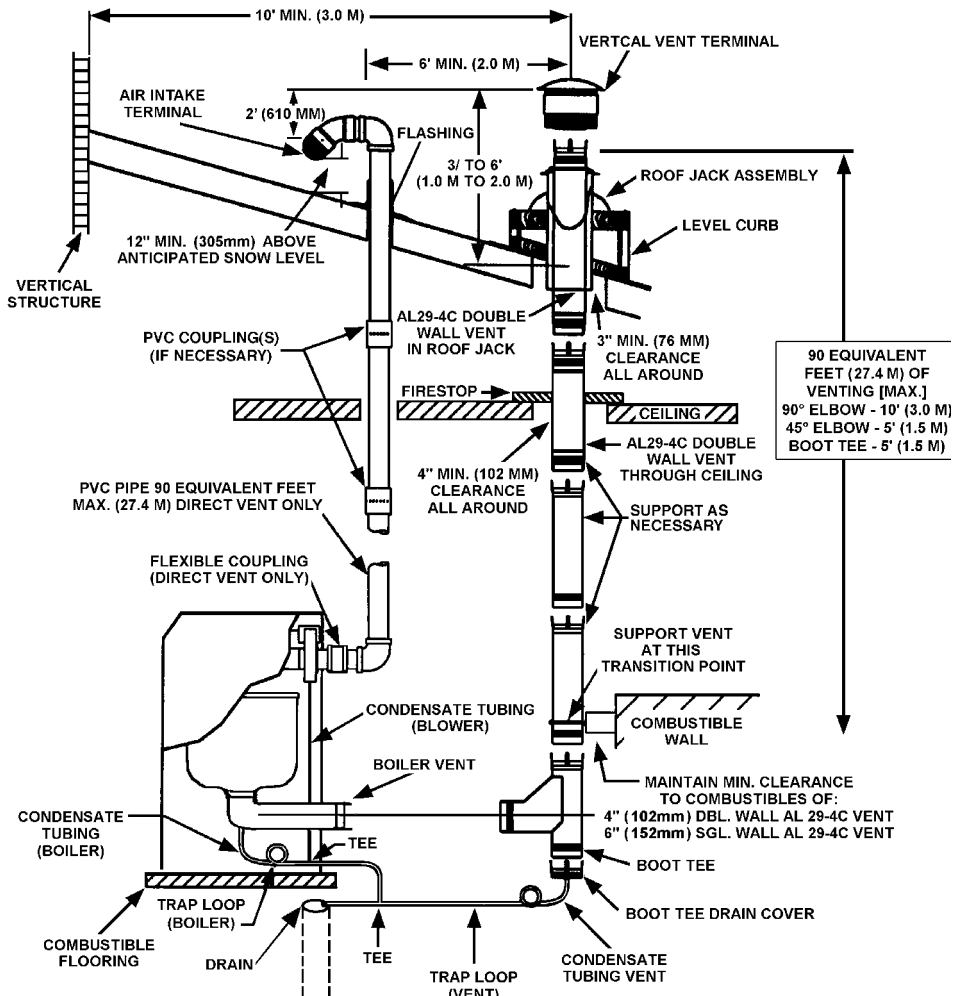
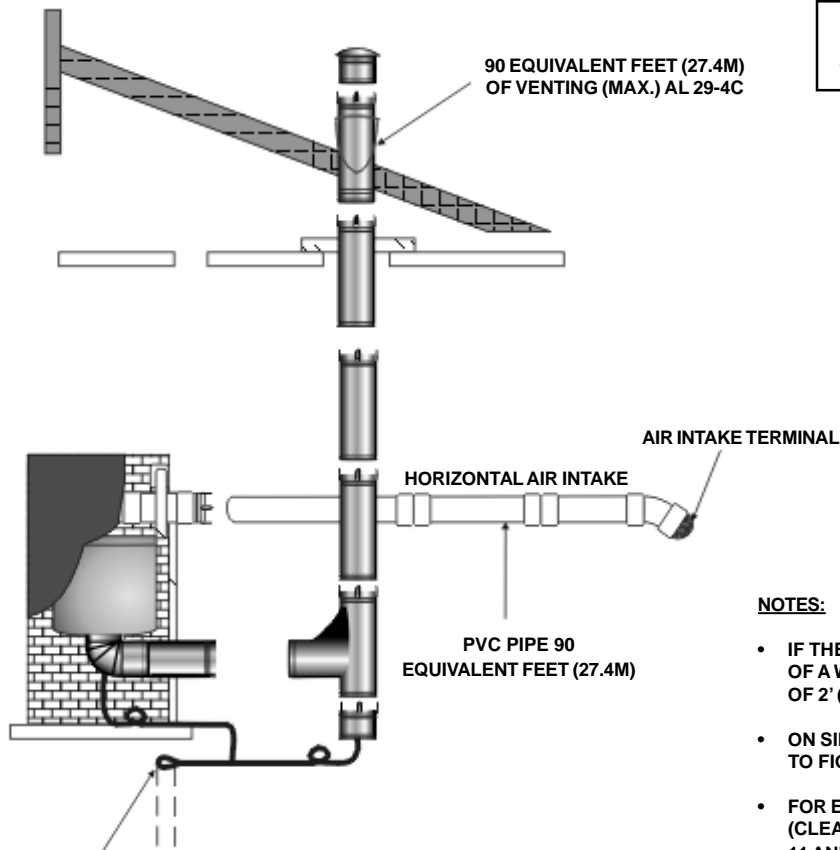


FIGURE 11A. DIRECT VENT VERTICAL



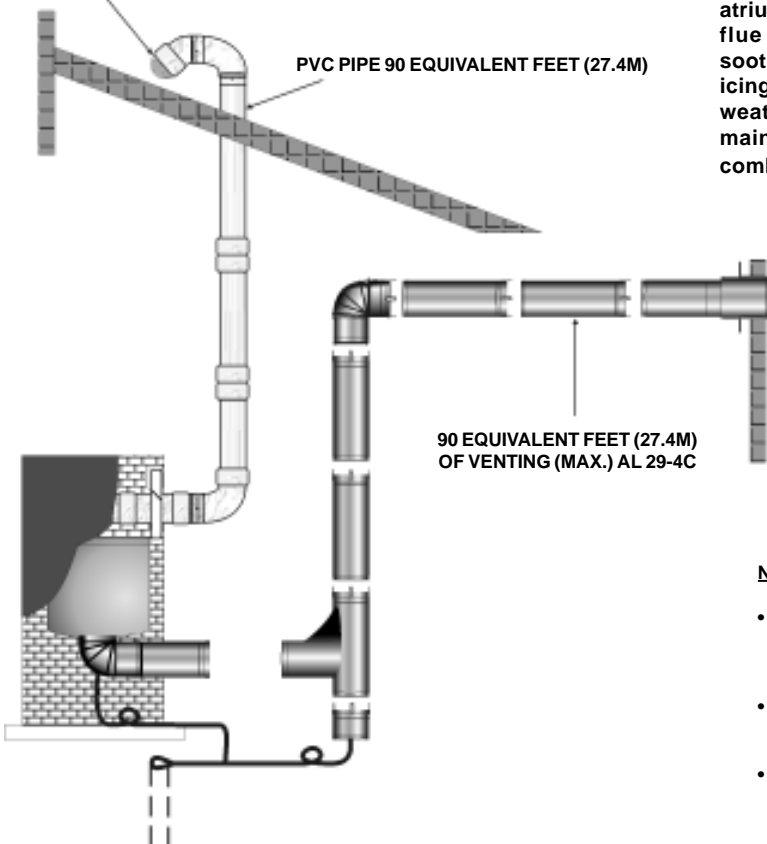
Option B (Figures 11B & 11C)
assures no recirculation of flue gases.

NOTES:

- IF THE EXHAUST VENT TERMINAL IS WITHIN 10' (3.0M) OF A WALL OR A PARAPET, IT MUST EXTEND A MINIMUM OF 2' (0.6M) ABOVE THE WALL OR PARAPET.
- ON SIDEWALL VENT INSTALLATION, REFER TO FIGURE 7 FOR SPACING SPECIFICATIONS
- FOR EXHAUST AND AIR INTAKE PIPE INSTALLATIONS (CLEARANCES, SUPPORT, ETC.) REFER TO FIGURES 11 AND 11A.

FIGURE 11B. DIRECT VENT, VERTICAL VENT TERMINATION WITH HORIZONTAL INTAKE

VERTICAL AIR INTAKE MUST BE 12" (305mm) ABOVE ANTICIPATED SNOW LEVEL.



CAUTION

Direct venting into dead air spaces such as; alleys, atriums and inside corners can cause recirculation of flue gases. Recirculation of flue gases will cause sooting, premature failure of the heat exchanger and icing of the combustion air intake during severe cold weather. To prevent the recirculation of flue gases, maintain as much distance as possible between the combustion air intake and the exhaust vent terminal.

NOTES:

- IF THE EXHAUST VENT TERMINAL IS WITHIN 10' (3.0M) OF A WALL OR A PARAPET, IT MUST EXTEND A MINIMUM OF 2' (0.6M) ABOVE THE WALL OR PARAPET.
- ON SIDEWALL VENT INSTALLATION, REFER TO FIGURE 8 FOR SPACING SPECIFICATIONS
- FOR EXHAUST AND AIR INTAKE PIPE INSTALLATIONS (CLEARANCES, SUPPORT, ETC.) REFER TO FIGURES 11 AND 11A.

FIGURE 11C. DIRECT VENT USING TWT WITH VERTICAL INTAKE

TWT shall not be greater than ninety (90) equivalent feet [27.4 m] of vent pipe nor less than nine (9) feet [3 m] (excluding fittings) unless the vent is through a non-combustible wall. A maximum of three (3) 90° degree elbows may be used. For standard installations where no air intake piping is included, the total distance can be extended to 180 equivalent feet [54.9 m] with a maximum of five (5) 90° degree elbows. Standard minimum horizontal vent length is three (3) feet [1.0 m]. See figures 9A and 11 for differences between standard and direct vent installations.

4. This horizontal exhaust vent system must pitch upward toward the termination at 1/4 inch per foot (21 mm per meter).
5. The TWT is designed such that the building is protected from degradation by flue gas and condensate. However, if additional protection is desired, install against the wall a non-corrosive metal sheet under the TWT.
6. Due to the normal formation of water vapor in the combustion process, horizontal terminations must not be located over areas of pedestrian or vehicular traffic, (i.e., public walkways or over areas where condensate could create a nuisance or hazard). This is especially true in colder climates where ice buildup is likely to occur. A.O. Smith Corporation will not be held liable for any personal injury or property damage due to any dislodging of ice.

DIRECT VENT INSTALLATION REQUIREMENTS

Follow the guidelines in the "HORIZONTAL INSTALLATION REQUIREMENTS" section for the exhausting of flue products.

IMPORTANT

The labels in the Direct Vent Kit must be affixed to the boiler in locations specified by the instruction sheet provided in the kit.

The following are requirements for the Air-Intake Terminal (AIT):

1. The Air-Intake System (AIS) must terminate with the venting equipment provided with the boiler, see "DIRECT VENT KIT PARTS LIST", part no. 192109.
2. The AIT shall not be located less than three (3) feet [1.0 m] below any exhaust vent within ten (10) feet [3.0 m], also see "HORIZONTAL INSTALLATION REQUIREMENTS" section.
3. The total horizontal distance of the AIS from the boiler's Blower Adapter to the outside of the "AIT" shall not be greater than ninety (90) "equivalent" feet [27.4 m] of vent pipe nor less than three (3) feet [1.0 m] (excluding elbows). A maximum of three (3) elbows, equivalent to ten (10) feet (3.0 m) of pipe each may be used.

SYSTEM INSTALLATION

GENERAL

If the system is to be filled with water for testing or other purposes during cold weather and before actual operation, care must be taken to prevent a downdraft entering the boiler or freezing air from contacting the system. Failure to do so may cause the water in the system to freeze with resulting damage to the system. Damage due to freezing is not covered by the warranty.

Good practice requires that all heavy piping, etc., be supported.

Figure 12 shows a typical primary, secondary piping method. This is the preferred piping method for most copper fin tube boilers. Other piping methods, however, may provide good system operation. A prime concern when designing heating systems is the maintenance of proper flow through the unit during boiler operation. The secondary pump should be sized per the recommended flow rate of the boiler. (See recommended flow charts on pages 2 and 3 of this manual.)

A system bypass should be installed as shown in fig. 12 to prevent boiler circulation starvation when the system zones call for reduced flow.

This bypass may also be used with multiple boilers manifolded for reverse-return flow. This system bypass would be installed from boiler outlet to suction side of pump.

HOT WATER HEATING (HYDRONIC) EQUIPMENT

The following is a brief description of the equipment required for the installations noted in this manual. All installations must comply with local code.

1. WATER SUPPLY LINE

These boilers can be used ONLY in a forced circulation hot water heating system. Since most forced circulation systems will be of the closed type, install the water supply line as shown on piping diagram, figure 12.

Fast filling of large pipe, old radiator installations and pressure purging of series loop systems (where high pressures are not available) requires bypassing of the pressure reducing valve.

Generally, pressure purging is not possible with a well pump system. High point air venting is essential.

If the system is of the open type, a pressure reducing valve will not be required as the water supply to the system will be controlled by a manually operated valve. An overhead surge tank is required. A minimum pressure of 15 psi (100 kPa) must be maintained on the boiler at all times to ensure avoidance of potential damage to the boiler which may not be covered by the warranty.

2. EXPANSION TANK

If the system is of the closed type, install an expansion tank as shown in figure 12. The sizing of the expansion tank for a closed system is very important and is directly related to the total water volume of the system. Refer to "Systems and Equipment" volume of the ASHRAE handbook.

An air separator as shown in the piping diagrams is recommended especially for modern commercial hydronic systems.

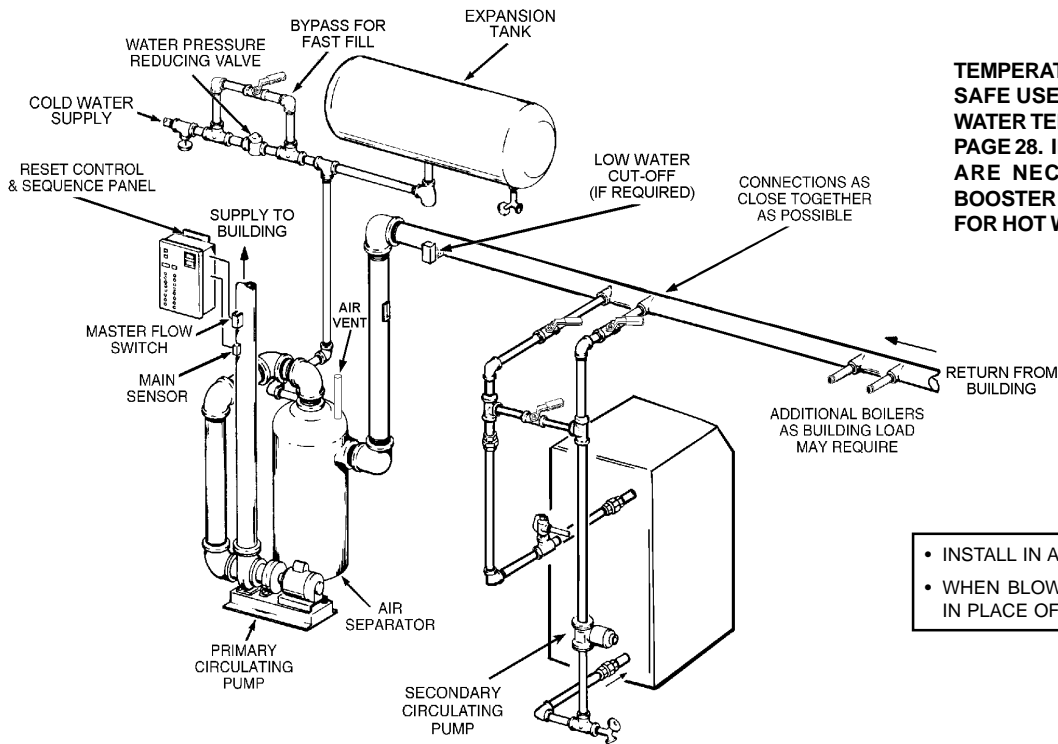
3. VENT VALVES

It is recommended that automatic, loose key or screw-driver type vent valves be installed at each convactor or radiator.

4. SYSTEM HEADERS

Split systems with individual supply and return lines from the boiler room should normally have this piping connected to supply and return manifold headers near the boiler. To achieve good water distribution with maximum pressure drop for several circuits, manifolds should be larger than system mains.

The circuits should be spaced on the heater at a minimum of 3" (76 mm) center to center. Install a balancing cock in each return line.



! DANGER

TEMPERATURE SETTING SHOULD NOT EXCEED SAFE USE TEMPERATURE AT FIXTURES. SEE WATER TEMPERATURE CONTROL WARNING ON PAGE 28. IF HIGHER PREHEAT TEMPERATURES ARE NECESSARY TO OBTAIN ADEQUATE BOOSTER OUTPUT, ADD AN ANTI-SCALD VALVE FOR HOT WATER SUPPLIED TO FIXTURES.

- INSTALL IN ACCORDANCE WITH ALL LOCAL CODES.
- WHEN BLOW DOWN VALVE IS REQUIRED, INSTALL IN PLACE OF THE DRAIN VALVE SHOWN.

FIGURE 12. TYPICAL PRIMARY, SECONDARY PIPING

Manifold headers are recommended for split systems with or without zone valves and also those installations with zone circulators. If the system is to be split at remote points, good practice requires special attention be given to main pipe sizing to allow balancing of water flow.

5. COOLING PIPING

When the boiler is used in conjunction with a refrigeration system it must be installed so that the chilled medium is piped in parallel with the boiler. Appropriate flow control valves, manual or motorized, must be provided to prevent the chilled medium from entering the boiler.

Water temperature in the heating system must be reduced to less than 100°F (38°C) before cooling system is started, or damage to the chiller unit may occur.

If the boiler is connected to chilled water piping or its heating coils are exposed to refrigerated air, the boiler piping system must be equipped with flow valves or other automatic means to prevent gravity circulation through the boiler during the cooling cycle.

Primary/secondary pumping of both the chiller(s) and the boiler(s) is an excellent winter-summer change-over method, because cooling flow rates are so much more than heating flow rates. In this way each system (heating or cooling) is circulated independently.

6. CIRCULATING PUMP

FOR HOT WATER HEATING SYSTEMS - LB MODELS, the circulating pump is NOT provided and must be field-installed.

NOTE: If a system pump is to be installed on a Legend LB model, the maximum rating of the pump motor must not exceed 1 hp.

INTERNAL CONTAMINANTS

The hydronic system must be internally cleaned and flushed after a new or replacement boiler has been installed, to remove contaminants that may have accumulated during installation. This is doubly important when a replacement boiler is installed into an existing system where Stop Leak or other boiler additives have been used.

Failure to clean and flush the system can produce acid concentrations that become corrosive, cause gases to form that block water circulation or lead to formation of deposits on the boiler surfaces, any of which could result in damage to the system and circulator.

All hot water heating systems should be completely flushed with a grease removing solution to assure trouble-free operation. Pipe joint compounds, soldering paste, grease on tubing and pipe all tend to contaminate a system

Failure to flush contaminants from a system can cause solids to form on the inside of boiler exchangers, create excessive amounts of air and other gases to block circulation, foul various system accessories and even deteriorate circulation seals and impellers.

HOT WATER SUPPLY BOILER SYSTEM- GENERAL WATER LINE CONNECTIONS

This section provides detailed installation diagrams for a typical method of application for the unit.

Piping diagrams will serve to provide the installer with a reference for the materials and methods of piping necessary for installation. It is essential that all water piping be installed and connected as shown on the diagrams. Check the diagrams to be used thoroughly before starting installation to avoid possible errors and to minimize time and material cost.

It is essential that all water piping be installed and connected as shown on the diagrams. Check the diagrams to be used thoroughly before starting installation to avoid possible errors and to minimize the time and material cost.

ONE LEGEND (MODEL LW) HOT WATER SUPPLY BOILER WITH VERTICAL TANK

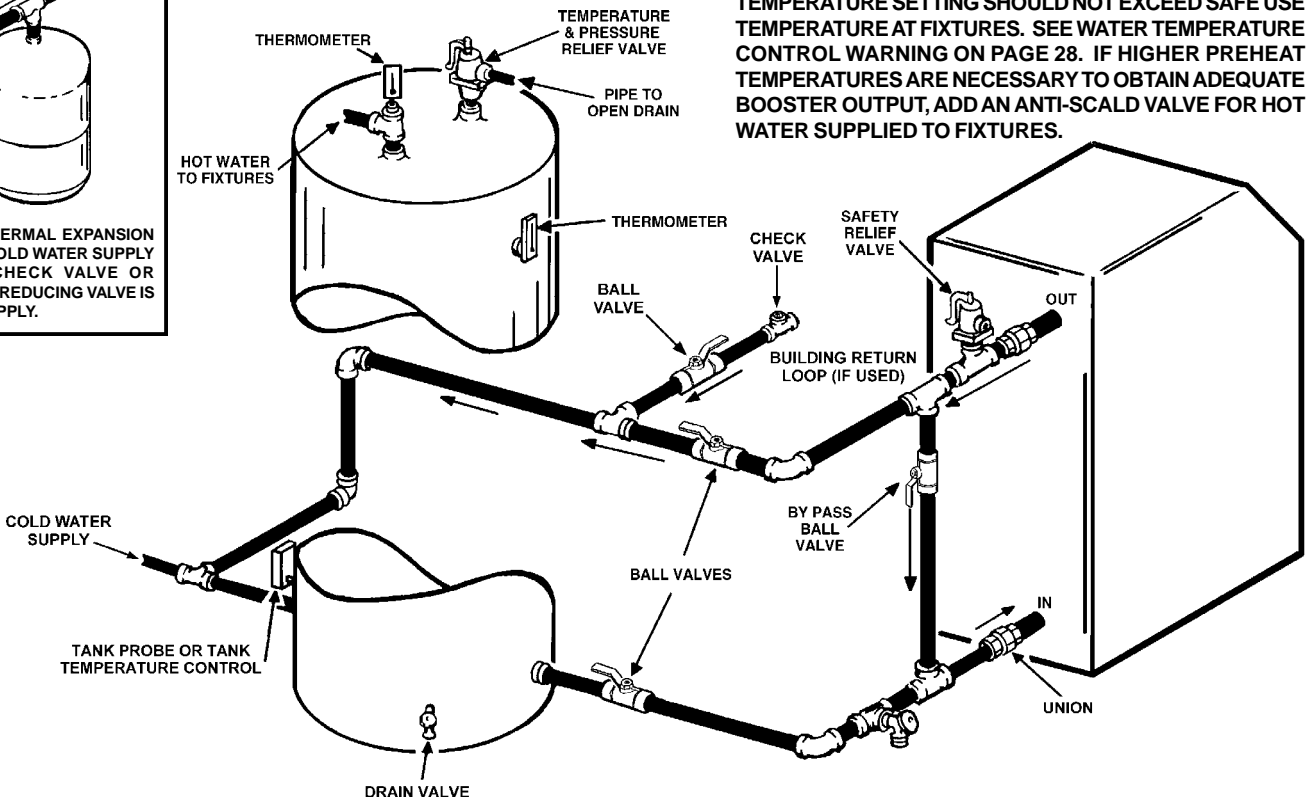
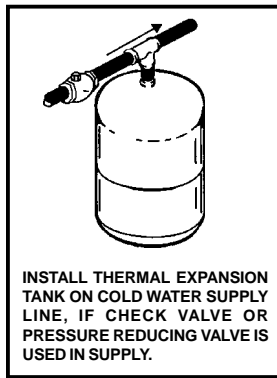


FIGURE 13.



TEMPERATURE SETTING SHOULD NOT EXCEED SAFE USE TEMPERATURE AT FIXTURES. SEE WATER TEMPERATURE CONTROL WARNING ON PAGE 28. IF HIGHER PREHEAT TEMPERATURES ARE NECESSARY TO OBTAIN ADEQUATE BOOSTER OUTPUT, ADD AN ANTI-SCALD VALVE FOR HOT WATER SUPPLIED TO FIXTURES.

ONE LEGEND (MODEL LW) HOT WATER SUPPLY BOILER WITH HORIZONTAL TANK

INSTALL IN ACCORDANCE WITH ALL LOCAL CODES.

PRESSURE RELIEF VALVE RATING SHOULD NOT EXCEED PRESSURE CAPACITY OF ANY COMPONENT IN THE SYSTEM.

INSTALL TEMPERATURE, PRESSURE GAUGE AND PRESSURE RELIEF AS CLOSE TO BOILER OUTLET AS POSSIBLE.

SHUTOFF VALVES SHOULD BE INSTALLED FOR SERVICING BOILER, LOCAL CODES SHALL GOVERN THEIR USAGE.

SAFETY RELIEF VALVE SETTING SHOULD NOT EXCEED PRESSURE RATING OF ANY COMPONENT IN THE SYSTEM.

STOP VALVES ARE SHOWN FOR SERVICING BOILER. HOWEVER, LOCAL CODES SHALL GOVERN THEIR USAGE.

CAUTION: IF BUILDING COLD WATER SUPPLY HAS A BACKFLOW PREVENTER CHECK VALVE OR WATER METER WITH CHECK VALVE, PROVISIONS FOR THERMAL EXPANSION OF WATER IN THE HOT WATER SYSTEM MUST BE PROVIDED.



TEMPERATURE SETTING SHOULD NOT EXCEED SAFE USE TEMPERATURE AT FIXTURES. SEE WATER TEMPERATURE CONTROL WARNING ON PAGE 28. IF HIGHER PREHEAT TEMPERATURES ARE NECESSARY TO OBTAIN ADEQUATE BOOSTER OUTPUT, ADD AN ANTI-SCALD VALVE FOR HOT WATER SUPPLIED TO FIXTURES.

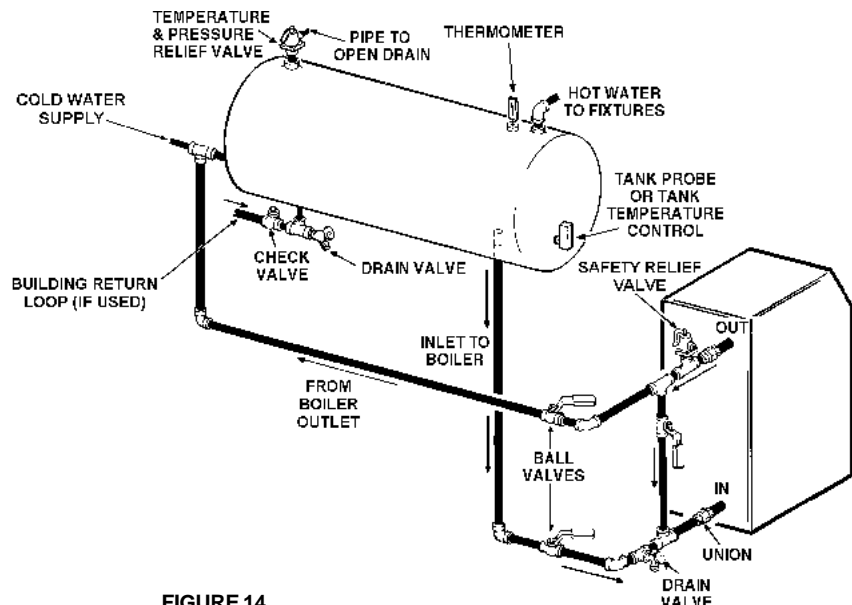
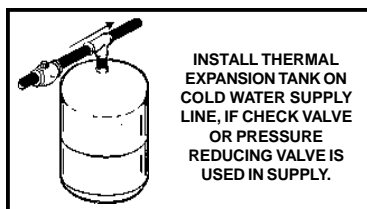


FIGURE 14.

HARD WATER CONDITIONS

Where hard water conditions exist, water softening or the threshold type of water treatment is recommended. This will protect the dishwashers, coffee urns, water heaters, water piping and other equipment. When water softening or water treatment is not practical, a comparatively easy method of periodic lime removal from the unit may be employed.

PRESSURE RELIEF VALVE RATING SHOULD NOT EXCEED PRESSURE CAPACITY OF ANY COMPONENT IN THE SYSTEM.

INSTALL TEMPERATURE, PRESSURE GAUGE AND PRESSURE RELIEF AS CLOSE TO BOILER OUTLET AS POSSIBLE.

SHUTOFF VALVES SHOULD BE INSTALLED FOR SERVICING BOILER, HOWEVER, LOCAL CODES SHALL GOVERN THEIR USAGE.

THERMAL EXPANSION (CLOSED SYSTEM)

Thermal expansion occurs in any hot water system when system water is heated or "recovered" during periods of non-use.

If the system is operated in an "open" condition such as being connected directly to the city main, the volume of expanded water generated during the recovery periods can be dissipated back through the "open" connection to the city main so pressure cannot build up.

However, once a back flow preventer is installed to isolate system water from the public supply; or a pressure reducing valve is installed to protect a water meter; or any device preventing flow back into the cold water supply, the "open" condition becomes "closed". During periods of temperature recovery and no usage, expanded water has no place to go, so the pressure builds up until a relief valve opens releasing hot water.

A relief valve opening on pressure will flow small amounts of water, whereas relieving on temperature releases large amounts of water.

If your system is closed, some provision must be made for THERMAL EXPANSION to protect the system from excessive pressure. Install an expansion tank that is properly and adequately sized for the expanding volume of water in the system.

Service problems or parts failure due to excessive pressure are **NOT** covered under warranty.

TANK PROBE INSTALLATION PROCEDURE

A tank probe system temperature sensor is supplied with each hot water supply boiler (LW models). When installed on a tank, the inlet water temperature on the Dia-Scan II will default to the tank temperature. **See figure 21 and 22 for position of tank probe jumper. As stated earlier, if one wishes to use an alternative method of temperature control, this jumper must be removed.**

The tank probe sensor wires are run from the plug on the control board to the junction box at the rear of the unit. Field wiring (in conduit) is required from the plug wires to the tank probe sensor wires. See figure 7.

TANK PROBE SET-POINT ADJUSTMENT

When the temperature sensor is installed in a water tank, and the sensor is used with the WHC1502 system, the controller will monitor and control the temperature of the water at the sensor location. Setting the temperature is accomplished through the Dia-Scan II control display. The programmable temperature range is 110°F to 190°F (43°C to 88°C). The switching differential is fixed at 5°F (3°C).

GAS CONNECTIONS



MAKE SURE THE GAS ON WHICH THE BOILER IS TO OPERATE IS THE SAME AS THAT SPECIFIED ON THE RATING PLATE. DO NOT INSTALL THE BOILER IF EQUIPPED FOR A DIFFERENT TYPE OF GAS. CONSULT YOUR GAS SUPPLIER.

THIS BOILER IS NOT INTENDED TO OPERATE AT GAS SUPPLY PRESSURE OTHER THAN SHOWN ON THE RATING PLATE. A LOCK-UP OR POSITIVE SHUT-OFF TYPE REGULATOR MUST BE INSTALLED IN THE GAS SUPPLY LINE. EXPOSURE TO HIGHER GAS SUPPLY PRESSURE MAY CAUSE DAMAGE TO GAS VALVES WHICH CAN RESULT IN FIRE OR EXPLOSION. IF OVERPRESSURE HAS OCCURRED SUCH AS THROUGH IMPROPER TESTING OF GAS LINES OR EMERGENCY MALFUNCTION OF THE SUPPLY SYSTEM, THE GAS VALVES MUST BE CHECKED FOR SAFE OPERATION. MAKE SURE THAT THE OUTSIDE VENTS ON THE SUPPLY REGULATORS AND THE SAFETY VENT VALVES ARE PROTECTED AGAINST BLOCKAGE. THESE ARE PARTS OF THE GAS SUPPLY SYSTEM, NOT THE BOILER. VENT BLOCKAGE MAY OCCUR DURING ICE BUILD-UP OR SNOWSTORMS.

THE BOILER MUST BE ISOLATED FROM THE GAS SUPPLY PIPING SYSTEM BY CLOSING ITS MAIN MANUAL GAS SHUT-OFF VALVE DURING ANY PRESSURE TESTING OF THE GAS SUPPLY PIPING SYSTEM AT TEST PRESSURES EQUAL TO OR LESS THAN 1/2 PSIG.

DISCONNECT THE BOILER AND ITS MAIN MANUAL GAS SHUT-OFF VALVE FROM THE GAS SUPPLY PIPING DURING ANY PRESSURE TESTING OF THE GAS SUPPLY SYSTEM OVER 1/2 PSIG. THE GAS SUPPLY LINE MUST BE CAPPED WHEN NOT CONNECTED TO THE BOILER.

IT IS IMPORTANT TO GUARD AGAINST GAS VALVE FOULING FROM CONTAMINANTS IN THE GAS WAYS. SUCH FOULING MAY CAUSE IMPROPER OPERATION, FIRE OR EXPLOSION. IF COPPER SUPPLY LINES ARE USED THEY MUST BE APPROVED FOR GAS SERVICE.

WHEN LOCAL CODES REQUIRE A MAIN MANUAL SHUT-OFF VALVE OUTSIDE THE BOILER JACKET, A SUITABLE MAIN MANUAL SHUT-OFF VALVE MUST BE INSTALLED IN A LOCATION COMPLYING WITH THOSE CODES.

BEFORE ATTACHING THE GAS LINE BE SURE THAT ALL GAS PIPE IS CLEAN ON THE INSIDE.

TO TRAP ANY DIRT OR FOREIGN MATERIAL IN THE GAS SUPPLY LINE, A DIRT LEG (SOMETIMES CALLED DRIP LEG) MUST BE INCORPORATED IN THE PIPING. THE DIRT LEG MUST BE READILY ACCESSIBLE AND NOT SUBJECT TO FREEZING CONDITIONS. INSTALL IN ACCORDANCE WITH RECOMMENDATIONS OF SERVING GAS SUPPLIER. REFER TO NATIONAL FUEL GAS CODE, ANSI Z223.1 OR CAN/CSA – B149.1-00 (AND LATEST ADDENDA).

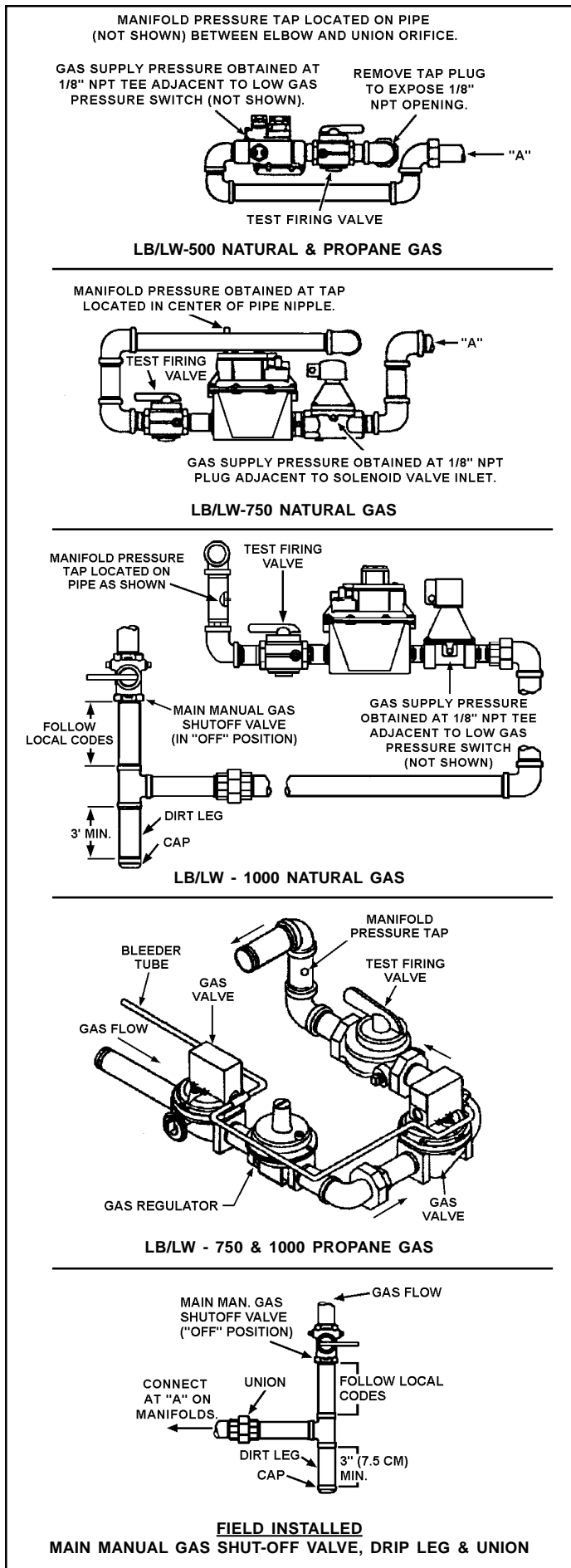


FIGURE 15. GAS MANIFOLDS

Size of gas supply piping may be larger than heater connection on installations where a significant run of piping is required.

To prevent damage, care must be taken not to apply too much torque when attaching gas supply pipe to boiler gas inlet.

Fittings and unions in the gas line must be of the metal to metal type.

Apply joint compounds (pipe dope) sparingly and only to the male threads of pipe joints. Do not apply compound to the first two threads. Use compounds resistant to the action of liquefied petroleum gases.

GAS SUPPLY LINE SIZING

The gas piping installation must be capable of supplying the maximum probable gas demand without excessive pressure loss. Depending on local practices, the ALLOWABLE PRESSURE LOSS between the gas meter, or service regulator and each appliance is generally 0.3 or 0.5 inches of water column (0.075 or 0.124 kPa).

For single boiler installation, refer to table 6 to size iron pipe or equivalent gas supply line size to be used with single unit.

For multiple boiler installation or installations of a single boiler with other gas appliances please refer to tables 7 and 8 to size iron pipe or equivalent gas supply line. These tables are taken from ANSI Z223.1 NATIONAL FUEL GAS CODE, or CAN/CSA – B149.1 - 00 (and latest addenda):

- Table 7 is based on a pressure drop of 0.5 inches water column (0.124 kPa), and a gas with a specific gravity of 0.60 and a heating value of 1,000 BTU/ft³, approximately that of Natural Gas.
- Table 8 is based on a pressure drop of 0.5 inches water column (0.124 kPa), and a gas with a specific gravity of 1.53 and a heating value of 2,500 BTU/ft³, approximately that of Propane Gas.

No additional allowance is necessary for an ordinary number of fittings. Where it is necessary to use more than the average number of fittings (i.e., elbows, tees and valves in gas supply line) use a pipe larger than specified to compensate for increased pressure drop.

**TABLE 6.
SINGLE UNIT INSTALLATION, SUGGESTED GAS PIPE SIZING.
MAXIMUM EQUIVALENT PIPE LENGTH (IN FEET).**

Btu Input	1-1/4"		1-1/2"		2"		2-1/2"	
	Nat.	Prop.	Nat.	Prop.	Nat.	Prop.	Nat.	Prop.
500,000	40	90	80	200	—	—	—	—
750,000	10	40	40	90	125	—	—	—
1,000,000	—	20	20	50	70	175	175	—

Natural gas 1000 Btu/ft³, 0.60 specific gravity @ 0.3 in. w.c. pressure drop
Propane gas 2500 Btu/ft³, 1.50 specific gravity @ 0.3 in. w.c. pressure drop.

Table 6 shows the maximum equivalent gas pipe length for a single unit installation. It does not take into account other appliances that may be connected to the gas line. For installation of multiple units, or instances where several appliances are connected to the same line, use tables 7 and 8 for proper sizing.

WIRING



CAUTION
LABEL ALL WIRES PRIOR TO DISCONNECTION WHEN SERVICING CONTROLS. WIRING ERRORS CAN CAUSE IMPROPER AND DANGEROUS OPERATION.

Table 7. Suggested Pipe Size For Multiple Gas Appliances (Natural Gas).

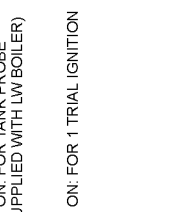
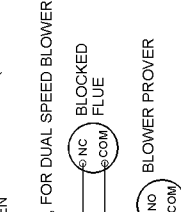
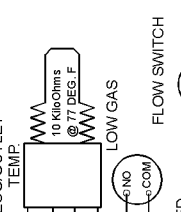
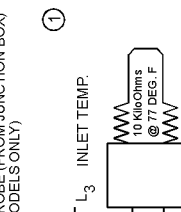
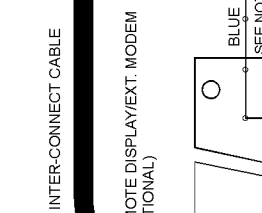
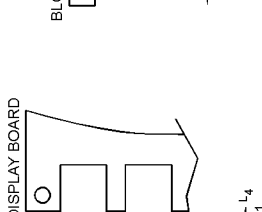
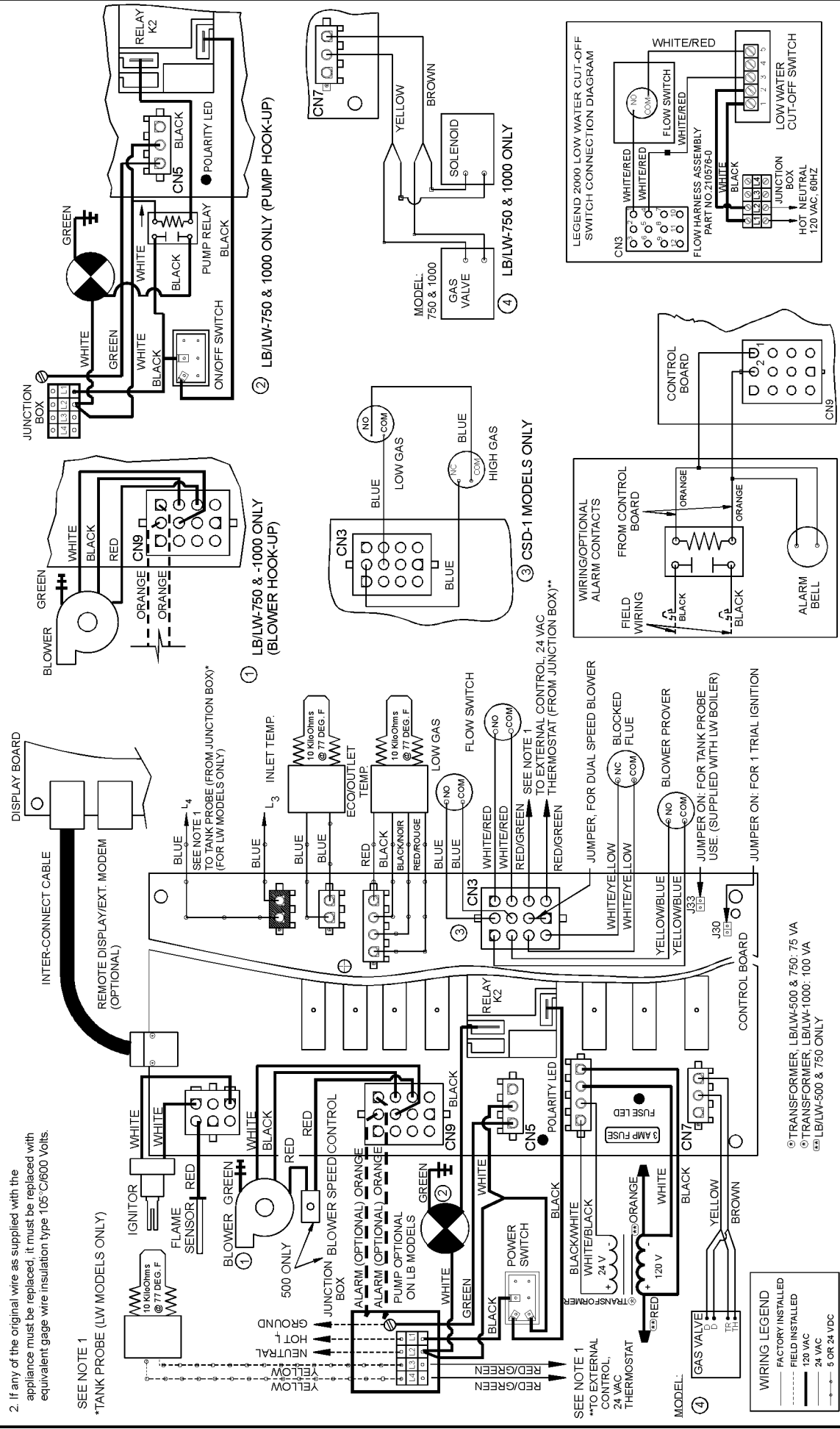
Nominal Iron Pipe Size (Inches)	Maximum Capacity of Pipe in BTU/hr and kW for Gas Pressures of 14 in. W.C. (0.5 psi) or Less and a Pressure Drop of 0.5 in. W.C. (based on 0.60 Specific Gravity Gas w/Heating Value of 1,000 BTU's/Ft3)																
	Length of Pipe in Feet (Meters)																
	10 (3.05)	20 (6.1)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.1)	150	175	200			
1 BTU/hr	680,000	465,000	—	—	—	—	—	—	—	—	—	—	—	—			
1 kW	199	136	—	—	—	—	—	—	—	—	—	—	—				
1 1/4 BTU/hr	1,400,000	950,000	770,000	660,000	580,000	530,000	490,000	460,000	—	—	—	—	—				
1 kW	410	278	226	193	170	155	144	135	—	—	—	—	—				
1 1/2 BTU/hr	2,100,000	1,460,000	1,180,000	990,000	900,000	810,000	750,000	690,000	650,000	620,000	550,000	500,000	460,000				
1 kW	615	428	346	290	264	237	220	202	190	182	161	146	135				
2 BTU/hr	3,950,000	2,750,000	2,200,000	1,900,000	1,680,000	1,520,000	1,400,000	1,300,000	1,220,000	1,150,000	1,020,000	950,000	850,000				
1 kW	1,157	805	644	556	492	445	410	381	357	337	299	278	249				
2 1/2 BTU/hr	6,300,000	4,350,000	3,520,000	3,000,000	2,650,000	2,400,000	2,250,000	2,050,000	1,950,000	1,850,000	1,650,000	1,500,000	1,370,000				
1 kW	1,845	1,274	1,031	879	776	703	659	600	571	542	483	439	401				
3 BTU/hr	11,000,000	7,700,000	6,250,000	5,300,000	4,750,000	4,300,000	3,900,000	3,700,000	3,450,000	3,250,000	2,950,000	2,650,000	2,450,000				
1 kW	3,222	2,255	1,830	1,552	1,391	1,259	1,142	1,084	1,010	952	864	776	718				
4 BTU/hr	23,000,000	15,800,000	12,800,000	10,900,000	9,700,000	8,800,000	8,100,000	7,500,000	7,200,000	6,700,000	6,000,000	5,500,000	5,000,000				
1 kW	6,736	4,627	3,749	3,192	2,841	2,577	2,372	2,197	2,109	1,962	1,757	1,611	1,464				

Table 8. Suggested Pipe Size For Multiple Gas Appliances (Propane Gas).

Nominal Iron Pipe Size (Inches)	Maximum Capacity of Pipe in BTU/hr and kW for Gas Pressures of 14 in. W.C. (0.5 psi) or Less and a Pressure Drop of 0.5 in. W.C. (based on 0.60 Specific Gravity Gas w/Heating Value of 1,000 BTU's/Ft3)																
	Length of Pipe in Feet (Meters)																
	10 (3.05)	20 (6.1)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.1)	150	175	200			
1 BTU/hr	1,060,800	725,400	585,000	499,200	—	—	—	—	—	—	—	—	—	—			
1 kW	311	212	171	146	—	—	—	—	—	—	—	—	—				
1 1/4 BTU/hr	2,184,000	1,482,000	1,201,200	1,029,600	904,800	826,800	764,400	717,600	670,800	624,000	561,600	507,000	468,000				
1 kW	640	434	352	302	265	242	224	210	196	183	164	148	137				
1 1/2 BTU/hr	3,276,000	2,277,600	1,840,800	1,544,400	1,404,000	1,263,600	1,170,000	1,076,400	1,014,000	967,200	858,000	780,000	717,600				
1 kW	959	667	539	452	411	370	343	315	297	283	251	228	210				
2 BTU/hr	6,162,000	4,290,000	3,432,000	2,964,000	2,620,800	2,371,200	2,184,000	2,028,000	1,903,200	1,794,000	1,591,200	1,482,000	1,326,000				
1 kW	1,805	1,256	1,005	868	768	694	640	594	557	525	466	434	388				
2 1/2 BTU/hr	9,828,000	6,786,000	5,491,200	4,680,000	4,134,000	3,744,000	3,510,000	3,198,000	3,042,000	2,886,000	2,574,000	2,340,000	2,137,200				
1 kW	2,878	1,987	1,608	1,371	1,211	1,097	1,028	937	891	845	754	685	626				
3 BTU/hr	17,160,000	12,012,000	9,750,000	8,268,000	7,410,000	6,708,000	6,084,000	5,772,000	5,382,000	5,070,000	4,602,000	4,134,000	3,822,000				
1 kW	5,026	3,518	2,856	2,421	2,170	1,965	1,782	1,690	1,576	1,485	1,348	1,211	1,119				
4 BTU/hr	35,880,000	24,648,000	19,968,000	17,004,000	15,132,000	13,728,000	12,636,000	11,700,000	11,232,000	10,452,000	9,360,000	8,580,000	7,800,000				
1 kW	10,508	7,219	5,848	4,980	4,432	4,021	3,701	3,427	3,290	3,061	2,741	2,513	2,284				

LEGEND 2000, Diascan II - CONNECTION DIAGRAM LB/LW-500/-750/-1000

NOTES:
 1. Use either the tank probe or an external control (24 VAC) for system control, but not both.
 2. If any of the original wire as supplied with the appliance must be replaced, it must be replaced with equivalent gage wire insulation type 105°C/600 Volts.

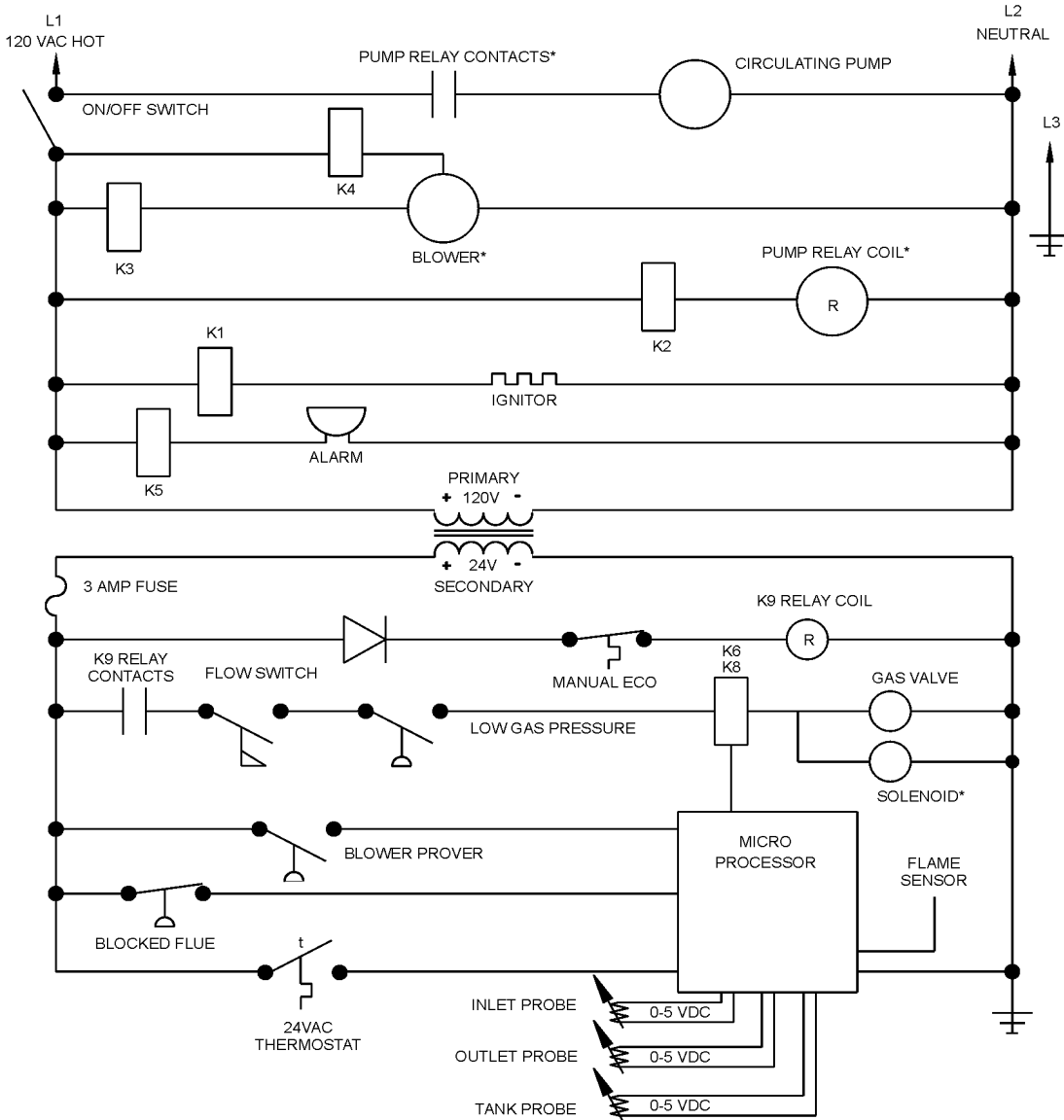


⊕ TRANSFORMER, LB/LW-500 & 750: 75 VA
 ⊖ TRANSFORMER, LB/LW-1000: 100 VA
 ⊗ LB/LW-500 & 750 ONLY

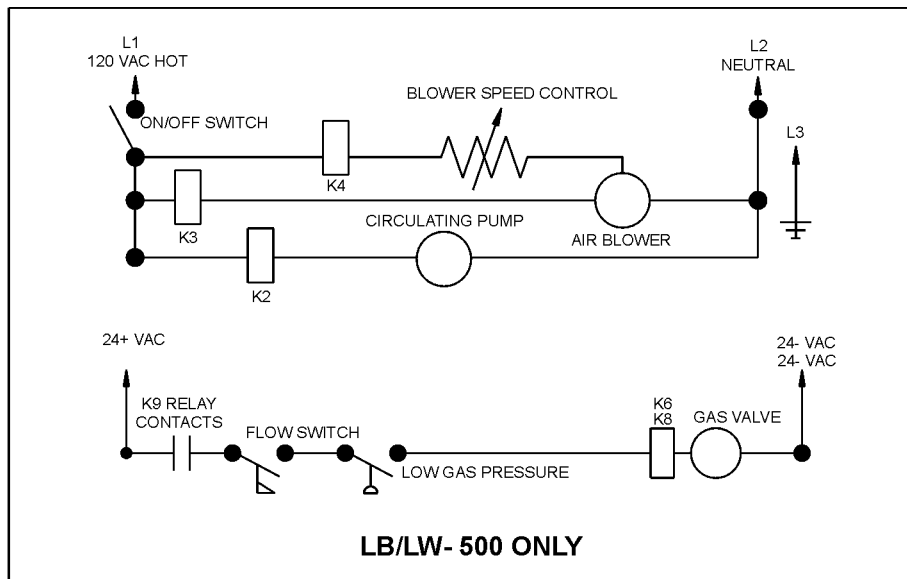
WIRING LEGEND
 - - - - - FACTORY INSTALLED
 - - - - - FIELD INSTALLED
 ——— 120 VAC
 ——— 24 VAC
 ——— 5 OR 24 VDC

FIGURE 16. CONNECTION DIAGRAM

LEGEND DIASCAN II, SCHEMATIC DIAGRAM LB/LW-500/-750/-1000



* LB/LW 750 -1000 ONLY



LB/LW- 500 ONLY

FIGURE 17 - SCHEMATIC DIAGRAM

VERIFY PROPER OPERATION AFTER SERVICING. STRICT ADHERENCE TO THE WIRING DIAGRAMS IS REQUIRED TO PREVENT CONSTANT PUMP OPERATION WHEN THE SYSTEM CONTROLLER IS SATISFIED. OTHERWISE THE WARRANTY IS VOID AS STIPULATED IN THE LIMITED WARRANTY IN THIS INSTALLATION MANUAL.

IF ANY OF THE ORIGINAL WIRE, AS SUPPLIED WITH THE APPLIANCE, MUST BE REPLACED, IT MUST BE REPLACED WITH TYPE 105°C WIRE OR ITS EQUIVALENT.

The LEGEND 2000® must be connected to a single phase independent line source that is:

120 Volts, 60 Hertz, 30 Amps

NOTE: For proper boiler performance, it is important that the Legend 2000® is on its own separate breaker. Do not put other appliances on the same breaker as the boiler.

There are five (5) electrical connections that must be made for the unit to operate correctly:

1. BLACK (No Stripe) 120V HOT
2. WHITE 120V NEUTRAL
3. GREEN GROUND
4. (2) TANK PROBE OR (2) RED/GREEN 24V THERMOSTAT.***

*** Either the tank probe or the 24V thermostat connections are to be made, but not both.

These connections shall be made at the rear of the unit where a junction box is provided. AN ELECTRICAL GROUND IS REQUIRED TO REDUCE THE RISK OF ELECTRIC SHOCK OR POSSIBLE ELECTROCUTION. A GROUND SCREW IS PROVIDED IN THIS JUNCTION BOX.

NOTE: On LW models the control board comes preset for the Tank Probe provided with the unit. Blue wires are run from the Control Board to the power strip at the rear of the unit. The connection of the Tank Probe should be across the L3 and L4 terminals. If the installer wishes to use an alternate 24 volt method of temperature control (thermostat, Aqua-stat, etc.), the connections need to be made to the Red/Green wires, also at the rear of the unit. The J33 jumper on the Control Board must be removed to use an alternate 24 volt temperature control.

NOTE: Tank probes are not provided on LB models, it is required that a system/operating temperature controller (field supplied) be installed to regulate loop and system temperatures. Two 24 Volt Red/Green wires are provided in the rear junction box for this connection. Do not operate this boiler without system or operating control.

DO NOT connect both sets of wires to a control. If the Tank Probe is being used, cap securely the Red/Green wires at the junction box. Do not connect the Red/Green wires together.

NOTE: If a system pump is to be installed on a Legend LB model, the maximum rating of the pump motor must not exceed 1 hp.

Refer to the Connection Diagram (figure 16) and to the Schematic Diagram (figure 17).

OPERATION

IMPORTANT

Only qualified personnel shall perform the initial firing of the heater. At this time the user should not hesitate to ask the start-up technician any questions regarding the operation and maintenance of the unit. If you still have questions, please contact the factory or your local A.O. Smith representative.

Lighting and Operating instructions are included with this manual. By using these instructions, the user may be able to make minor operational adjustments and save unnecessary service calls. However the user should not attempt repairs, but should contact a service technician or gas supplier.

GENERAL

Never operate the boiler without first making sure the boiler and system are filled with water, in addition:

For hot water supply installations:

- Make sure a temperature and pressure relief valve is installed at the boiler and, if used, the storage tank. Also check for leaks.

For heating boiler installations:

- Make sure that the boiler and system have been purged of air and checked for leaks.

Also be sure to check the gas piping for leaks before beginning the initial firing of the boiler.

FILLING AND PURGING FOR HEATING BOILER INSTALLATION

1. Fast fill system through bypass until pressure approaches desired system pressure. Close bypass valve and permit pressure to be established by the pressure reducing valve.
2. Vent all high points in system to purge system of air.

Provisions should be made to permit manual venting of radiators or convectors.

FILLING FOR HOT WATER SUPPLY BOILER INSTALLATION

1. Close the systems drain valve by turning handle clockwise.
2. Open a nearby hot water faucet to permit the air in the system to escape.
3. Fully open the cold water inlet pipe valve allowing the heater and piping to be filled.
4. Close the hot water faucet as water starts to flow.
5. The heater is ready to be operated.

PURGING OF GAS LINE

Gas line purging is required with new piping or systems in which air has entered.



CAUTION

PURGING SHOULD BE PERFORMED BY PERSONS EXPERIENCED IN THIS TYPE OF GAS SERVICE TO AVOID RISK OF FIRE OR EXPLOSION. PURGE DISCHARGE MUST NOT ENTER CONFINED AREAS OR SPACES WHERE IGNITION CAN OCCUR. THE AREA MUST BE WELL VENTILATED AND ALL SOURCES OF IGNITION MUST BE DEACTIVATED OR REMOVED.

BEFORE PLACING THE BOILER IN OPERATION, CHECK FOR GAS LEAKAGE. USE A SOAP AND WATER SOLUTION OR OTHER MATERIAL ACCEPTABLE FOR THE PURPOSE OF LOCATING GAS LEAKS. DO NOT USE MATCHES, CANDLES, FLAME OR OTHER SOURCES OF IGNITION FOR THIS PURPOSE.



WARNING

THE GAS VALVE MUST HAVE BEEN IN THE OFF POSITION FOR AT LEAST 5 MINUTES. This waiting period is an important safety step. Its purpose is to permit gas that may have accumulated

LIGHTING & OPERATION INSTRUCTIONS FOR MODELS LB/LW-500 ONLY:

FOR YOUR SAFETY READ BEFORE OPERATING

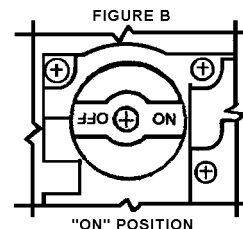
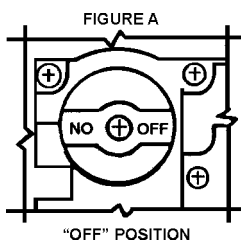
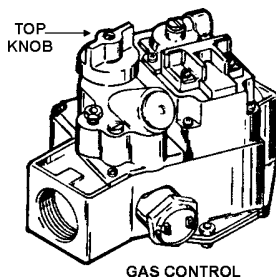


WARNING: IF YOU DO NOT FOLLOW THESE INSTRUCTIONS EXACTLY, A FIRE OR EXPLOSION MAY RESULT CAUSING PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE.



- A. THIS APPLIANCE DOES NOT HAVE A PILOT. IT IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.
- B. **BEFORE LIGHTING:** SMELL ALL AROUND THE APPLIANCE AREA FOR GAS. BE SURE TO SMELL NEXT TO THE FLOOR BECAUSE SOME GAS IS HEAVIER THAN AIR AND WILL SETTLE ON THE FLOOR.
- WHAT TO DO IF YOU SMELL GAS**
- DO NOT TRY TO LIGHT ANY APPLIANCE.
 - DO NOT TOUCH ANY ELECTRIC SWITCH; DO NOT USE ANY PHONE IN YOUR BUILDING.
 - IMMEDIATELY CALL YOUR GAS SUPPLIER FROM A NEIGHBOR'S PHONE. FOLLOW THE GAS SUPPLIER'S INSTRUCTIONS.
 - IF YOU CANNOT REACH YOUR GAS SUPPLIER, CALL THE FIRE DEPARTMENT.
- C. USE ONLY YOUR HAND TO PUSH IN OR TURN THE GAS CONTROL KNOB. VALVE HANDLE. NEVER USE TOOLS. IF THE HANDLE WILL NOT TURN BY HAND, DON'T TRY TO REPAIR IT, CALL A QUALIFIED SERVICE TECHNICIAN. FORCE OR ATTEMPTED REPAIR MAY RESULT IN A FIRE OR EXPLOSION.
- D. DO NOT USE THIS APPLIANCE IF ANY PART HAS BEEN UNDER WATER. IMMEDIATELY CALL A QUALIFIED SERVICE TECHNICIAN TO INSPECT THE APPLIANCE AND TO REPLACE ANY PART OF THE CONTROL SYSTEM AND ANY GAS CONTROL WHICH HAS BEEN UNDER WATER.
- E. DO NOT OPERATE APPLIANCE UNLESS UNIT IS FILLED WITH WATER AND WATER LINES ARE FULLY OPEN.

ROBERTSHAW® GAS CONTROL



OPERATING INSTRUCTIONS

1. STOP! READ THE SAFETY INFORMATION ABOVE ON THIS LABEL.
2. SET THE SYSTEM CONTROLLER TO THE LOWEST SETTING.
3. TURN POWER SWITCH ON APPLIANCE TO "OFF" POSITION (SWITCH LIGHT GOES OUT).
4. THIS APPLIANCE IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.
5. REMOVE TOP COVER TO EXPOSE GAS CONTROL.
6. REFER TO DIAGRAMS ABOVE. TURN TOP KNOB OF GAS CONTROL CLOCKWISE TO "OFF" POSITION, (FIG. A).
7. WAIT FIVE (5) MINUTES TO CLEAR OUT ANY GAS. THEN SMELL FOR GAS, INCLUDING NEAR THE FLOOR. IF YOU SMELL GAS,
8. STOP! FOLLOW "B" IN THE SAFETY INFORMATION ABOVE ON THIS LABEL. IF YOU DON'T SMELL GAS, GO TO THE NEXT STEP.
8. TURN TOP KNOB OF GAS CONTROL COUNTER-CLOCKWISE TO "ON" POSITION, (FIG. B).
9. REPLACE TOP COVER.
10. TURN POWER SWITCH TO "ON" POSITION (SWITCH LIGHT COMES ON).
11. SET THE SYSTEM CONTROLLER TO DESIRED SETTING.
12. IF THE APPLIANCE WILL NOT OPERATE, FOLLOW THE INSTRUCTIONS "TO TURN OFF GAS TO THE APPLIANCE" AND CALL YOUR SERVICE TECHNICIAN OR GAS SUPPLIER.

TO TURN OFF GAS TO APPLIANCE

1. SET THE SYSTEM CONTROLLER TO THE LOWEST SETTING.
2. TURN POWER SWITCH ON APPLIANCE TO "OFF" POSITION (SWITCH LIGHT GOES OUT).
3. REMOVE TOP COVER TO EXPOSE GAS CONTROL.
4. REFER TO DIAGRAMS ABOVE. TURN TOP KNOB OF GAS CONTROL CLOCKWISE TO "OFF" POSITION (FIG. A).
5. REPLACE TOP COVER.

LIGHTING & OPERATION INSTRUCTIONS FOR MODELS LB/LW-750 AND 1000 ONLY:

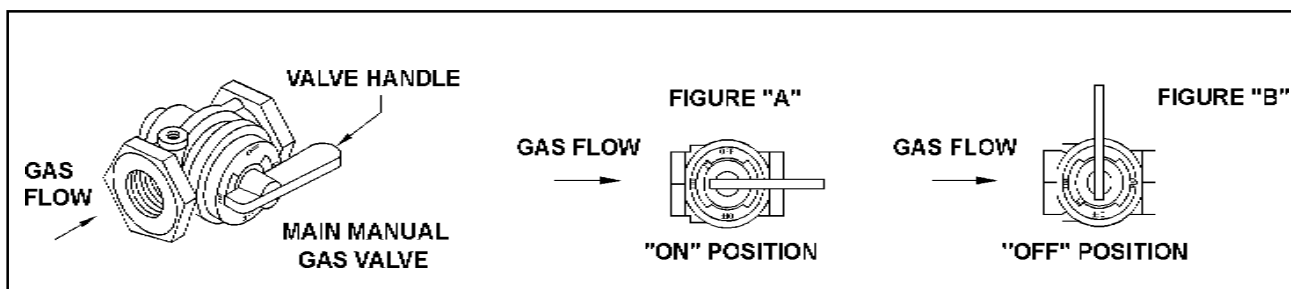
FOR YOUR SAFETY READ BEFORE OPERATING



WARNING: IF YOU DO NOT FOLLOW THESE INSTRUCTIONS EXACTLY, A FIRE OR EXPLOSION MAY RESULT CAUSING PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE.



- A. THIS APPLIANCE DOES NOT HAVE A PILOT. IT IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.
- B. **BEFORE LIGHTING:** SMELL ALL AROUND THE APPLIANCE AREA FOR GAS. BE SURE TO SMELL NEXT TO THE FLOOR BECAUSE SOME GAS IS HEAVIER THAN AIR AND WILL SETTLE ON THE FLOOR.
WHAT TO DO IF YOU SMELL GAS
- DO NOT TRY TO LIGHT ANY APPLIANCE.
 - DO NOT TOUCH ANY ELECTRIC SWITCH; DO NOT USE ANY PHONE IN YOUR BUILDING.
 - IMMEDIATELY CALL YOUR GAS SUPPLIER FROM A NEIGHBOR'S PHONE. FOLLOW THE GAS SUPPLIER'S INSTRUCTIONS.
 - IF YOU CANNOT REACH YOUR GAS SUPPLIER, CALL THE FIRE DEPARTMENT.
- C. USE ONLY YOUR HAND TO PUSH IN OR TURN THE GAS CONTROL KNOB. NEVER USE TOOLS. IF THE KNOB WILL NOT PUSH IN OR TURN BY HAND, DON'T TRY TO REPAIR IT, CALL A QUALIFIED SERVICE TECHNICIAN. FORCE OR ATTEMPTED REPAIR MAY RESULT IN A FIRE OR EXPLOSION.
- D. DO NOT USE THIS APPLIANCE IF ANY PART HAS BEEN UNDER WATER. IMMEDIATELY CALL A QUALIFIED SERVICE TECHNICIAN TO INSPECT THE APPLIANCE AND TO REPLACE ANY PART OF THE CONTROL SYSTEM AND ANY GAS CONTROL WHICH HAS BEEN UNDER WATER.
- E. DO NOT OPERATE APPLIANCE UNLESS UNIT IS FILLED WITH WATER AND WATER LINES ARE FULLY OPEN.



OPERATING INSTRUCTIONS

1. STOP! READ THE SAFETY INFORMATION ABOVE ON THIS LABEL.
2. SET THE SYSTEM CONTROLLER TO THE LOWEST SETTING.
3. TURN POWER SWITCH ON APPLIANCE TO "OFF" POSITION (SWITCH LIGHT GOES OUT).
4. THIS APPLIANCE IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.
5. REMOVE TOP COVER TO EXPOSE GAS CONTROL.
6. REFER TO DIAGRAMS ABOVE. TURN TOP KNOB OF GAS CONTROL CLOCKWISE TO "OFF" POSITION, (FIG. A).
7. WAIT FIVE (5) MINUTES TO CLEAR OUT ANY GAS. THEN SMELL FOR GAS, INCLUDING NEAR THE FLOOR. IF YOU SMELL GAS,
8. STOP! FOLLOW "B" IN THE SAFETY INFORMATION ABOVE ON THIS LABEL. IF YOU DON'T SMELL GAS, GO TO THE NEXT STEP.
9. TURN TOP KNOB OF GAS CONTROL COUNTER-CLOCKWISE TO "ON" POSITION, (FIG. B).
9. REPLACE TOP COVER.
10. TURN POWER SWITCH TO "ON" POSITION (SWITCH LIGHT COMES ON).
11. SET THE SYSTEM CONTROLLER TO DESIRED SETTING.
12. IF THE APPLIANCE WILL NOT OPERATE, FOLLOW THE INSTRUCTIONS "TO TURN OFF GAS TO THE APPLIANCE" AND CALL YOUR SERVICE TECHNICIAN OR GAS SUPPLIER.

TO TURN OFF GAS TO APPLIANCE

1. SET THE SYSTEM CONTROLLER TO THE LOWEST SETTING.
2. TURN POWER SWITCH ON APPLIANCE TO "OFF" POSITION.
3. REMOVE TOP COVER TO EXPOSE GAS CONTROL.
4. REFER TO DIAGRAMS ABOVE. TURN TOP KNOB OF GAS CONTROL CLOCKWISE TO "OFF" POSITION (FIG. A).
5. REPLACE TOP COVER.

in the combustion chamber to clear. **IF YOU DETECT GAS ODOR AT THE END OF THIS PERIOD DO NOT PROCEED WITH LIGHTING. RECOGNIZE THAT GAS EVEN IF IT SEEMS WEAK, MAY INDICATE PRESENCE OF ACCUMULATED GAS SOMEPLACE IN THE AREA WITH RISK OF FIRE OR EXPLOSION. SEE THE FRONT PAGE FOR STEPS TO BE TAKEN.**

INLET GAS PRESSURE

The inlet gas pressure is measured at the main manual gas shut-off valve, which is upstream of the unit's gas valves and pressure regulators. The maximum supply pressure of 13.8 inches W.C. (3.44 kPa) must not be exceeded. The minimum values are shown in the GAS AND ELECTRICAL CHARACTERISTICS table on pages 2 and 3 of this manual. The gas valves supplied with the boiler are for low pressure service. If the upstream pressure exceeds 13.8 inches W.C. (3.44 kPa) an intermediate gas pressure regulator of the lockup type must be installed.



CAUTION

SHOULD OVERHEATING OCCUR OR THE GAS SUPPLY FAIL TO SHUT OFF, SHUT OFF THE GAS SUPPLY AT A LOCATION EXTERNAL TO THE BOILER (i.e. MAIN MANUAL GAS SHUTOFF VALVE).

LIGHT THE BOILER IN ACCORDANCE WITH THE INSTRUCTIONS PROVIDED ON THE LABEL AFFIXED TO THE BOILER'S FRONT DOOR ON THE INSIDE. THESE INSTRUCTIONS ARE REPEATED IN DETAIL ON THE FOLLOWING PAGE.

MANIFOLD PRESSURE CONNECTIONS

Take the manifold pressure, refer to figure 15, by removing the pipe plug and inserting a suitable 1/8" NPT hose barb for connection to the manometer/pressure gauge. Upon completion of measurements and adjustments, remove the hose barb and replace the pipe plug. Check for gas leaks and insure all connections are gas tight.

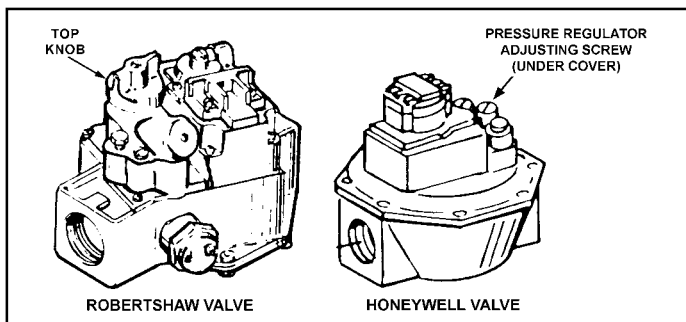


FIGURE 18. HONEYWELL VALVE

GAS PRESSURE REGULATORS

For natural gas boilers, the gas pressure regulator is included in the combination gas valve, figure 18. For propane boilers, the gas pressure regulator is a separate device (except on the LW-500 model), figure 15. The gas pressure regulator is factory set to operate on the gas specified on the boiler rating plate.

DO NOT subject the gas valve to inlet gas pressures of more than 13.8 in. w.c. (3.4 kPa). If higher gas pressures are encountered, a service regulator is necessary.

A minimum supply gas pressure of 7.0" in. w.c. (2.74 kPa) for Natural Gas, or 11.0 in. w.c. (2.49 kPa) for Propane Gas, must be maintained. The minimum supply gas pressure must be

maintained when all gas appliances connected to the system are operating simultaneously and at full fire supply. Pressure drops of more than 1/2" w.c. (0.12 kPa) are not acceptable.

The designed manifold pressures are 3.5 in. w.c. (0.87 kPa) for natural gas and 10.0 in. w.c. (2.49 kPa) for propane gas. In order to check and/or adjust the pressure regulator setting, perform the following:

1. Set the system controller at its lowest setting so that the boiler will not call for heat.
2. Refer to Figure 15 and MANIFOLD PRESSURE CONNECTIONS for the proper method of measuring manifold pressure.
3. Reset the system controller dial to desired setting (ensure ON/OFF switch is "ON"). The main burner will ignite.
4. With the main burner firing, adjust the pressure, if necessary, by turning the pressure regulator adjusting screw with a slot-type screwdriver. The pressure should be 3.5 in. w.c. (0.87 kPa) for natural gas or 10.0 in. w.c. (2.49 kPa) for propane gas.
 - Clockwise to increase pressure.
 - Counterclockwise to decrease pressure.
5. Set the system controller to lowest setting.
6. Remove pressure gauge and replace pipe plug in pipe nipple.
7. Set the system controller to desired setting.



DO NOT INCREASE THE PRESSURE ABOVE THAT SPECIFIED ON THE RATING PLATE, AS OVER-FIRING WILL RESULT IN DAMAGE TO THE BOILER.

If the gas pressure regulator cannot be adjusted to the correct pressure, and there is sufficient gas supply pressure at the valve, replace with a new gas valve (in the case of propane boilers, replace with a new gas pressure regulator).

SAFETY CHECKS

After placing the boiler in operation, perform the following steps to ensure proper performance:

FOR LB/LW-500 MODELS:

1. Manually shut off the gas supply by turning the top knob of the gas control clockwise  to the "OFF" position. The boiler will shut down (main burner extinguished) and will try and re-light within 15 seconds. After three (3) ignition attempts (or 1 attempt on CSD-1 models) the system will lock out. Check that there is no voltage across the D-D or TH-TR terminals on the gas control. Proceed to Step 2.
2. Shut off the gas supply to the boiler by closing the main manual gas shutoff valve in the gas supply line located outside of the boiler cabinet. Turn the top knob on the gas control counterclockwise  to the "ON" position. Reset the power to the boiler by turning the power switch on the boiler to the "OFF" position, wait one (1) minute and then turn to the "ON" position. If there is sufficient gas supply pressure to hold the low gas pressure switch contacts closed, the unit will proceed with the Trial-For-Ignition and as soon as the gas control opens, the Gas Pressure Fail Light (red) on the DIA-SCAN II display will come on and the gas control will close. If the gas supply pressure is low where the low gas pressure switch contacts remain open, the Gas Pressure Fail Light (red) on the DIA-SCAN II display will remain on. The boiler will remain in this state for approximately two minutes and then proceed to enter lock out mode. Check that there is no voltage across the gas control terminals before and after the unit enters the lock out mode. The lock out message under this condition should be either "Circulation Fail" or "Inducor Fail" depending upon the state of the switch when the cycle is initiated.

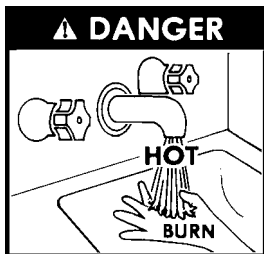
FOR LB/LW-750 AND LB/LW-1000 MODELS:

1. Manually shut off the gas supply by one of the two methods. On boilers that have a manual shutoff valve downstream from the automatic gas valves, turn the manual shut off valve to the "OFF" position. On boilers that do not have the manual shut off valve located downstream from the automatic valve, the gas supply must be interrupted at the automatic valves to perform this check. This may be done by disconnecting the 24 volt lead that supplies the valves. The boiler will shut down (main burner extinguished) and will try and re-light within 15 seconds. After three (3) ignition attempts (or 1 attempt on CSD-1 models) the system will lock out. Once lockout has occurred, check to insure that there is no voltage across the terminals on the gas control or leading to the gas control in the case where the lead was disconnected. Return all valves and wires to their original positions and proceed to Step 2.
2. Shut off the gas supply to the boiler by closing the main manual gas shut off valve in the gas supply line located outside of the boiler cabinet. Reset the power to the boiler by turning the power switch on the boiler to the "OFF" position, wait one (1) minute and then turn to the "ON" position. If there is sufficient gas supply pressure to hold the low gas pressure switch contacts closed, the unit will proceed with the Trial-For-Ignition and as soon as the gas control opens, the Gas Pressure Fail Light (red) on the DIA-SCAN II display will come on and the gas control will close. If the gas supply pressure is low where the low gas pressure switch contacts remain open, the Gas Pressure Fail Light (red) on the DIA-SCAN II display will remain on. The boiler will remain in this state for approximately two minutes and then proceed to enter lock out mode. Check that there is no voltage across the gas control terminals before and after the unit enters the lock out mode. The lock out message under this condition should be either "Circulation Fail" or "Inducer Fail" depending upon the state of the switch when the cycle is initiated.



HOT WATER TEMPERATURES REQUIRED FOR AUTOMATIC DISHWASHER AND LAUNDRY USE CAN CAUSE SCALD BURNS RESULTING IN SERIOUS PERSONAL INJURY AND/OR DEATH. THE TEMPERATURE AT WHICH INJURY OCCURS VARIES WITH THE PERSON'S AGE AND TIME OF EXPOSURE. THE SLOWER RESPONSE TIME OF CHILDREN, AGED OR DISABLED PERSONS INCREASES THE HAZARDS TO THEM. NEVER ALLOW SMALL CHILDREN TO USE A HOT WATER TAP, OR TO DRAW THEIR OWN BATH WATER. NEVER LEAVE A CHILD OR DISABLED PERSON UNATTENDED IN A BATHTUB OR SHOWER.

THE WATER HEATER SHOULD BE LOCATED IN AN AREA WHERE THE GENERAL PUBLIC DOES NOT HAVE ACCESS TO SET TEMPERATURES.



It is recommended in domestic hot water applications that lower water temperatures be used to avoid the risk of scalding. It is further recommended, in all cases, that the water temperature be set for the lowest temperature which satisfies the user's hot water needs. This will also provide the most

energy efficient operation of the boiler and minimize scale formation in the heat exchanger, thus prolonging the life of the boiler.

SETTING THE WATER HEATER TEMPERATURE AT 120°F (49°C) WILL REDUCE THE RISK OF SCALDS. Some states require settings at specific lower temperatures. Table 9 below shows the approximate time-to-burn relationship for normal adult skin.

TABLE 9. Risk of Scalds

Temperature Setting	Time to Produce 2nd & 3rd Degree Burns on Adult Skin
Over 170°F (77°C)	Nearly instantaneous
160°F (71°C)	About 1/2 second
150°F (66°C)	About 1-1/2 seconds
140°F (60°C)	Less than 5 seconds
130°F (54°C)	About 30 seconds
120°F (49°C) or less	More than 5 minutes

Valves for reducing the point-of-use temperatures by mixing cold and hot water are available. Also available are inexpensive devices that attach to faucets to limit hot water temperatures. Contact a licensed plumber or the local plumbing authority.

SHOULD OVERHEATING OCCUR OR THE GAS SUPPLY FAIL TO SHUT OFF, TURN OFF THE MAIN MANUAL GAS SHUTOFF VALVE TO THE APPLIANCE.

WATER TEMPERATURE REGULATION

The operating temperature of the boiler must be maintained as follows:

- 140°F (60°C) or higher inlet water temperature to the boiler.
- 20°F (11°C) differential between the boiler's inlet and outlet (e.g. 140°F [60°C] inlet, 160°F [71°C] outlet minimum design temperatures).

If the inlet water temperature into the boiler is less than 140°F (60°C), adjustments on the water bypass and the outlet valves at the rear of the boiler, figures 13 and 14, are required; wait at least one minute between adjustments for the temperature to stabilize.

- 1) If necessary, throttle down (close) the water outlet gate/ball valve until the desired outlet water temperature (160°F [71°C] minimum) is reached. Wait one minute.
- 2) Note the outlet and inlet temperature indicator readings.
 - a) If the inlet water temperature is less than 140°F (60°C), open, in small increments, the bypass (balancing) valve until the minimum 140°F (60°C) inlet water temperature or 20°F (11°C) differential, whichever has the higher inlet temperature, is attained.
 - b) If the inlet water temperature is greater than 140°F (60°C) and the 20°F (11°C) differential is not present, close the bypass valve until the 20°F (11°C) differential is attained.

NOTE: It may be necessary to make further adjustments on the outlet and bypass valves until the desired inlet and outlet water temperatures are reached.

SEQUENCE OF OPERATION

1. When power is applied to the WHC1502 ignition control, the Display board will initially run through a self-diagnostic routine, and then go into its operating mode, displaying the temperature sensed at the outlet temperature probe.

2. If the ignition control determines the actual water temperature at the outlet temperature sensing probe is below the programmed temperature set-point less the switching differential, and the thermostat circuit is closed, a call for heat is activated.
3. The control then performs selected system diagnostic checks. This includes confirming the proper state of the ECO/ Manual Reset Limit device, flow switch, and pressure switches.
4. If all checks are successfully passed, the circulating pump circuit is energized then combustion blower is energized for the 20 second pre-purge cycle.
5. When the pre-purge cycle is complete, power is applied to the ignitor element for the ignitor warm-up period (pump and blower should continue to run). Blower should go to low speed when ignitor is powered.
6. The control will verify ignitor current. At the conclusion of the ignitor warm-up period (17 seconds), the gas valve will open, allowing gas to enter the burner.
7. After an additional 1 second, the control will monitor the flame sense probe to confirm a flame is present. If a flame is not verified within 4 seconds, the gas valve is immediately closed, and the control will return to step 2.

NOTE: If the control is configured for one ignition trial, the control will go into a lockout state at this point of the operation.

8. If a flame is confirmed, the control will enter the heating mode where it will continue heating until the set-point temperature is reached, and the thermostat circuit is open. At that point, the gas valve is closed and the control enters the post-purge and post-circulate cycles.
9. The combustion blower will run for a 25 second post purge cycle. When the post purge cycle is complete, the blower is de-energized and will coast to a stop. The circulating pump will continue with the post-circulate cycle for the programmed amount of time (factory default 45 seconds). See **Circulating Pump Adjustment Procedure** in Dia-Scan section of the manual.
10. The control now enters the idle state while continuing to monitor temperature and the state of other system devices. If the temperature drops below the set-point value minus the switching differential, and the thermostat circuit closes, the control will return to step 2 and repeat the entire operating cycle. During this idle state, if the control detects an improper operating state for external devices such as the ECO switch, air pressure switch, gas pressure switch, etc., the appropriate LED(s) on the Display Board will illuminate or, error message will scroll indicating the nature of the fault.

MAINTENANCE

At Start-Up and at least every six months thereafter, the boiler should be checked for proper operation of the WHC-1502 Ignition Control and all safety shutoff devices by checking against the Sequence of Operation. The devices on the boiler including, but not limited to, water temperature controls, water flow switch, air pressure switches, gas pressure switches, manual shutoff valve(s) and electrically operated valve(s) should also be checked for proper operation. The safety shutoff valves should be inspected for gas tightness. Any safety devices including Low Water Cutoffs used in conjunction with this boiler should receive periodic (every six months) inspection to assure proper operation. A Low Water Cutoff device of the float type should be flushed

every six months. All relief valves should be inspected and manually operated at least twice a year.

VENTING MAINTENANCE

It is recommended that the venting system be checked monthly by a qualified professional for dust, deterioration, carbon deposits and foreign debris.

Normal operation of this boiler does not result in deposits of soot in the vent system. However, if soot or other debris is found to be in the venting system or as indicated by BLOCKED FLUE on the display board, it must be removed in order for the boiler to operate properly. An authorized service agent should be contacted to determine the reason for sooting.

The venting system should be inspected monthly not only for soot and other debris but also for signs of condensate leakage or combustion products at all joints. If any leakage is found, the boiler should be turned off (see "Lighting and Operating Instructions" to turn boiler off), and the leaks must be repaired. Any damaged or deteriorated venting parts must be replaced.



CAUTION
DO NOT USE A NYLON BRUSH OR OTHER STATIC CREATING MATERIAL TO CLEAN THE VENT. DEPOSITS SUCH AS DUST AND CARBON SOOT COULD BE FLAMMABLE AND MAY BE IGNITED BY STATIC ELECTRICITY. THEREFORE, USE A METAL BRUSH TO MINIMIZE THE DANGER OF EXPLOSION.

THE FOLLOWING CHECKS ARE CARRIED OUT WITH THE BOILER SHUT DOWN:

TO INSPECT THE VERTICAL VENT

The vertical vent terminal is not (or should not be) sealed to the vent pipe; therefore, simply lift off the terminal to begin inspection. After inspection, replace the terminal but do not seal it into position. If a Saf-T Vent Rain Cap is used, pry up the locking tabs that secure it to the vent pipe and remove the cap. After inspection, replace the cap by inserting the locking tabs back under the ring and bending them back into position. The system can also be inspected and cleaned by removing a vent pipe or fitting.

TO INSPECT A SEALED VENT SECTION

Pry up the locking tabs on both sides of the chosen piece to be removed. Carefully cut and remove the silicone sealant located in between the joints so as to not damage the parts. Take off the vent piece and clean up any remaining silicone sealant present on the exposed venting sections. After inspection, replace the vent piece carefully and correctly.

TO INSPECT THE CONDENSATE DRAIN HOSE

Check at the same time the venting system is inspected to ensure that the condensate is allowed to flow out to a suitable drain. It is also important to have and maintain water in the trap loop to prevent the products of combustion from escaping into the room area, see "CONNECTING VENT TO BOILER" and "CONDENSATE REMOVAL SYSTEM".

BURNER AND FLAME PATTERN

To maintain safe operation and the greatest efficiency from the boiler, the burner should be checked by a qualified service agency once every six months for proper flame characteristics.

The burner, figure 19, should display the following characteristics:

- Provide complete combustion of gas.
- Cause rapid ignition and carryover of flame across entire burner.
- Give reasonably quiet operation during ignition, burning and extinction.
- Cause no excessive lifting of flame from burner port.

Flame pattern should have hard, uniform blue flames surrounding the burner, see figure 19.

If the flame is pulsing, floating, yellow and/or lifting off the burner, check the manifold gas pressure and combustion air supply; maintain a clear area around the boiler at all times.

If the aforementioned flame characteristics are not evident, check for accumulation of lint or other foreign material that restricts or blocks the air/gas openings to the burner or boiler.

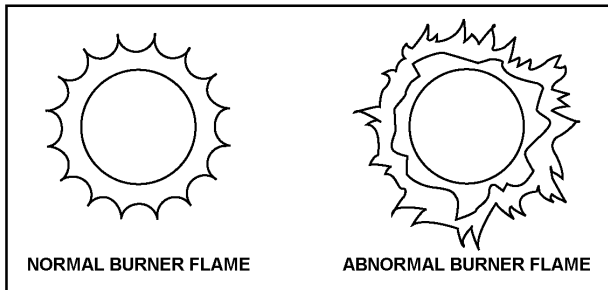


FIGURE 19. BURNER FLAMES

BURNER MAINTENANCE

Qualified servicers should follow this procedure when the boiler's burner needs cleaning.

1. Turn off the electrical power to the boiler and close the main manual gas shutoff valve(s). Allow the boiler parts to cool before disassembly.
2. Separate the blower from the manifold assembly by first removing the four (4) screws, nuts and washers and subsequently, the blower gaskets and air orifice. Then loosen the nut that holds the blower bracket which supports the blower. The blower should be free to move at this point.

FOR DIRECT VENT UNITS: It is necessary to loosen and slide the rubber coupling on the blower adaptor in order to move the blower.

3. Loosen the union orifice and separate the gas train from the manifold assembly.
4. Loosen the nuts (7) at the manifold base and move the burner ground wire (Green) aside.
5. Lift the manifold assembly up from the six (6) studs located on the cover plate and remove the burner gasket.
6. Lift the burner and cone assembly up from the cover plate. Ensure that the white insulation disc (1/2" [13 mm] thick, 3 3/4" [9.5 cm] diameter) is attached to the burner base (closed end).
7. Remove any loose foreign material such as dust or lint with a vacuum. Check all ports for blockage. Dislodge any foreign material causing blockage. Remove any soot or carbon deposits with a rag making sure to remove any lint left on the burner by vacuuming again.
8. Reverse the steps to reassemble the unit.

Ensure that the insulation disc is affixed to the burner base. If not, clean the burner base from the residual insulation. Apply spray adhesive to the cleaned area and press the insulation against the base. Allow it to set a sufficient time before reassembly.

9. Restore electrical power and gas supply to the boiler.

- Put the boiler back in operation by following the Lighting and Operating instructions in this manual.
- Check for gas leaks and proper boiler and vent operation.

CONDENSATE REMOVAL SYSTEM

Due to the highly efficient operation of this unit, condensate is formed during operation and must be removed by the condensate drain systems. Inspect the condensate drains and tubes at least once a month and insure they will allow the free flow of condensate at all times. The system must be inspected more frequently in cold weather if the drain system is located in an area, such as along the floor, where freezing temperatures are likely to occur. The condensate drain system must be protected against freezing. Contact a qualified service agent to inspect and correct the condition if freezing of the condensate lines is a problem. The unit is equipped with a blocked flue switch which will shut the unit off if condensate is unable to drain and backs up in the unit. The Dia-Scan II display board red light indication when sufficient condensate accumulates for this condition will be **BLOCKED FLUE**.

The transparent drain lines and condensate drain on the bottom of the vent collector should be visually inspected at one month intervals for blockage, particularly in the areas of the loops in the lines which trap a small amount of condensate, and the exit point of the vent collector drain. Condensate in portions of the line other than the loop area indicates a blockage in the drain line. Flush the lines with air or water and clear or replace the blocked portions of the line as necessary. Note that areas of the drain line which include a sag or low spot in the line will also form a condensate trap which can be removed by levelling the tube and does not indicate a blocked system.

Inspect the metal vent drain and vent collector drain connectors at six month intervals. Remove the hoses from the connections, then check with a small wooden dowel or plastic rod passed up through the metal connection to insure the passage is clear, using caution to not bend or damage the connector. Call a qualified service agent to inspect and correct the problem if any obstructions are found in the connectors. Replace all hoses and clamps immediately after inspection and before starting the boiler in accordance with the Lighting and Operating Instructions. **DO NOT OPERATE THE BOILER UNLESS ALL CONDENSATE DRAIN LINES ARE PROPERLY CONNECTED AND WORKING.** When a means to neutralize condensate has been installed you must also follow operating, inspection and maintenance procedures specified by the manufacturer of the product. Inspect the installed device to insure that it does not cause condensate to remain in the boiler or vent for any reason.

DIA-SCAN II SELF DIAGNOSTIC SYSTEM

The WHC1502 ignition control is a fully integrated, state of the art electronic control system. The ignition control includes a microprocessor, which governs all temperature and ignition control functions for the appliance.

Inherent in the design are the normal operating sequences and safety features associated with a gas ignition control system.



FIGURE 20.

The ignition control continuously performs various diagnostic tests to verify proper appliance and control operation. Should an unsafe condition occur, the control will shut down the burner and illuminate the appropriate diagnostic indicators on the Display Board, figure 20, indicating a need for service. All operating programs are stored in permanent memory on the ignition control and a second programmable memory is used for retaining user specific operating parameters in the event main power is ever interrupted. If a failure lock-out occurs, the board must be reset by depressing the enter/reset button on the display board, indicating a need for service.

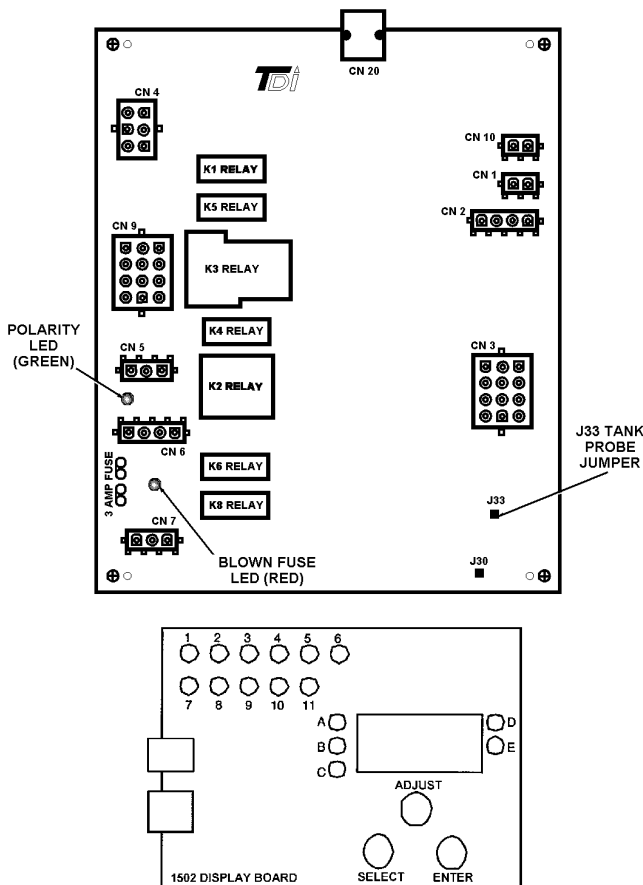


FIGURE 21. DIA-SCAN II CONTROL AND DISPLAY BOARD

NOTE: PC board jumpers are used on the WHC 1502 (see figure 21) to control the mode of temperature regulation (tank probe or 24 V control) and number of ignitions trials (Standard VS. CSD-1 Models). The jumper is a small rectangular plastic piece which fits over two control board leads (see figure 22). It is used on LW models to allow for the use of the tank probe provided with the unit. If the installer wishes to use an alternate

24-Volt method of temperature control, the J33 jumper must be removed and the red/green wires in the junction box at the rear of the unit must be used. (see figure 21 and 22). Standard LB models will not have a jumper across the J33 board leads. Wires are provided in the junction box for a 24-Volt method of temperature control.

LINE POLARITY INDICATOR

A green LED is mounted on the ignition control board to indicate line voltage polarity is properly connected. When 120 VAC input power is properly connected to the ignition Control Board, the green LED will illuminate. If an error is made when connecting 120 VAC input power, this LED will not light. Improperly connecting the input power may result in a false flame sensor failure.

FUSE PROTECTION

The 24 VAC circuitry is protected with a 3 amp auto fuse. If the fuse opens, a red LED located near the fuse will light. If the red LED is illuminated, replace the fuse. **Repeated failure of the fuse is an indication of possible damage to the ignition control.**
Note: An extra fuse and 1 jumper are supplied with the boiler.

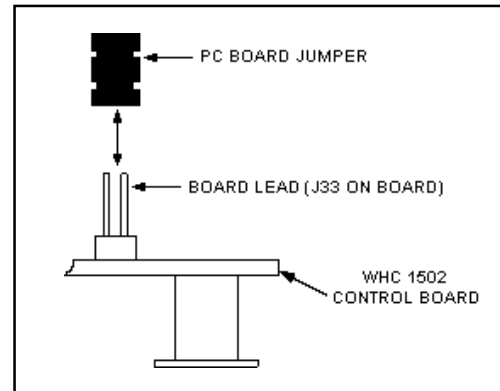


FIGURE 22.

DIA-SCAN II DISPLAY BOARD OPERATING PROCEDURES

The Display Board, figure 20, provides a user friendly interface to the WHC1502 Ignition Control Board. With the Display Board, the user can control appliance functions and view the overall operating status of the appliance. If an error condition occurs, the Display Board will scroll a diagnostic message across the LED display. Under normal operating conditions, the four digit LED display on the Display Board will continuously illustrate the water temperature sensed at the outlet temperature probe. The push buttons on the Display Board are connected to the Ignition Control Board through a 6 conductor cable assembly with modular plug terminations. In addition, an 8 conductor modular jack on the Display Board allows for connecting a remote display board.

When power is applied to the WHC1502 System, the Display Board will initially run through a self-diagnostic test, and then display the Outlet temperature. If the Tank Probe is connected to the board the tank temperature will be displayed. To display a specific setting or temperature, press the SELECT push-button until the appropriate LED is illuminated (see figure 20). After 5 seconds, the Display Board will automatically revert to display the Outlet temperature. Pressing the ENTER/RESET push-button will hold the display in the indicated mode until the SELECT push-button is pressed.

With the display board, the user can make adjustments to many of the appliance's control features. This includes the following:

Options/Features Setting Procedures:

- Set Appliance Temperature Set-Point Value
- Set Appliance Switching Differential Value
- Select Appliance Post-Circulate Time
- Set Appliance Circulating Pump Mode
- Check Appliance Cycle Count
- Control the water temperature in a storage tank

Green Status Lights:

- LED 1: Call for Heat
- LED 2: Flow Switch
- LED 3: Pressure Switch
- LED 4: Ignitor Current
- LED 5: Gas Valve
- LED 6: Flame Sensor

Red Fault Lights:

- LED 7: Ignition Fail
- LED 8: Circulate Failure
- LED 9: Blower Failure
- LED 10: Blocked Flue
- LED 11: Gas Pressure Failure

Water Temperature Set Lights:

- LED A: Inlet Water Temperature*
- LED B: Outlet Water Temperature
- LED C: Inlet/Outlet Differential Temperature
- LED D: Set-Point Temperature
- LED E: Outlet/Set-Point Differential Temperature

*Defaults to water temperature sensor when third temperature probe (Tank Probe) is used.

TEMPERATURE SET-POINT ADJUSTMENT PROCEDURE FOR APPLIANCE

Setting this temperature determines where the appliance will shut down. It is controlled by the outlet/ECO temperature probe on the outlet of the unit. In most cases, it should be set approximately 30 degrees (17°C) above the thermostat or tank probe temperature setting. The controller has a standard programmable temperature set-point range of 110°F (43°C) to 240°F (115°C). The user can easily change the temperature set-point at any time by using the following procedure. In all cases, you must apply input power to the controller to perform any programming operations. The factory default setting is 180°F (82°C).

To change or view the current programmed temperature set-point value:

1. Press the SELECT push-button on the display board until both the Set-Pt LED (LED D, see figure 21) and Outlet Water Temperature LED (LED B, see figure 21) are illuminated.
2. The LED display will show the current set-point temperature.
3. Press and hold the ADJUST push-button. The displayed temperature will either increase or decrease. To alternate between increasing or decreasing the temperature, release then press and hold the ADJUST push-button.
4. When the desired set-point temperature is reached, release the ADJUST push-button.
5. Press the ENTER/RESET push-button once, this enters the selected set-point temperature into controller memory.
6. The appliance will now control the temperature to the desired set-point value.

If the ADJUST push-button is held down long enough, the set-point will reach 110°F [43°C], the minimum value (or 240°F [115°C], the maximum value) and stop. At this point, if the desired setting is not obtained, release the ADJUST push-button and depress it again. The set-point value will now restart at 110°F [43°C] (240°F [115°C]) and once again increase (decrease) in value for as long as the ADJUST push-button is pressed.

NOTE: The boiler must complete a full cycle in order for the new setting to take effect. If the unit is turned off prior to a complete cycle, the setting will be lost and the previous setting will remain in effect.

NOTE: If the tank probe is connected to the system, the appliance Set-Point temperature will only act as a back-up to the system temperature, which will be controlled through the tank probe. (See Tank Probe Sensor/Heating System Temperature Sensor Section of manual). If a tank probe is being utilized (LW Models), it is recommended that the appliance set-point be at least 30°F [17°C] above the tank probe set-point. This is also true if using an alternate 24 Volt control for tank or loop temperature regulation.

NOTE: Do not use the appliance Set-Point temperature as the system temperature regulation device in hydronic (LB) applications. An external 24-Volt temperature control located in the return loop of the closed water system should be used for system regulation. This device should be attached to the red/green wires in junction box at the rear of the unit. The appliance temperature setting should only be used as a limit control for the system.

SWITCHING DIFFERENTIAL ADJUSTMENT PROCEDURE FOR APPLIANCE

To facilitate proper operation and maximize appliance performance, the control has a programmable operating switching differential or "hysteresis" about the set-point. This means a call for heat will become active when the water temperature measured at the outlet temperature sensing probe drops to the set-point value minus the switching differential value. The burner will remain on until the water temperature measured at the outlet temperature probe reaches the set-point value. The switching differential value is fully programmable from 5°F (3°C) to 50°F (28°C) using the push-button(s) located on the Display Board.

To change or view the current programmed switching differential:

1. Press the SELECT push-button on the display board until the Set-Pt Diff LED (LED E, see figure 21) is illuminated.
2. The LED display will show the current switching differential.
3. Press and hold the ADJUST push-button. The displayed value will either increase or decrease. To alternate between increasing and decreasing the switching differential, release then press and hold the ADJUST push-button.
4. When the desired switching differential is reached, release the ADJUST push-button.
5. Press the ENTER push-button once, this enters the selected switching differential value into controller memory.
6. The appliance will now control temperature utilizing the desired switching differential value.

If the ADJUST push-button is held down long enough, the switching differential setting will reach 5°F (3°C), the minimum

value (or 50°F [28°C], the maximum value) and stop. At this point, if the desired switching differential is not obtained, release the ADJUST push-button and depress it again. The switching differential value will now start at 5°F (3°C) to (50°F [28°C]) and once again increase (decrease) in value for as long as the ADJUST push-button is pressed.

CIRCULATING PUMP ADJUSTMENT PROCEDURE

The Controller is factory set with a 45 second post circulate function. With the Display Board, the user has the capability to choose between a 45, 90, or 180 second post circulate time period, or turn the pump on continuously. This provides flexibility in selecting the post circulate time to meet specific installation requirements, and improves the efficiency of the circulating pump operation.

NOTE: It is recommended that intermittent post circulate pump modes be used for maximum efficiency.

To change or view the current programmed post-circulating time:

1. Press the SELECT push-button on the display board until the LED display reads OPT (Options).
2. To enter into the options mode, press the ENTER push-button.
3. The display will illustrate Circ. Enter this mode by pressing the ENTER push-button.
4. The display will now illustrate the current post circulate time. Press the ADJUST push-button to select the desired post circulate time (45, 90, 180, On).
5. When you have selected the desired post circulate time mode, press the ENTER push-button once, this enters the selected post circulate time into controller memory.
6. The display will automatically return to showing the outlet temperature.

DISPLAY CURRENT MODE

In this mode, the Display Board will show the current functional step in the appliance operational sequence. For example, if the appliance is performing Ignitor Warm-up, the display will show IGnt. To enter into this mode, perform the following steps:

1. Press the SELECT push-button on the display board until the LED display reads OPT (Options).
2. To enter into the options mode, press the ENTER push-button.
3. The display will show Circ. Press the SELECT push-button until the display shows StEP. Enter this mode by pressing the ENTER push-button.
4. The display will show the current appliance operating step.
5. The display will automatically resort to illustrating the outlet temperature, after five (5) seconds. To keep the display in the Display Step Mode, press ENTER twice in step 3.

Table 10.

Display Message	Appliance Mode
IdLe	Idle state
NoSn	Wait for No Sensor Inputs
CrSn	Wait for Circulate Sense
Circ	Circulate Pump is ON
PrSn	Wait for Blower Pressure Sense
PreP	Pre-Purge state
IGnt	Ignitor Warm-up
rEdn	Turn ON redundant Gas Valve relay
IAct	Turn ON Gas Valves
StAb	Turn OFF Ignitor and wait for Flame Sense Stabilization
HEAt	Heat Mode
PoPC	Post Purge and Post Circulate
Po C	Post Circulate

DISPLAY TOTAL CYCLE COUNT

The Main Control Board counts the number of cycles the appliance has operated. In the Main Control Board, a cycle is counted every time the gas valve is energized. To access this number, perform the following procedure:

1. Press the SELECT push-button on the display board until the LED display reads OPT (Options).
2. To enter into the options mode, press the ENTER push-button.
3. The display will show Circ. Press the SELECT push-button until the display shows Count. Enter this mode by pressing the ENTER push-button.
4. The display will now show the current number of cycles the appliance has cycled through.
5. The display will automatically resort to show the outlet temperature

TANK PROBE TEMPERATURE SET-POINT ADJUSTMENT PROCEDURE

The user can easily change the water temperature set-point at any time by using the following procedure:

1. Press the SELECT push-button on the display board until both the Set-Pt LED (LED D, see figure 21) and Inlet Water Temperature LED (LED A, see figure 21) are illuminated.

NOTE: When a third probe is installed on the board at location CN10, the Inlet Water Temperature LED defaults to Tank Water Temperature.

2. The LED display will show the current set-point temperature.
3. Press and hold the ADJUST push-button. The displayed temperature will either increase or decrease. To alternate between increasing or decreasing the temperature, release then press and hold the ADJUST push-button.
4. When the desired set-point temperature is reached, release the ADJUST push-button.
5. Press the ENTER push-button once, this enters the selected tank set-point temperature into controller memory.
6. The appliance will now control the water temperature to the desired set-point value.

TROUBLESHOOTING

SHORTCYCLING

If the ADJUST push-button is held down long enough, the set-point will reach 110°F (43°C), the minimum value (or 190°F [88°C], the maximum value) and stop. At this point, if the desired set-point is not obtained, release the ADJUST push-button and depress it again. The set-point value will now restart at 110°F (43°C) to 190°F [88°C] and once again increase (decrease) in value for as long as the ADJUST push-button is pressed.

Display Board LED Indicators

The Display Board contains eleven (11) solid state LED indicators for viewing various states of appliance operation and for troubleshooting if problems occur. Under normal operating conditions, the appropriate LED's will sequence with steady illumination according to the particular appliance operating state. In cases where problems or a lockout occurs, the appropriate LED's will illuminate indicating the general area where the problem exists.

A description of the LED's and their corresponding functions are as follows. See figure 20.

<u>LED(GREEN)</u>	<u>Controller Function</u>
Call for Heat	*** Monitors the outlet probe & switching differential. LED is ON when the temperature at the outlet is less than the set-point minus the switching differential.
Flow Switch	Monitors the condition of the flow switch. LED is ON when the flow switch closes, indicating water flow through the system.
Pressure Switch	Monitors the condition of the pressure switch(s). LED is ON when the pressure switch(s) are in their correct state.
Ignitor Current	Monitors current flow through the ignitor element. LED is ON when current flow through the ignitor is sensed.

*****Note: The call for heat function will also monitor the tank probe or a 24 volt control, depending upon the application, when one is connected to the control board. It will cycle on the control with the lowest temperature setting, however, the 1502 control board will not allow the appliance outlet temperature Set-Point to be set below that of the tank probe supplied with LW models.**

Gas Valve	Monitors Gas Valve output. LED is ON when the output relay supplying power to the gas valve(s) is closed.
Flame Sense	Monitors the Flame Sense Rod. LED is ON when a signal from the flame rod is sufficient to indicate flame.

<u>LED(RED)</u>	<u>Controller Function</u>
Blocked Flue	Indicates a blockage or interference at the appliance flue.
Gas Pressure Fail	Indicates low gas pressure at the inlet of the appliance or a malfunctioning switch. NOTE: On CSD-1 models can also indicate a high manifold pressure problem
Blower Fail	Indicates an error/malfunction in the blower motor circuit.
Circulate Fail	Indicates an error/malfunction in the circulating pump circuit.
Ignition Fail	Indicates a malfunction in the ignition system circuit.

Shortcycling is a condition where the boiler starts up and shuts down frequently in a short time period. This usually indicates that an abnormal operating condition is present.

Monitor the DIA-SCAN II display board to pinpoint the shortcycling source, then determine the probable cause(s) and take the necessary corrective actions to eliminate them.

If the DIA-SCAN II display board shows normal sequence of operation, the problem is field related; check the field wiring or the system controller.

Note: In hot water applications, this condition is often caused by the system control and the unit's operating control being set too close. A thirty (30) degree [17°C] separation between the two control settings is recommended.

HARD STARTS

A "hard start" occurs during start up and is indicated by small rumbling noises and/or minor quivering. This condition is a result of improper air/gas mixture. Before making any adjustments to the boiler, ensure that adequate combustion and ventilation air are provided, see the "AIR REQUIREMENTS" section. If "hard starts" are experienced, often an air or gas manifold pressure adjustment will remedy the problem. An air shutter is provided to help fine-tune the air/gas ratio.

TROUBLESHOOTING ERROR CODES

The WHC1502 Series Control System has many inherent diagnostic and fault detection routines built into its operating hardware and software. These routines, in conjunction with the four (4) digit LED display and eleven (11) LED status indicators on the Display Board, can greatly assist any service person in quickly pinpointing the source of a problem which may occur within the appliance. In certain circumstances, multiple LED's will illuminate to better pinpoint the target area(s).

The following list defines the error code messages that scroll across the LED display:

<u>ERROR MESSAGE</u>	<u>REPORTED ERROR</u>
OPEn InLEt ProbE	No probe detected at connector CN1 on Control Board.
OPEn OutLEt ProbE	No probe detected at connector CN2 on Control Board.
Circulation FAIL	No flow detected at flow switch.
Inducor FAIL	No pressure detected at pressure switch.
FLAmE SenSE FAIL	Flame sense detected before gas valve is turned on.
SenSor FAIL	One of the sensors, Flow, Pressure, Hi Gas, or Lo Gas was not in the correct state.
Ignitor FAIL	No Ignitor current sensed (no Ignition).
no Ignition	Flame not detected after 1 or 3 tries.
ECO FAIL	ECO/High Limit switch opened.
Control FAIL	Relay did not open or close properly.

NOTE: Under certain circumstances, a problem with the low gas pressure switch (and/or high gas pressure switch on CSD-1 models) may cause an error code of Circulation FAIL or Inducor FAIL depending on when the failure occurred in the cycle.

NOTE: Upon lockout, manually push the ENTER/RESET button on the display board to restart the boiler.

IMPORTANT NOTES

If you experience trouble with your Legend unit, the best advice is to start at the main power source and work forward. Here are some hints to help you.

- Make sure the correct electrical connections are made to the unit. The Legend 2000 requires a 120V, 60 Hz, 30 Amp. circuit to function properly. The unit must be the only appliance on this circuit.
- Make sure the gas line is sized properly. Having multiple appliances on a single gas line can cause gas pressure fluctuations and gas volume problems that can hinder performance. See manual for correct sizing.
- Check the five important electrical connections to the unit. (120V line, 120V neutral line, Ground, (2) Tank Probe or (2) Thermostat connections.)
- If rough starting is a problem, concentrate on the air/gas mixture. Make certain there is 3.5" W.C. of gas pressure at the manifold. Adjust the blower speed on the blower until the situation improves. If the unit is "howling", blower speed adjustment is often the answer.
- If a blower speed adjustment does not improve starting, verify the gas and air orifice dimensions and/or pull the burner and check for debris.
- If a system pump is added to the unit and run directly from the control board, the maximum power rating of the motor should not exceed 1 hp.
- The board is set to sense ignitor current once the ignitor is energized. The sensing threshold is between 3.2 and 2.7 amps. If the unit's ignitor is coming on, but the gas valves are not opening, check the ohm rating of the ignitor. It must be between 40 to 70 ohms. Allow the ignitor to cool before you take the ohm reading.
- If the unit has progressed in the cycle but will not fire, check the pressure switches. Check the DIA-SCAN II display and see if any of the RED LED's are lit to help you identify the problem. If you notice that the IGNITOR CURRENT LED is flashing, check the polarity of the transformer wires. Switch the position of the 24V wires on the terminals.
- The LW units come set-up for the tank probe. If one wishes to use an alternate 24V method of temperature control (Honeywell, White Rodgers, etc.), the Red/Green wires must be used and the J33 control board jumper must be removed. **Either the tank probe connection or the thermostat connection is to be used, but not both.** See previous pages.

- The display defaults to the outlet water temperature under normal circumstances. On LW models, however, the display defaults to the tank probe temperature once the probe supplied with the unit is connected to the control board.
- Set the unit's automatic reset limit at least thirty 30°F (17°C) above the tank temperature setting on hot water supply applications. However, the temperature setting should not exceed 210°F (99°C) for such applications.
- The unit has an adjustable Set-Pt Differential. The tank Probe's Set-Pt Differential is not adjustable and is fixed at 5°F (3°C).
- The display will only show the tank temperature when the tank probe supplied with the unit is used. Alternate 24V temperature controls (Honeywell, White Rodgers, etc.) will have to be set manually.
- Once the system is set up and a system temperature is determined, make sure the unit's automatic reset limit does not interfere with the tank probe's function. If the Set-Point differential of the unit is set too high, it may alter the system's intended target temperature.
- Under any failure code, the ENTER/RESET button on the display must be pushed before the unit will function.
- It is recommended that intermittent post circulate pump modes be used for maximum efficiency.
- The inlet water temperature must be 140°F (60°C) to prevent heat exchanger damage (use by-pass kit supplied with this unit).
- It is imperative that installation specification be adhered to when working with the Legend 2000. Correct gas pipe sizing, vent installation, and electrical connections are critical for the unit to function effectively.
- On LW models, verify that the J33 PC board jumper is in place. It may fall out during shipping. A replacement jumper is provided with the unit.
- Do not use the tank probe provided with the unit for loop temperature regulation if using an LW model in a hydronic heating application. An alternate 24 volt control must be used.
- In a large system where the system pump exceeds the maximum 1 hp rating, the pump cannot be powered directly from the control board. Use the 120 Volt pump connections to energize the coils of an external relay. Connect the power to the pump through the contacts of the relay. The power for the pump and the unit should be on separate breakers.
- Do not use the outlet water temperature control as the system temperature regulation device on LB models. 24 Volt connections are provided at the rear of the unit for a thermostat, aquastat, etc. The outlet temperature control should only be used as a limit for the system temperature control. The system temperature control should be located in the return loop of the hydronic system.

LIMITED WARRANTY

A. O. Smith Corporation, the warrantor, extends the following LIMITED WARRANTY to the owner of this boiler:

1. If within TEN years after initial installation of the boiler, a coiled heat exchanger or gas burner shall prove upon examination by the warrantor to be defective in material or workmanship, the warrantor, at his option will exchange or repair such part or portion. This term is reduced to FIVE years if this boiler is used for water heating purposes other than hydronic space heating.

- a. This warranty is extended to the owner for all other parts or portion during the FIRST year following initial installation of this boiler.
- b. The warranty on the repair or replacement of the part or portion will be limited to the unexpired term of the original warranty.

2. CONDITIONS AND EXCEPTIONS

This warranty shall apply only when the boiler is installed in accordance with local plumbing and building codes, ordinances and regulations, the printed instructions provided with it and good industry practices. In addition, a pressure relief valve, certified by A.G.A./C.G.A. and approved by the American Society of Mechanical Engineers, must have been installed and fresh water used for filling and make-up purposes.

a. This warranty shall apply only when the boiler is used:

- (1) with inlet water temperature 140°F (60°C) and above and outlet water temperatures not exceeding the maximum setting of its operative and/or high limit control;
- (2) at water pressure not exceeding the working pressure shown on the boiler;
- (3) when filled with boiler water, free to circulate at all times and with the heat exchanger free of damaging scale deposits;
- (4) in a non-corrosive and non-contaminated atmosphere;
- (5) in the United States, its territories or possessions, and Canada;
- (6) at a water velocity flow rate not exceeding or below the boiler's designed rates;
- (7) indoor installation only.

b. Any accident to the boiler, any misuse, abuse (including freezing) or alteration of it, any operation of it in a modified form, or any attempt to repair leaks in the coil or heat exchanger will void this warranty.

3. SERVICE AND REPAIR EXPENSE

Under this limited warranty the warrantor will provide only a replacement part. The owner is responsible for all other costs. Such costs may include but are not limited to:

- a. Labor charges for service, removal, repair, or reinstallation of the component part;
- b. Shipping, delivery, handling, and administrative charges for forwarding the replacement part from the nearest distributor and returning the claimed defective part to such distributor.
- c. All cost necessary or incidental for any material and/or permits required for installation of the replacement.

4. LIMITATIONS ON IMPLIED WARRANTIES

Implied warranties, including any warranty of merchantability imposed on the sale of this boiler under state or provincial law are limited to one (1) year duration for the heater or any of its parts. Some states and provinces do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

5. CLAIM PROCEDURE

Any claim under this warranty should be initiated with the dealer who sold the boiler, or with any other dealer handling the warrantor's products. If this is not practicable, the owner should contact:

U.S. Customers

A. O. Smith Corporation
5621 West 115th Street
Alsip, IL 60803
Telephone: 800 323-2636

Canadian Customers

A. O. Smith Enterprises Ltd.
P. O. Box, 310 - 768 Erie Street
Stratford, Ontario N5A 6T3
Telephone: 800-265-8520

- a. The warrantor will only honor replacement with identical or similar parts thereof which are manufactured or distributed by the warrantor.
- b. Dealer replacements are made subject to in-warranty validation by warrantor.

6. DISCLAIMERS

NO OTHER EXPRESS WARRANTY HAS BEEN OR WILL BE MADE ON BEHALF OF THE WARRANTOR WITH RESPECT TO THE MERCHANTABILITY OF THE BOILER OR THE INSTALLATION, OPERATION, REPAIR OR REPLACEMENT OF THE BOILER. THE WARRANTOR SHALL NOT BE RESPONSIBLE FOR WATER DAMAGE, LOSS OF USE OF THE UNIT, INCONVENIENCE, LOSS OR DAMAGE TO PERSONAL PROPERTY, OR OTHER CONSEQUENTIAL DAMAGE. THE WARRANTOR SHALL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR DAMAGE TO ANY PERSONS OR PROPERTY, WHETHER DIRECT OR INDIRECT, AND WHETHER ARISING IN CONTRACT OR TORT.

- a. Some states and provinces do not allow the exclusion or limitation of the incidental or consequential damage, so the above limitations or exclusions may not apply to you.
- b. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state or province to province.

Fill in the following for your own reference. Keep it. Registration is not a condition of warranty. The model and serial number are found on the boiler's rating plate.

Owner _____

Installation Address _____

City and State _____ Zip Code _____

Date Installed _____ Model No. _____ Serial No. _____

Dealer's Name _____ Phone No. _____

Dealer's Address _____

FILL IN WARRANTY AND KEEP FOR FUTURE REFERENCE