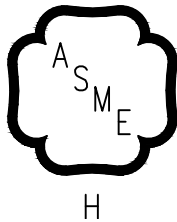


Installation, Operating and Service Instructions for

# V1™ RO/FO Series

## Residential



- Natural Draft
- Oil-Fired
- Water Boiler

### Models:

- V1 3A RO/FO



For service or repairs to boiler, call your heating contractor or oil supplier. When seeking information on boiler, provide Boiler Model Number and Serial Number as shown on Rating Label located on top of the boiler.

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## IMPORTANT INFORMATION - READ CAREFULLY

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All boilers must be installed in accordance with National, State and Local Plumbing, Heating and Electrical Codes and the regulations of the serving utilities. These Codes and Regulations may differ from this instruction manual. Authorities having jurisdiction should be consulted before installations are made.

In all cases, reference should be made to the following Standards:

### USA BOILERS

- A. Current Edition of American National Standard ANSI/NFPA 31, "Installation of Oil Burning Equipment"; for recommended installation practices.
- B. Current Edition of American National Standard ANSI/NFPA 211, "Chimneys, Fire places, Vents, and Solid Fuel Burning Appliances"; For Venting requirements.
- C. Current Edition of American Society of Mechanical Engineers ASME CSD-1, "Controls and Safety Devices for Automatically Fired Boilers"; for assembly and operations of controls and safety devices.
- D. All wiring on boilers installed in the USA shall be made in accordance with the National Electrical Code and/or Local Regulations.

The following terms are used throughout this manual to bring attention to the presence of hazards of various risk levels, or to important information concerning product life.



**DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death, serious injury or substantial property damage.



**WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death, serious injury or substantial property damage.



**CAUTION** Indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury or property damage.

**NOTICE** Indicates special instructions on installation, operation, or maintenance which are important but not related to personal injury hazards.

**NOTICE** This boiler has a limited warranty, a copy of which is included with the boiler.

- The warranty for this boiler is valid only if the boiler has been installed, maintained and operated in accordance with these instructions.
- Surface rust on cast iron sections may be attributed to the manufacturing process as well as condensation during storage. Surface rust is normal and does not affect the performance or longevity of a boiler.



**DO NOT** store or use gasoline or other flammable vapors or liquids in the vicinity of this or any other appliance.



Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Failure to follow all instructions in the proper order can cause personal injury or death. Read and understand all instructions, including all those contained in component manufacturers manuals which are provided with the appliance before installing, starting-up, operating, maintaining or servicing this appliance. Keep this manual and literature in legible condition and posted near appliance for reference by owner and service technician.

- This boiler requires regular maintenance and service to operate safely. Follow the instructions contained in this manual.
- Installation, maintenance, and service must be performed only by an experienced, skilled and knowledgeable installer or service agency.
- All heating systems should be designed by competent contractors and only persons knowledgeable in the layout and installation of hydronic heating systems should attempt installation of any boiler.
- Installation is NOT complete unless a pressure relief valve is installed into the 3/4" tapping located in top left corner of front section - See Figure 1 and "Water Boiler Piping" Section of this manual for details.
- It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when the installation is complete including verifying that the limit sensor is fully installed. Failure to properly install Limit Sensor may result in property damage, personal injury or loss of life due to elevated operating temperatures and/or pressures.
- This boiler is suitable for installation on combustible flooring. DO NOT install boiler on carpeting.
- DO NOT tamper with or alter the boiler or controls.
- Inspect flueways at least once a year - preferably at the start of the heating season. The inside of the combustion chamber, the vent system and boiler flueways should be cleaned if soot or scale has accumulated.
- When cleaning this boiler, take precaution to avoid damage to target wall, chamber liner or burner mounting plate insulation. If damaged, or if there is evidence of previous damage, replace the damaged insulation piece(s) immediately.
- Oil Burner and Controls must be checked at least once a year or as may be necessitated.
- DO NOT operate unit with jumpered or absent controls or safety devices.
- DO NOT operate unit if any control, switch, component, or device has been subject to water.
- Boiler materials of construction, products of combustion and the fuel contain alumina, silica, heavy metals, carbon monoxide, nitrogen oxides, aldehydes and/or other toxic or harmful substances which can cause death or serious injury and which are known to the state of California to cause cancer, birth defects and other reproductive harm. Always use proper safety clothing, respirators and equipment when servicing or working nearby the appliance.



**WARNING** This boiler contains very hot water under high pressure. **DO NOT** unscrew any pipe fittings nor attempt to disconnect any components of this boiler without positively assuring the water is cool and has no pressure. Always wear protective clothing and equipment when installing, starting up or servicing this boiler to prevent scald injuries. **DO NOT** rely on the pressure and temperature gauges to determine the temperature and pressure of the boiler. This boiler contains components which become very hot when the boiler is operating. **DO NOT** touch any components unless they are cool. Do not mix components from listed manufacturers.

- This boiler must be properly vented. The boiler must be connected to an approved chimney or vent system in good condition. Serious property damage could result if the boiler is connected to a dirty or inadequate chimney or vent system. The chimney must be inspected for any obstructions and cleaned prior to each heating season. A clean and unobstructed chimney flue is necessary to produce the minimum draft required to safely evacuate noxious fumes that could cause personal injury or loss of life. **DO NOT** operate boiler with the absence of an approved vent system. Evidence of loose debris and or condensate induced stains at the base of the chimney flue, connector or smokepipe joints may be signs of condensing flue gases. Flue gas condensate is corrosive, which requires special consideration and must be addressed immediately. Refer to "Venting (Natural Draft - Chimney)" listed in Table of Contents below.
- This boiler needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.
- This boiler is supplied with controls which may cause the boiler to shut down and not re-start without service. If damage due to frozen pipes is a possibility, the heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on the heating system to prevent damage if the boiler is inoperative.
- This boiler is designed to burn No. 2 fuel oil only. **DO NOT** use gasoline, crankcase drainings, or any oil containing gasoline. Never burn garbage or paper in this boiler. **DO NOT** convert to any solid fuel (i.e. wood, coal). **DO NOT** convert to any gaseous fuel (i.e. natural gas, LP). All flammable debris, rags, paper, wood scraps, etc., should be kept clear of the boiler at all times. Keep the boiler area clean and free of fire hazards.

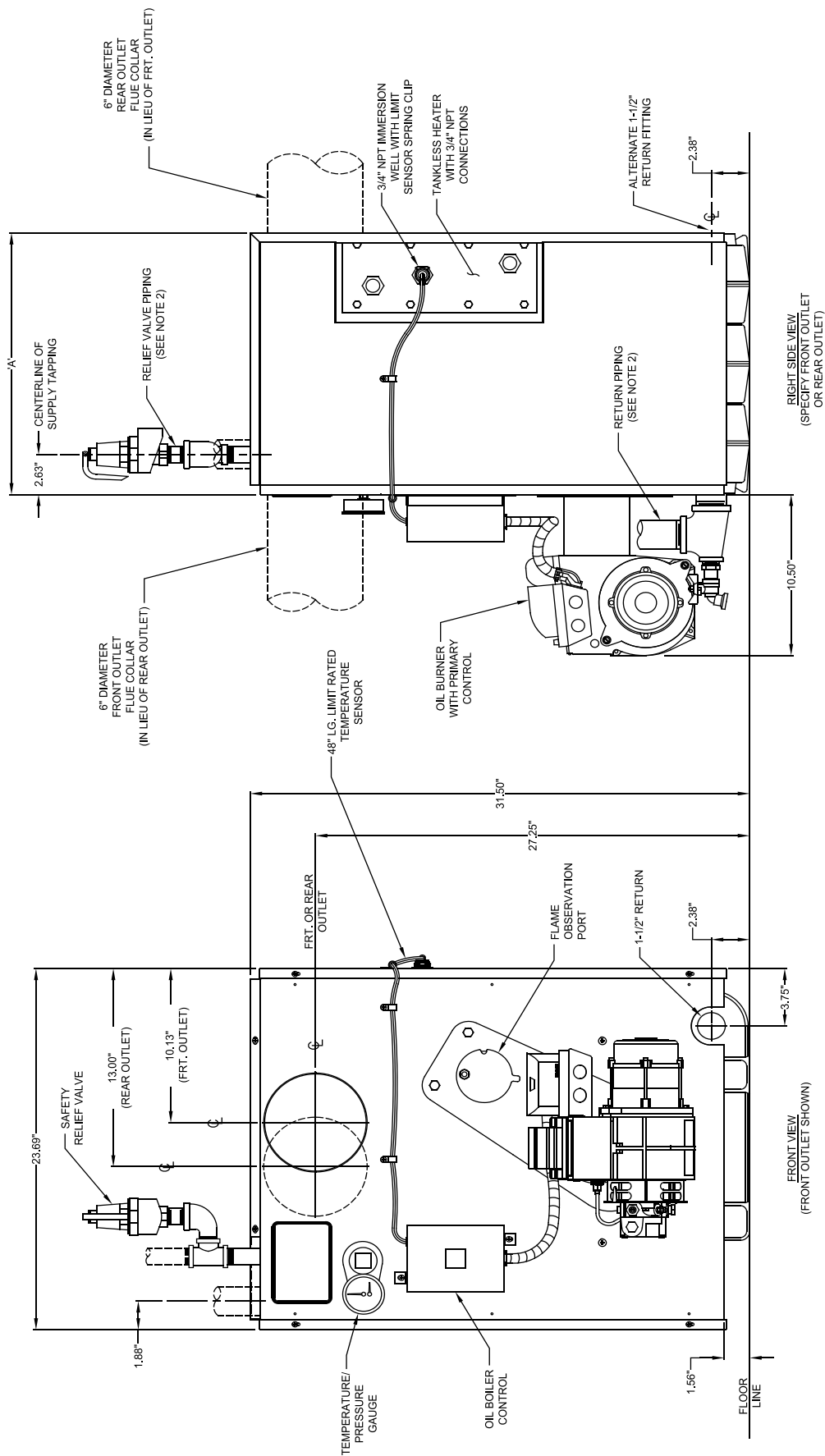
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# SECTION I: GENERAL INFORMATION



- NOTES:
1. PIPING SHOWN IN HIDDEN LINES NOT SUPPLIED BY MANUFACTURER.
  2. DRAIN VALVE, RELIEF VALVE, CIRCULATOR, RELATED HARDWARE, AND PIPING FITTINGS SHIPPED LOOSE.

**Figure 1: VI-RO/FO Water Boiler with Tankless Heater, Beckett AFG Burner**

## SECTION I: GENERAL INFORMATION (continued)

**Table 1A: Dimensional Data/General Information (See Figure 1)**

Boiler Model No.	Dimensions	Water Content - Gallons	Heat Transfer Surface Area - Sq. Ft.	Actual Shipping Weight (LB.)
	"A"			
V13A RO/FO	15-7/8"	13.5	13.95	519

NOTE: Maximum Working Pressure: Water: 30 PSI (Water Only)

**Table 1B: Rating Data**

Boiler Model No.	Burner Capacity		DOE Heating Capacity MBH (2)	AHRI NET Ratings (3)	AFUE %	Tankless Heater Capacity	Minimum Chimney Requirements		
	GPH	MBH (1)		Water MBH	Water Boiler	V1-2 Heater GPM	Round In. Dia.	Rectangle In. x In.	Height Ft.
V13A RO/FO	0.75	105	89	77	84.0	3-1/4	6	8 x 8	15

(1) MBH refers to thousand BTU per hour.

(2) Based on standard test procedures prescribed by the United States Department of Energy at combustion conditions of 13.5% CO<sub>2</sub>.

(3) Net AHRI Ratings are based on piping and pickup allowance of 1.15.

## SECTION II: PRE-INSTALLATION

**A. INSPECT SHIPMENT** carefully for any signs of damage.

1. ALL EQUIPMENT is carefully manufactured, inspected and packed. Our responsibility ceases upon delivery of created Boiler to the carrier in good condition.
2. ANY CLAIMS for damage or shortage in shipment must be filed immediately against the carrier by the consignee. No claims for variances from, or shortage in orders, will be allowed by the manufacturer unless presented within sixty (60) days after receipt of goods.

**B. LOCATE BOILER** in front of final position before removing crate. See Figure 1.

1. LOCATE so that smoke pipe connection to chimney will be short and direct. BOILER IS SUITABLE FOR INSTALLATION ON COMBUSTIBLE FLOOR.
2. FOR BASEMENT INSTALLATION, provide a concrete base if floor is not perfectly level, or if water may be encountered on floor around Boiler.
3. PROVIDE CLEARANCE of at least 24" on right side of Boiler for cleaning flueways and for removal of Tankless Heater. Provide clearance of at least 14" in front (measured from front jacket panel) for servicing burner.

**C. PROVIDE COMBUSTION AND VENTILATION**

**AIR.** Local code provisions may apply and should be referenced.



**WARNING** Adequate combustion and ventilation air must be provided to assure proper combustion and to maintain safe ambient air temperatures.

**DO NOT** install boiler where gasoline or other flammable vapors or liquids, or sources of hydrocarbons (i.e. bleaches, fabric softeners, etc.) are used or stored.

1. Determine volume of space (boiler room). Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the space.  
$$\text{Volume}(\text{ft}^3) = \text{Length}(\text{ft}) \times \text{Width}(\text{ft}) \times \text{Height}(\text{ft})$$
2. Determine total input of all appliances in the space.  
Add inputs of all appliances in the space and round the result to the nearest 1000 BTU per hour.
3. Determine type of space. Divide Volume by total input of all appliances in space. If the result is greater than or equal to 50 ft<sup>3</sup>/1000 BTU per hour, then it is considered an *unconfined space*. If the result is less than 50 ft<sup>3</sup>/1000 BTU per hour then the space is considered a *confined space*.

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## SECTION II: PRE-INSTALLATION (continued)

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4. For boiler located in an *unconfined space of a conventionally constructed building*, the fresh air infiltration through cracks around windows and doors normally provides adequate air for combustion and ventilation.
5. For boiler located in a confined space or an unconfined space in a building of unusually tight construction, provide outdoor air with the use of two permanent openings which communicate directly or by duct with the outdoors or spaces (crawl or attic) freely communicating with the outdoors. Locate one opening within 12 inches of top of space. Locate remaining opening within 12 inches of bottom of space. Minimum dimension of air opening is 3 inches. Size each opening per following:
  - a. **Direct communication with outdoors.** Minimum free area of 1 square inch per 4,000 BTU per hour input of all equipment in space.
  - b. **Vertical ducts.** Minimum free area of 1 square inch per 4,000 BTU per hour input of all equipment in space. Duct cross-sectional area shall be same as opening free area.
  - c. **Horizontal ducts.** Minimum free area of 1 square inch per 2,000 BTU per hour input of all equipment in space. Duct cross-sectional area shall be same as opening free area.

*Alternate method for boiler located within confined space.* Use indoor air if two permanent openings communicate directly with additional space(s) of sufficient volume such that combined volume of all spaces meet criteria for unconfined space. Size each opening for minimum free area of 1 square inch per 1,000 BTU per hour input of all equipment in spaces, but not less than 100 square inches.

6. Louvers and Grilles of Ventilation Ducts
  - a. All outside openings should be screened and louvered. Screens used should not be smaller than 1/4 inch mesh. Louvers will prevent the entrance of rain and snow.
  - b. Free area requirements need to consider the blocking effect of louvers, grilles, or screens protecting the openings. If the free area of the louver or grille is not known, assume wood louvers have 20-25 percent free area and metal louvers and grilles have 60-75 percent free area.
  - c. Louvers and grilles must be fixed in the open position, or interlocked with the equipment to open automatically during equipment operation.

### III: INSTALLATION INSTRUCTIONS

#### A. REMOVE CRATE -

1. Remove all fasteners at crate skid.
2. Lift outside container and remove with all other inside protective spacers and bracing. Remove Parts Carton containing Safety Relief Valve, Boiler Drain Valve, Circulator, Fittings and Miscellaneous Hardware.

#### B. REMOVAL OF BOILER FROM SKID

1. Boiler is secured to base with 4 bolts, 2 on left side and 2 on right side, see Figure 2. Remove all bolts.

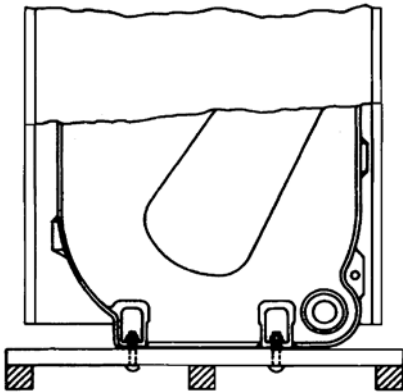


Figure 2: Removal of Boiler From Skid

2. Tilt boiler to right and to rear. Using right rear leg as pivot, rotate boiler 90° in a clockwise direction, and lower left side of boiler to floor. Tilt boiler and remove crate skid. Care should be exercised to prevent damage to Jacket or Burner.

#### C. MOVE BOILER TO PERMANENT POSITION

by sliding or walking.

#### D. INSPECT COMBUSTION TARGET WALL.

1. OPEN FLAME OBSERVATION DOOR on front of boiler.
2. Use flashlight to inspect Target Wall secured to rear section with silastic. If damaged, replace.



**WARNING** Any combustion chamber insulation which was damaged must be replaced immediately.

#### E. INSTALL CANOPY

The canopy is shipped in a separate carton.

1. Open canopy carton and remove canopy.
2. Remove two (2) sheet metal screws securing front of jacket top panel and (2) sheet metal screws near the top of both side panels. Pull side panels outward to allow jacket top panel to swing upward as shown in Figure 3, Step 1.

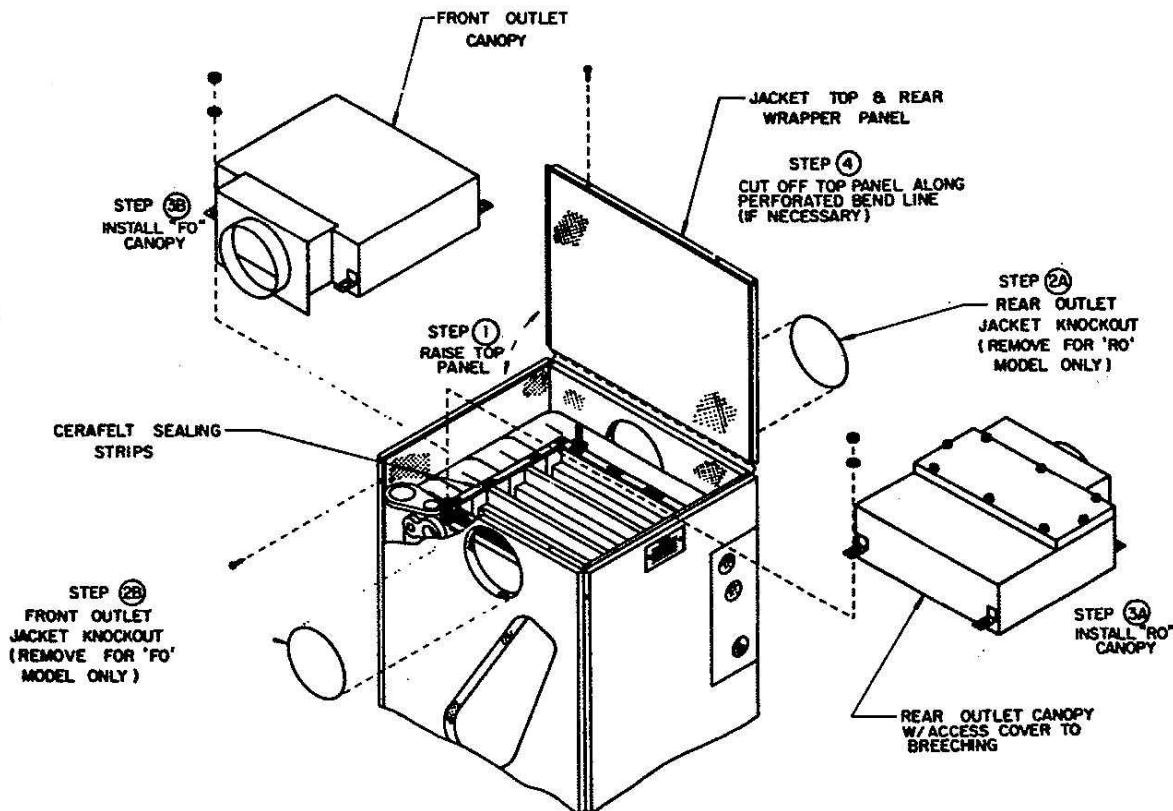


Figure 3: Installation of Canopy (See text for proper procedure)



### III: INSTALLATION INSTRUCTIONS (continued)

3. Check that cerafelt gasket is in place on top of the cast iron block.
4. Using screwdriver and pliers, remove the 6½" knock out from the rear panel, AS SHOWN IN Figure 3, Step 2.
5. Insert the canopy onto the top of the block and fasten with the four (4) bolts and nuts provided as shown in Figure 3, Step 3. Be sure that the canopy tightens evenly onto the cerafelt gasket.

**⚠ WARNING** DO NOT assemble canopy without cerafelt gaskets between canopy and heat exchanger.

NOTE: The Rear Outlet Canopy is provided with a removable cover for inspection and cleaning of the chimney breeching, as necessary in confined installations.

6. Before replacing jacket top panel, determine if future access to the chimney breeching through the canopy opening is anticipated. If so, cut along perforated bend line to separate jacket top panel from the rear panel as shown in Figure 3, Step 4. Close or replace top panel and secure with sheet metal screws removed in Step 2 above.

#### F. INSTALL LIMIT RATED TEMPERATURE SENSOR

1. **Locate Limit Sensor and Hardware Envelope** packed in Miscellaneous Parts Carton.
2. Insert the Limit Sensor into Immersion Well until it rests against the bottom of the well as shown in Figure 4.

**⚠ WARNING** Failure to properly install Limit Sensor may result in property damage, personal injury or loss of life due to elevated operating temperatures and/or pressures.

3. Securing Limit Sensor, see Figure 5.

**Step a.** Bend the Limit Sensor lead wires over front edge of Immersion Well making sure

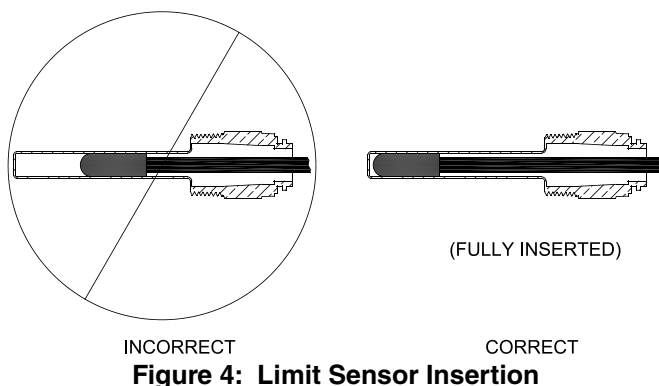


Figure 4: Limit Sensor Insertion

that sensor is still fully seated.

**Step b.** Position Limit Sensor clip as shown in Figure 5. Engage the hook end of the clip over the lead wires upstream of the Immersion Well.

**Step c.** While sliding clip toward Immersion Well, engage retaining ring end of sensor clip into locking groove on Immersion Well until it snaps into place around collar.

4. Slide rubber grommet to within 12" of connector end of Limit Sensor wire if it is not already there.

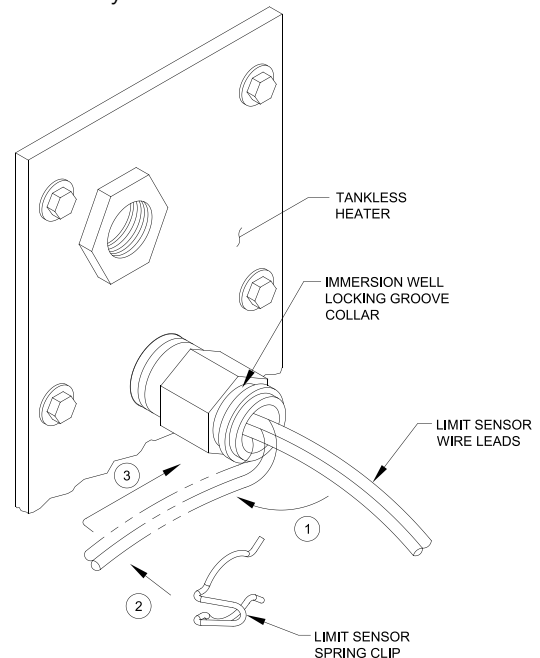


Figure 5: Securing Limit Sensor

5. Use (3) 1/4" cable clamps and (3) #8 x 1/2 sheet metal screws to secure Limit Sensor lead wires using pre-punched holes in side panel and jacket front panel as shown in Figure 1.
6. Remove top right knockout on boiler control as shown in Figure 1. Insert connector end of Limit Sensor through knockout. Remove all slack from lead wires and slide rubber grommet along wires until fully seated into control knockout.
7. Carefully connect sensor into the L7224 Boiler Control circuit board by pressing connector on sensor unit into mating connector on circuit board (refer to Figure 22).

#### G. CONNECT SUPPLY AND RETURN PIPING TO HEATING SYSTEM.

CLEARANCES - Hot water pipes shall have clearances of at least ½" from all combustible construction.

### III: INSTALLATION INSTRUCTIONS (continued)

1. For Forced Circulation HOT WATER HEATING, refer to Figure 6 for recommended boiler piping. Consult I=B=R, "Residential Hydronic Heating Installation and Design Guide".
2. Plug lower rear 1½" tapping if it is not to be used.
3. Install relief valve and fittings in top of front section, see Figure 1.
4. Install drain valve and return piping in lower front 1-1/2" return tapping. If using return side circulator, mount circulator on 18" return piping nipple provided, otherwise mount circulator in supply side piping, see Figure 1 and Figure 6.

#### CAUTION: OXYGEN CORROSION

Oxygen contamination of the boiler water will cause corrosion of the iron and steel boiler components, which can lead to failure. As such, any system must be designed to prevent oxygen absorption in the first place or prevent it from reaching the boiler. Problems caused by oxygen contamination of boiler water are not covered by U.S. Boiler Company's standard warranty.

There are many possible causes of oxygen contamination such as:

- a. Addition of excessive make-up water as a result of system leaks.
- b. Absorption through open tanks and fittings.
- c. Oxygen permeable materials in the distribution system.

In order to insure long product life, oxygen sources should be eliminated. This can be accomplished by taking the following measures:

- a. Repairing system leaks to eliminate the need for addition of make-up water.
  - b. Eliminating open tanks from the system.
  - c. Eliminating and/or repairing fittings which allow oxygen absorption.
  - d. Use of non-permeable materials in the distribution system.
  - e. Isolating the boiler from the system water by installing a heat exchanger.
5. If the boiler is to be operated in a system which has a large volume or excessive radiation where low boiler water temperatures may be encountered (i.e. converted gravity circulation system, etc.) the use of a boiler water bypass is recommended to maintain optimum operation.

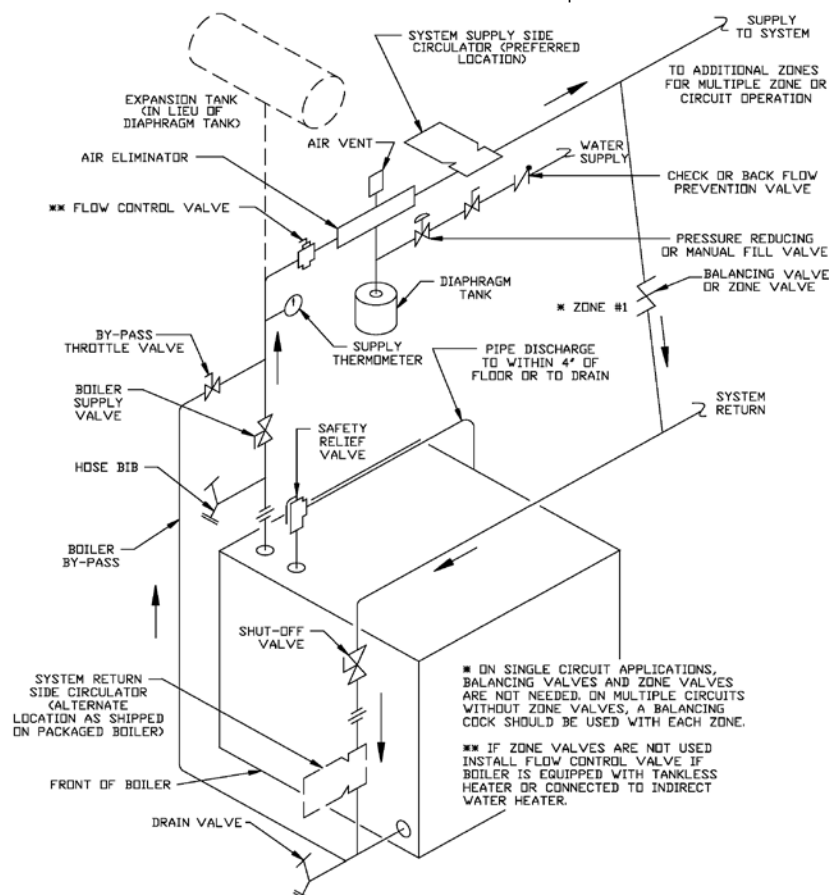
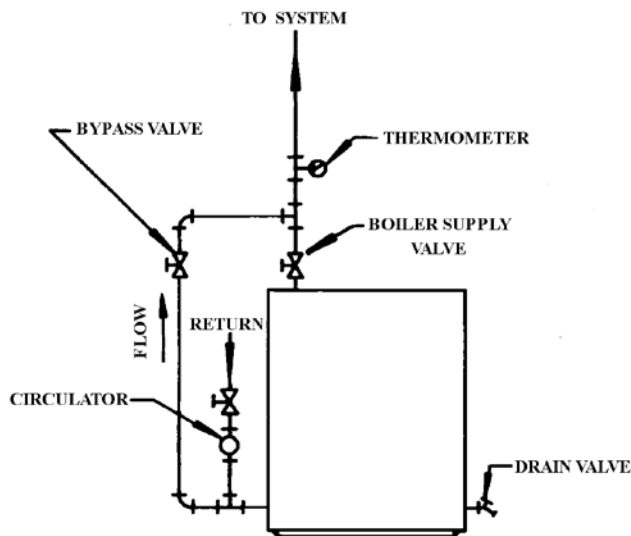


Figure 6: Recommended Water Piping for Zone Valve Zoned Heating Systems

### III: INSTALLATION INSTRUCTIONS (continued)



**Figure 7: Recommended Bypass Piping for V1 RO/FO**

Remove the circulator and install a pipe tee between the circulator and boiler return along with a second tee in the supply piping as shown in Figure 7. The bypass should be the same size as the supply and return lines with valves located in the bypass and supply outlet as illustrated in Figure 7 in order to regulate water flow to maintain higher boiler water temperatures.

Set the by-pass and boiler supply valves to a half throttle position to start. Operate boiler until the system water temperature is at a normal operating range.

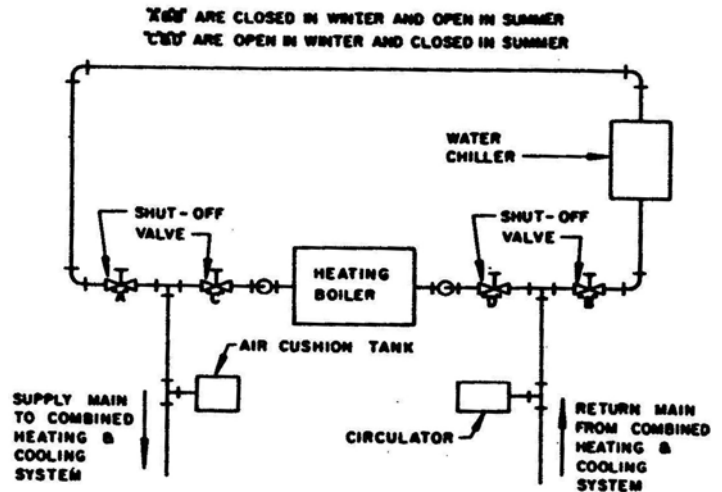
Adjust the valves to provide 180° to 200°F supply water temperature. Opening the boiler supply valve will raise the system temperature, while opening the by-pass valve will lower the system supply temperature.

6. If this boiler is used in connection with refrigeration systems, the boiler must be installed so that the chilled medium is piped in parallel with the heating boiler using appropriate valves to prevent the chilled medium from entering the boiler, see Figure 8. Also consult I=B=R, "Residential Hydronic Heating Installation and Design Guide".
7. If this boiler is connected to heating coils located in air handling units where they may be exposed to refrigerated air the boiler piping must be equipped with flow control valves to prevent gravity circulation of boiler water during the operation of the cooling system.

#### IMPORTANT

8. A hot water boiler installed above radiation level must be provided with a low water cutoff device as part of the installation.

If a low water cut-off is required, it must be



**Figure 8: Recommended Piping for Combination Heating & Cooling (Refrigeration) System**

mounted in the system piping above the boiler. The minimum safe water level of a hot water boiler is just above the highest water containing cavity of the boiler; that is, a hot water boiler must be full of water to operate safely. Refer to Appendix "A" at the rear of this manual.

9. If it is required to perform a long term pressure test of the hydronic system, the boiler should first be isolated to avoid a pressure loss due to the escape of air trapped in the boiler.

To perform a long term pressure test including the boiler, ALL trapped air must first be removed from the boiler.

**WARNING** Assure that there is not air left inside boiler when checking for leaks. DO NOT test for leaks with pressurized air.

A loss of pressure during such a test, with no visible water leakage, is an indication that the boiler contained trapped air.

#### H. CONNECT TANKLESS HEATER PIPING AS SHOWN IN Figure 9. See Table 2 for Tankless Heater Ratings.

THE FOLLOWING GUIDELINES SHOULD BE FOLLOWED WHEN PIPING THE TANKLESS HEATER:

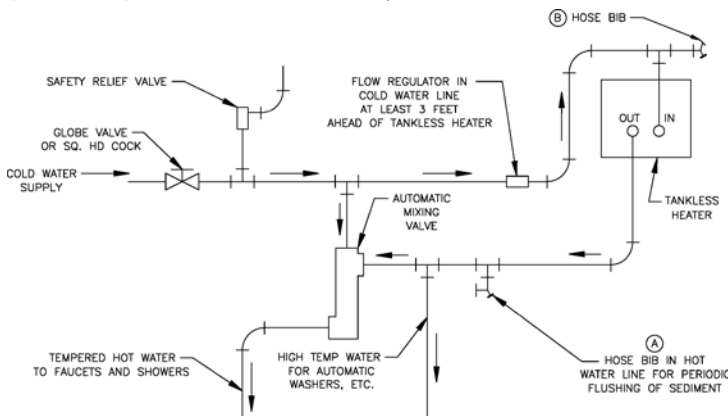
1. FLOW REGULATION - If flow through the heater is greater than its rating, the supply of adequate hot water may not be able to keep up with the demand. For this reason a flow regulator matching the heater rating should be installed in the cold water line to the heater. The flow regulator should preferably be located below the inlet to the heater and a minimum of 3' away from the inlet so that the regulator is not subjected to excess temperatures that may occur during "off" periods when it is possible for heat to be conducted back

### III: INSTALLATION INSTRUCTIONS (continued)

**Table 2: Tankless Heater Data**

Boiler Model	Heater No.	Heater Rating (GPM)	Pressure Drop Thru Heater (PSI)
V13A RO/FO	V1-2	3¼	5.6

**NOTE:** Tankless heater ratings in the V1 RO/FO oil boilers are based on intermittent draw, temperature rise of 100°F (40-140°F) and boiler water temperature of 200°F.



**Figure 9: Schematic Tankless Heater Piping**

through the supply line. The flow regulator also limits the flow of supply water regardless of inlet pressure variations in the range of 20 to 125 psi.

**⚠ WARNING** Install automatic mixing valve at tankless heater outlet to avoid risk of burns or scalding due to excessively hot water at fixtures. Adjust and maintain the mixing valve in accordance with the manufacturer's instructions.

2. **TEMPERING OF HOT WATER** - Installation of an automatic mixing valve will lengthen the delivery of the available hot water by mixing some cold water with the hot. This prevents excessive and possibly scalding hot water at the fixtures. In addition, savings of hot water will be achieved since the user will not waste as much hot water while seeking water temperature to his liking. Higher temperature hot water required by dishwashers and automatic washers is possible by piping the hot water from the heater prior to entering the mixing valve. The mixing valve should be "trapped" by installing it below the cold water inlet to heater to prevent lime formation in the valve.
3. **FLUSHING OF HEATER** - All water contains some sediment which settles on the inside of the coil. Consequently, the heater should be periodically backwashed. This is accomplished by installing hose bibs as illustrated in Figure 9 and allowing

water at city pressure to run into hose bib A, through the heater, and out hose bib B until the discharge is clear. The tees in which the hose bibs are located should be the same size as heater connections to minimize pressure drop.

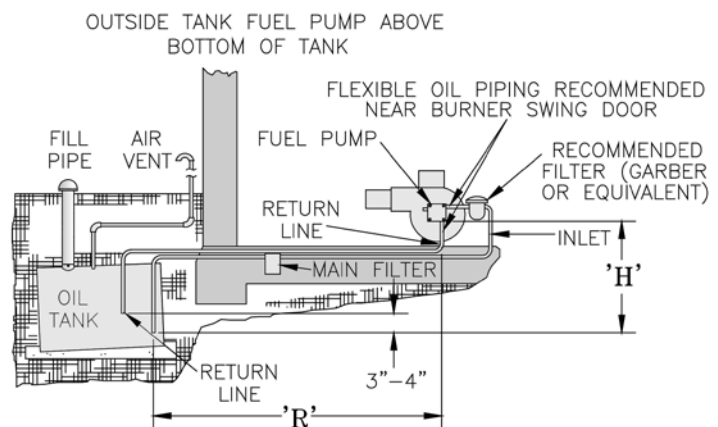
4. **HARD WATER** - This applicable to some city water and particularly to well water. This should not be a deterrent but precautions are necessary. A water analysis is necessary and an appropriate water softener installed. This is not only beneficial to the heater but to piping and fixtures plus the many other benefits derived from soft water.

- I. **CONNECT OIL LINES** - do not use compression fittings. Use only flare fitting. Note that the pump supplied on the V1 RO/FO is TWO-STAGE and is set up for TWO-PIPE operation, see Figure 10. Refer to Table 3 for recommended maximum lengths to be used.

**Table 3: Two-Pipe Systems - Two Stage Pump**

Lift "L" (feet)	Length of Tubing* (feet)	
	Two-Stage Units	
	3/8" OD	1/2" OD
0	68	100
2	63	100
4	58	100
6	53	100
8	48	100
10	42	100
12	37	100
14	32	100
16	27	100
18	22	88

\* Line lengths include *both* vertical and horizontal lengths.



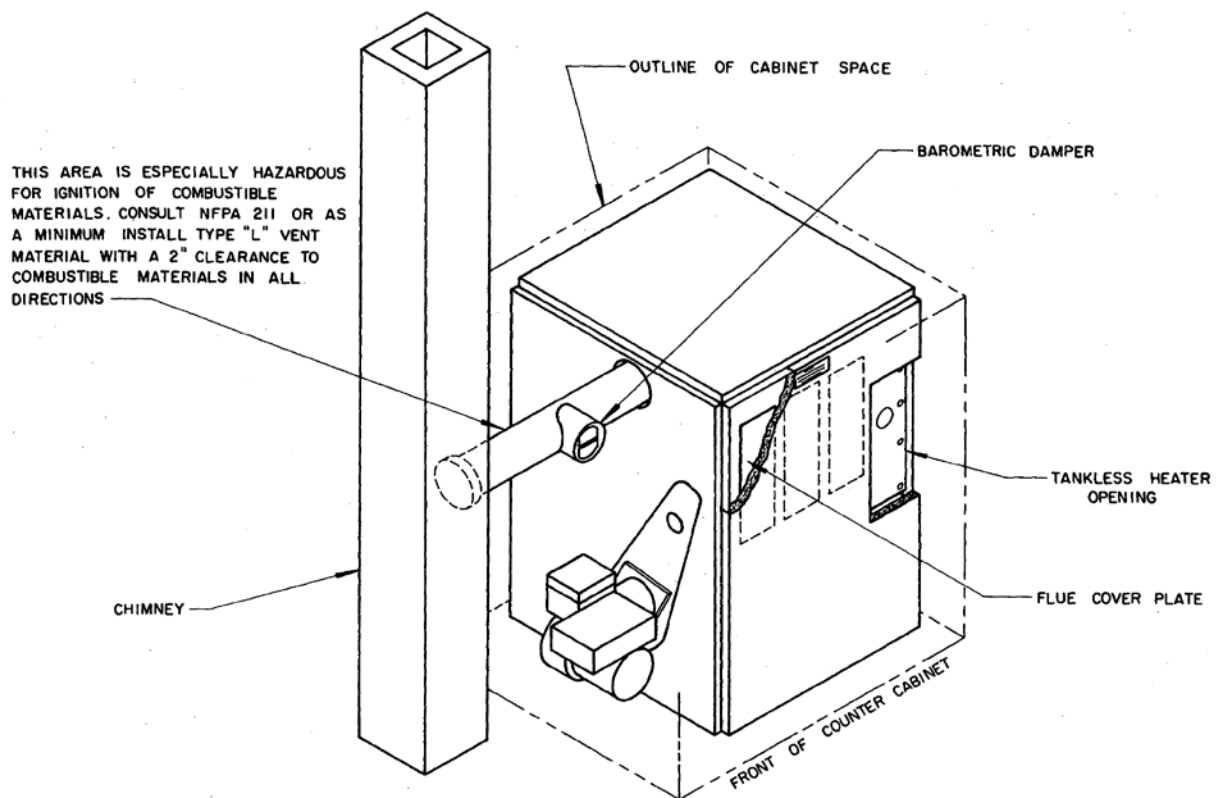
**Figure 10: Two-Pipe Installation**

## IV: VENTING (NATURAL VENT - CHIMNEY)

- J. INSTALL BREECHING.** For normal installation in a large confined space refer to local codes for proper selection of the breeching materials.

For installation in a confined space such as an under-counter installation, special consideration must be given to the selection of breeching material. The temperature within the confined space will be higher than in the normal installation. One major source of those higher temperature is the exposed breeching within the confined space. Thus, it is required that any exposed breeching be constructed of type "L" are equivalent vent material.

Furthermore, the likelihood of accidental ignition of combustibles within 12" of the breeching is increased when the boiler is installed in a confined space. This is due to the lack of free air movement over the surfaces to cool them. For this reason THE ENTIRE LENGTH OF BREECHING FROM THE OUTLET OF THE BOILER TO THE CHIMNEY MUST BE INSTALLED ACCORDING TO NFPA 211, OR LOCAL CODES. Refer to Figures 11, 12 and 13.

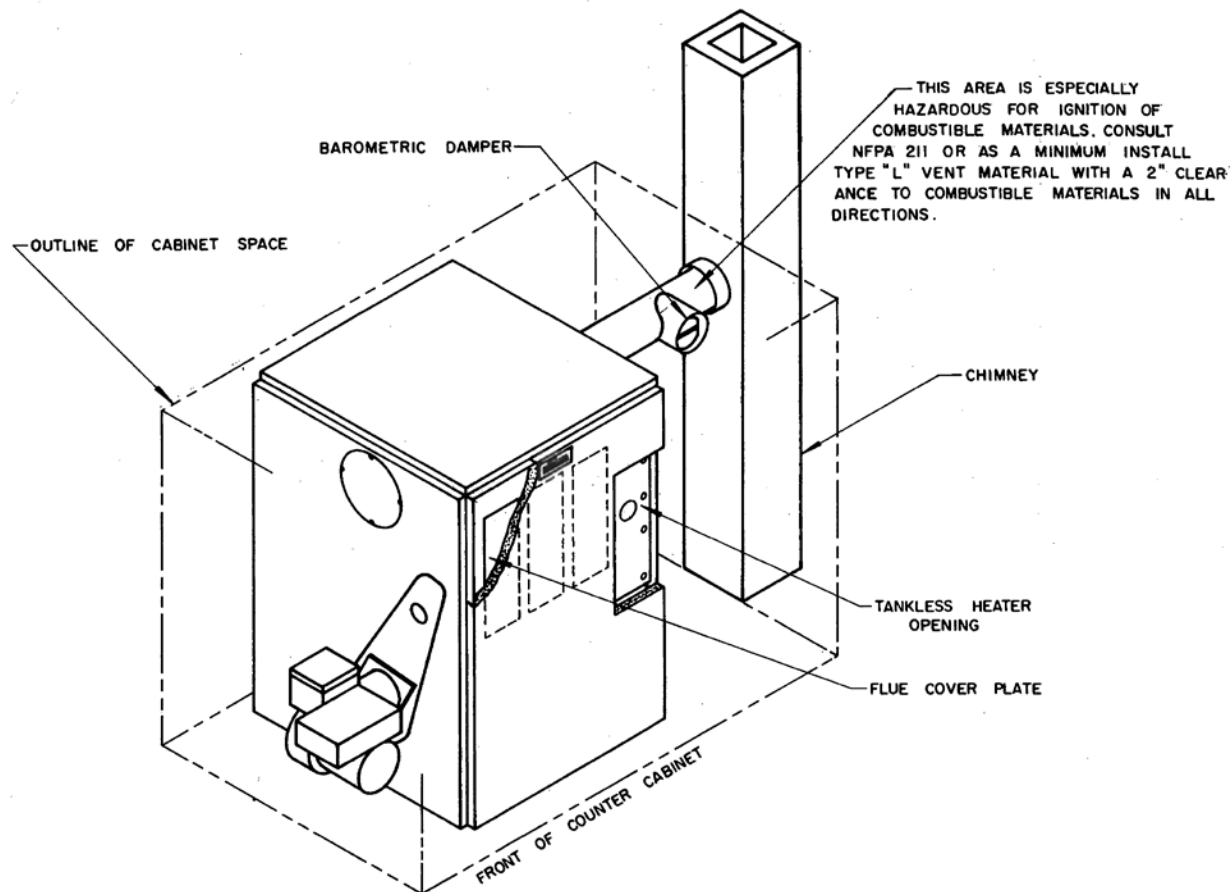


**Figure 11: Installation of FO in a Confined Space with Adjacent Chimney**

NOTE:

1. Type L Vent Material generally means stainless steel inner liner and stainless steel outer covering and separated with 1" thick special high temperature insulation - factory assembled and rated.
2. In a confined space, provide ventilation air to the burner and size such ventilation air openings to provide not less than 28 square inches free area per gallon of fuel input to the burner.
3. Keep right side of boiler accessible for flue cleanout and tankless coil maintenance.
4. Boiler is heavily insulated and is suitable for 1" clearance from jacket surface to combustibles.
5. Boiler is of wet base design and suitable for installation on combustible floors.
6. The original installation may have been under poor or outdated building codes. Replacement boilers are subject to codes in effect at the time of replacement. Be sure to consult with local code officials before starting replacement.

## IV: VENTING (NATURAL VENT - CHIMNEY) (continued)

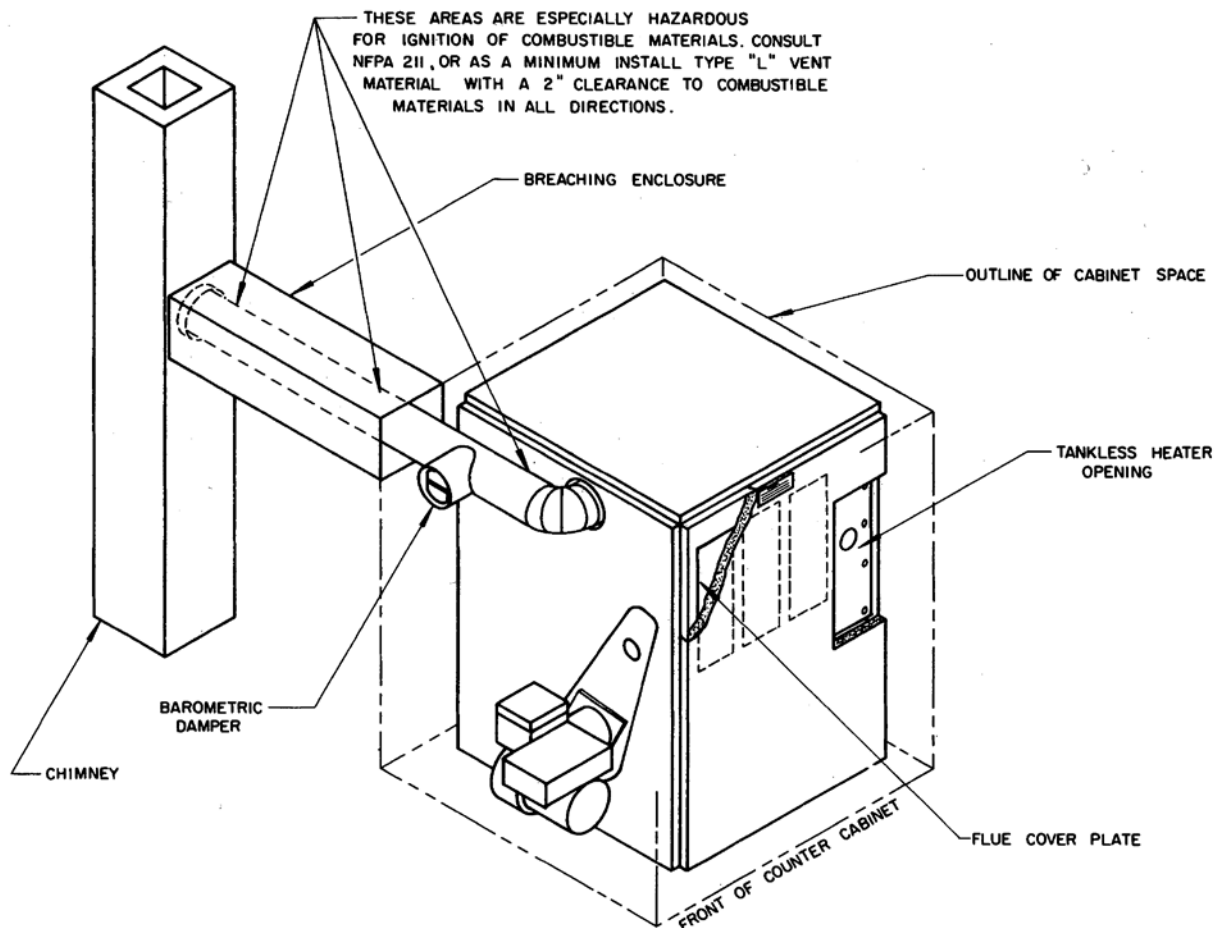


**Figure 12: Installation of RO in a Confined Space with Adjacent Chimney**

**NOTE:**

1. Type L Vent Material generally means stainless steel inner liner and stainless steel outer covering and separated with 1" thick special high temperature insulation - factory assembled and rated.
2. In a confined space, provide ventilation air to the burner and size such ventilation air openings to provide not less than 28 square inches free area per gallon of fuel input to the burner.
3. Keep right side of boiler accessible for flue cleanout and tankless coil maintenance.
4. Boiler is heavily insulated and is suitable for 1" clearance from jacket surface to combustibles.
5. Boiler is of wet base design and suitable for installation on combustible floors.
6. The original installation may have been under poor or outdated building codes. Replacement boilers are subject to codes in effect at the time of replacement. Be sure to consult with local code officials before starting replacement.

## IV: VENTING (NATURAL VENT - CHIMNEY) (continued)



**Figure 13: Installation of FO in a Confined Space with Remote Chimney**

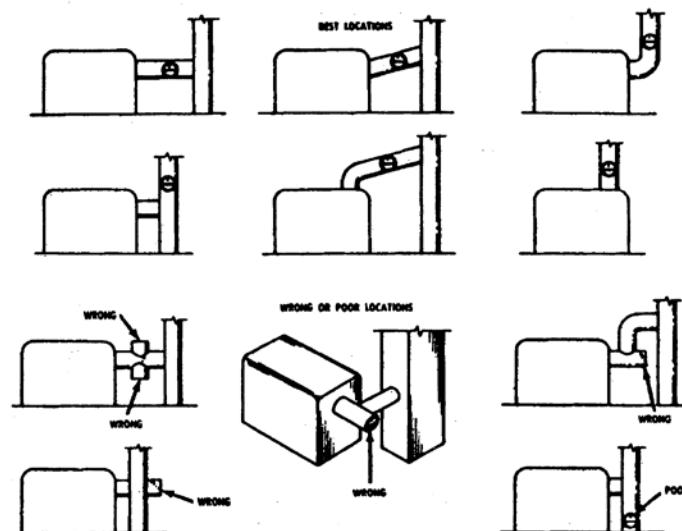
**NOTE:**

1. Type L Vent Material generally means stainless steel inner liner and stainless steel outer covering and separated with 1" thick special high temperature insulation - factory assembled and rated.
2. In a confined space, provide ventilation air to the burner and size such ventilation air openings to provide not less than 28 square inches free area per gallon of fuel input to the burner.
3. Keep right side of boiler accessible for flue cleanout and tankless coil maintenance.
4. Boiler is heavily insulated and is suitable for 1" clearance from jacket surface to combustibles.
5. Boiler is of wet base design and suitable for installation on combustible floors.
6. The original installation may have been under poor or outdated building codes. Replacement boilers are subject to codes in effect at the time of replacement. Be sure to consult with local code officials before starting replacement.
7. Copies of NFPA 211 are available from National Fire Protection Association, Battery March Park, Quincy, MA 02269 or at your local fire code officers office.

## IV: VENTING (NATURAL VENT - CHIMNEY) (continued)

1. INSTALL DRAFT REGULATOR following instructions furnished with Regulator. See Figure 14.
2. Consider the chimney overall. Chimneys that have a high heat loss may become less suitable as the heat loss of the home goes down and the efficiency of the boiler installed goes up. Most homes have a chimney appropriate for the fuel and the era in which the home was built. That may have been a coal fired or an inefficient oil fired boiler built into a home without insulation or storm windows. With increasing fuel prices that home probably has been insulated and fitted with storm windows so that the heat loss of the home has been reduced. This requires less fuel to be burned and sends less heat up the chimney.

A new boiler probably has a higher efficiency than the boiler being replaced. That probably means that the stack temperature from the new boiler will be lower than that from the old boiler and with less room air being drawn up the chimney to dilute the stack gases. The combination of a large uninsulated chimney, reduced firing rate, reduced firing time, lower stack temperature and less dilution air can, in some cases, contribute to the condensing of small amounts of water vapor in the chimney. Such condensation, when it occurs, can cause chimney deterioration. In extreme cases,



**Figure 14: Proper and Improper Locations of Draft Regulator**

condensed water may be visible on the outside of the breeching or chimney. In those extreme cases, the chimney may have to be lined to insulate the chimney and thus prevent the condensation. The addition of dilution air into the chimney may assist in drying the chimney interior surfaces.

3. For the same reasons as in (b) above, heat extractors mounted into the breeching are not recommended.



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## V: ELECTRICAL

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**DANGER** Positively assure all electrical connections are unpowered before attempting installation or service of electrical components or connections of the boiler or building. Lock out all electrical boxes with padlock once power is turned off.



**WARNING** Failure to properly wire electrical connections to the boiler may result in serious physical harm.

- Electrical power may be from more than one source. Make sure all power is off before attempting any electrical work.
- Each boiler must be protected with a properly sized fused disconnect.
- Never jump out or make inoperative any safety or operating controls.
- The wiring diagrams contained in this manual are for reference purposes only. Refer to the wiring diagram of any controls used with the boiler. Read, understand and follow all wiring instructions supplied with the controls.

### A. GENERAL

1. Install wiring and electrically ground boiler in accordance with requirements of the authority having jurisdiction, or in absence of such requirements the National Electrical Code, ANSI/NFPA 70, and/or the CSA C22.1 Electric Code.
2. A separate electrical circuit must be run from the main electrical service with an over-current device/disconnect in the circuit. A service switch is recommended and may be required by some local jurisdictions.
3. Wiring should conform to Figures 15 and 16.

### B. SYSTEM CONTROLS AND WIRING

1. Refer to National Electric Code or Local Electric Codes for proper size and type of wire required. Follow Code.
2. Use anti-short bushings on all wiring passing through boiler jacket, junction boxes and/or control boxes.
3. Use armored cable (BX) over all exposed line voltage wiring.
4. If an indirect water heater is used, use priority zoning. **DO NOT** use priority zoning for Hydro-Air Systems.
5. Single/Multiple Zone System – Refer to Figure 15 for the electrical diagram for this type of system. Connect the system circulator wire leads to the proper terminal on the L7224 Aquastat control as shown in Figure 15.

- C. INSTALL A ROOM THERMOSTAT on an inside wall about four feet above floor. Never install thermostat on an outside wall or where it will be influenced by drafts, hot or cold water pipes, lighting fixtures, television, rays of the sun or near a fireplace. Keep large furniture away from thermostat so there will be free movement of room air around this control.

Connect the thermostat to the 'T-T' terminals on the L7224 control.

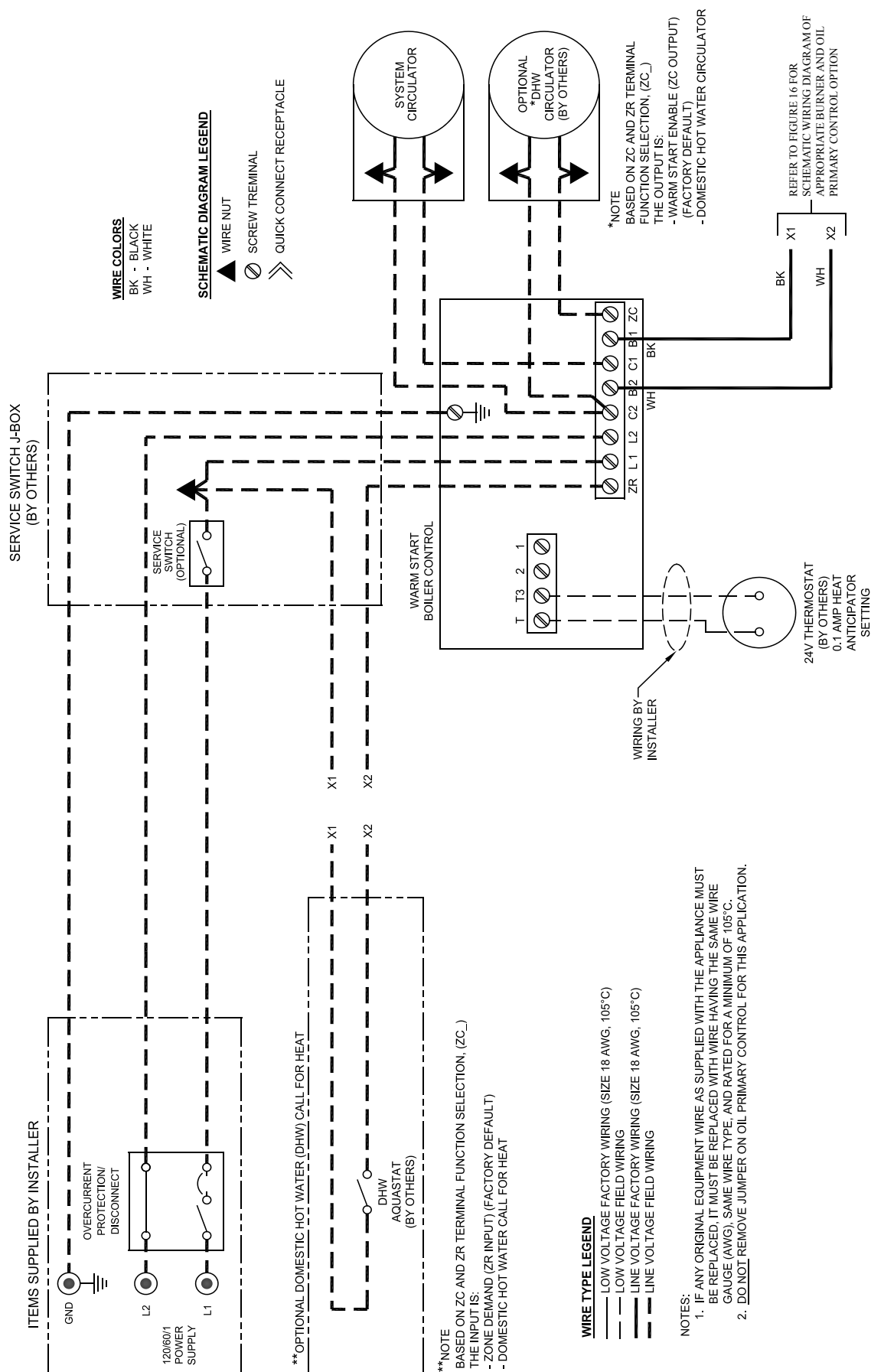
Heat Anticipator in Thermostat should be set to .1 amps.

If system tends to overheat above the thermostat's temperature setting, reduce heat anticipator setting by .1 or .2 amps. If system tends to short cycle without reaching desired room temperature, increase heat anticipator setting by .1 or .2 amps.



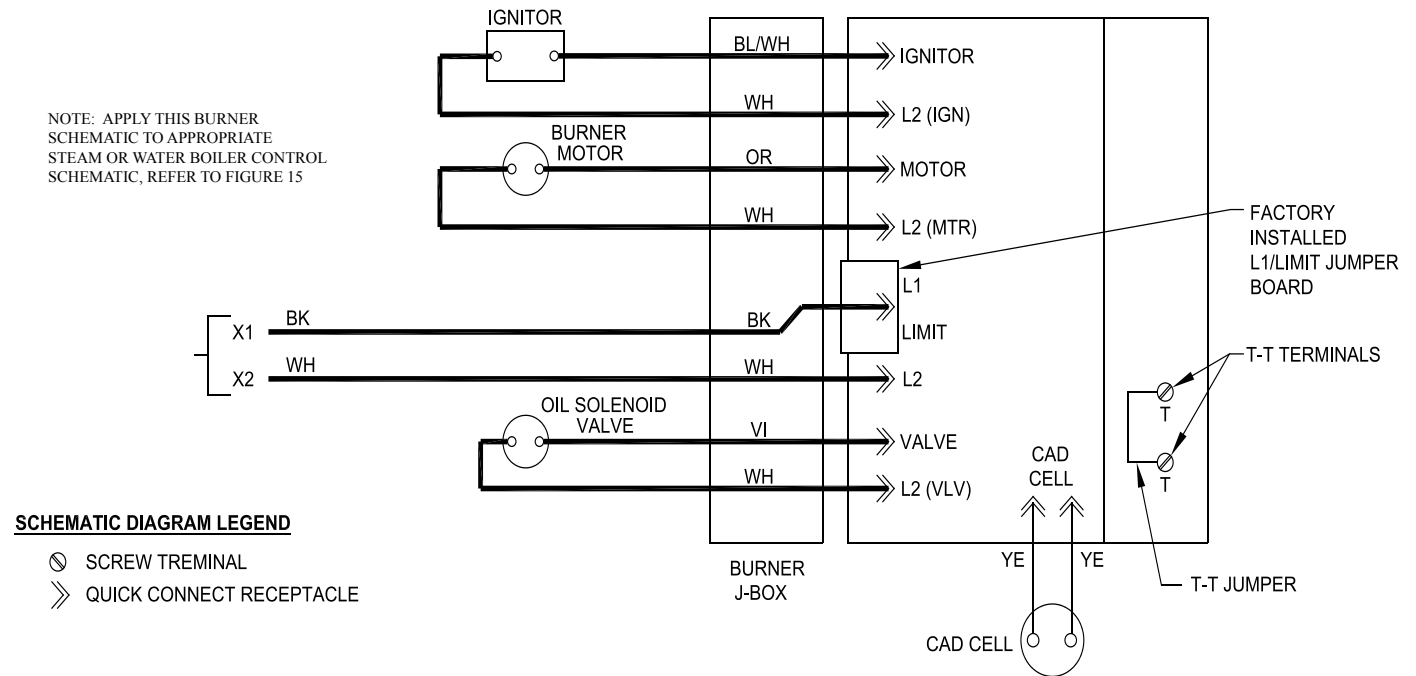
**WARNING** The maximum allowable current for each circulator is 5 amps at 120V AC. For circulators with higher amp ratings, you must install a circulator relay or starter coil to provide line voltage to the circulator and connect only the relay or starter coil to boiler terminals. The combined boiler and circulator amperage must not exceed 15 amps.

Install over-current protection in accordance with authority having jurisdiction or, in the absence of such requirements, follow the National Electric Code, NFPA 70, and/or CSA C22.1 Electrical Code. **DO NOT** provide over-current protection greater than 15 amperes.



**Figure 15: Schematic Wiring Diagram, with Tankless Heater, Warm Start Control (Beckett Burner)**

## V: ELECTRICAL (continued)



**WIRE COLORS**

- BK - BLACK
- BL/WH - BLUE W/ WHITE TRACER
- WH - WHITE
- VI - VIOLET
- YE - YELLOW
- OR - ORANGE
- RD - RED

### WIRE TYPE LEGEND

- LOW VOLTAGE FACTORY WIRING (SIZE 18 AWG, 105°C)
- LOW VOLTAGE FIELD WIRING
- LINE VOLTAGE FACTORY WIRING (SIZE 18 AWG, 105°C)
- LINE VOLTAGE FIELD WIRING

### NOTES:

1. IF ANY ORIGINAL EQUIPMENT WIRE AS SUPPLIED WITH THE APPLIANCE MUST BE REPLACED, IT MUST BE REPLACED WITH WIRE HAVING THE SAME WIRE GAUGE (AWG), SAME WIRE TYPE, AND RATED FOR A MINIMUM OF 105°C.

**Figure 16: Schematic Wiring Diagrams For Beckett GeniSys Oil Primary Control**


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## VI: SYSTEM START-UP

---

### A. ALWAYS INSPECT INSTALLATION BEFORE STARTING BURNER.

1. Verify that the venting, water piping, oil piping, and electrical system are installed properly. Refer to Installation Instructions contained in this manual.
2. Confirm all electrical, water and oil supplies are turned off at the source and that the vent is clear from obstructions.

 **WARNING** Completely read, understand and follow all instructions in this manual before attempting start up.

### B. FILL HEATING SYSTEM WITH WATER.

**NOTICE** It is important to properly remove the oil and dirt from the system. Failure to clean the system can result in clogged air vents, circulator damage and seized zone valves.


CLEAN HEATING SYSTEM if boiler water is dirty.

Refer to Maintenance and Service Instructions Section of this manual for proper cleaning instructions for water boilers.

1. HOT WATER BOILERS. Fill entire heating system with water and vent air from system. Use the following procedure on a series loop or multi-zoned system installed as per Figure 6 to remove air from system when filling:
  - a. Close full port ball valve in boiler system piping.
  - b. Isolate all zones by closing zone valves or shut-off valves in supply and return of each zone(s).
  - c. Attach a hose to vertical purge valve in boiler system supply piping up stream from the full port ball valve.  
(Note - Terminate hose in five gallon bucket at a suitable floor drain or outdoor area).
  - d. Starting with one zone at a time, open zone valve or shut-off valve in boiler supply and return piping.
  - e. Open purge valve.
  - f. Open shut-off valve in cold water supply piping located between the air scoop and expansion tank.
  - g. Allow water to overflow from bucket until discharge from hose is bubble free for 30 seconds.
  - h. When zone valve is completely purged of

air, close zone valve or shut-off valve. Open zone valve to the next zone to be purged. Repeat this step until all zones have been purged. At completion, open all zone valves.

- i. Close purge valve, continue filling the system until the pressure gauge reads 12 psi. Close shut-off valve in cold water supply piping.

 **WARNING** The maximum operating pressure of this boiler is posted on the Rating Label located on the front of the boiler. Never exceed this pressure. Do not plug relief valve.

**NOTICE** If make-up water line is equipped with pressure reducing valve, system will automatically fill to 12 psi. Follow fill valve manufacturer's instructions.

- j. Open full port ball valve in boiler system piping.
- k. Remove hose from purge valve.
- l. Confirm that the boiler and system have no water leaks.
- m. It may be necessary to clean the air vent assembly after a few days of operation.

### C. CHECK CONTROLS, WIRING AND BURNER

to be sure that all connections are tight and burner is rigid, that all electrical connections have been completed and fuses installed, and that oil tank is filled and oil lines have been tested.

### D. ADJUST CONTROL SETTINGS with burner service switch turned "ON".

1. SET ROOM THERMOSTAT about 10°F below room temperature.
2. PRESS RED RESET BUTTON on burner primary control, hold for one second and release to reset the control.
3. WATER BOILERS WITH TANKLESS HEATERS are equipped with a Warm Start Intelligent Oil Boiler Control (Warm Start Boiler Control). The Warm Start Boiler Control is factory programmed with a High Limit setpoint of 180°F. The High Limit setpoint is adjustable between 140°F and 240°F. High Limit Differential is factory programmed at 10°F. Additionally, the Warm Start Boiler Control is factory programmed with a Low Limit setpoint of 110°F. The Low Limit setpoint is adjustable between 110°F and 220°F. These temperatures may be varied to suit the installation requirements.

## VI: SYSTEM START-UP (continued)

### 4. CHECKOUT

Put the system into operation and observe at least one complete cycle to make sure that the controller operates properly. See Operating Section to use Boiler Control Display to assist in determining system operation.

### E. CHECK / ADJUST OIL BURNER BEFORE STARTING.

#### Natural Vent Applications:

1. CHECK BURNER SETTINGS and readjust if necessary, see Burner Specifications, Table 4. Turn off power to burner before proceeding.

#### 2. Beckett AFG Burner

This Beckett AFG Burner is equipped with a non-adjust MB(L1) Fixed Head.

- a. Remove Gun Assembly.
- b. Verify nozzle size, head size, gun setting, and positioning of electrodes. This information is shown in Figure 17 and Beckett AFG Burner Specifications, Table 4. Replace Gun Assembly.
- c. Inspect Beckett head setting. Even if factory set, verify that the "Z" dimension has not been changed. The important "Z" dimension is the distance from the leading edge of the head to the end of the air tube. This distance for L1 & L2 heads is 1-3/8" if the tube has a straight shroud or 1-3/4" if the air tube has a conic shroud.

- i. Disconnect the oil connector tube from the nozzle line. Loosen the splined nut and hex head screw securing the escutcheon plate to the burner housing.
- ii. Place the end of a ruler at the leading edge of the head and, using a straight edge across the end of the air tube, measure the distance to the end of the tube. Only readjust if necessary. To readjust, slide the nozzle line forward or back until the "Z" is correct.
- iii. Tighten the hex head screw to secure the escutcheon plate to the burner chassis. Then tighten the splined nut and attach the oil connector tube.
- d. Check burner air band and air shutter settings. Readjust if necessary, see Burner Specifications Table 4.
- e. OPEN ALL SHUT-OFF VALVES in the oil supply line to the burner.
- f. ATTACH A PLASTIC HOSE TO FUEL PUMP VENT/BLEED FITTING and place the other hose end into an empty container to catch the oil.
- g. SLIGHTLY OPEN FLAME OBSERVATION PORT COVER on burner swing door, enough to insert draft gauge probe later.

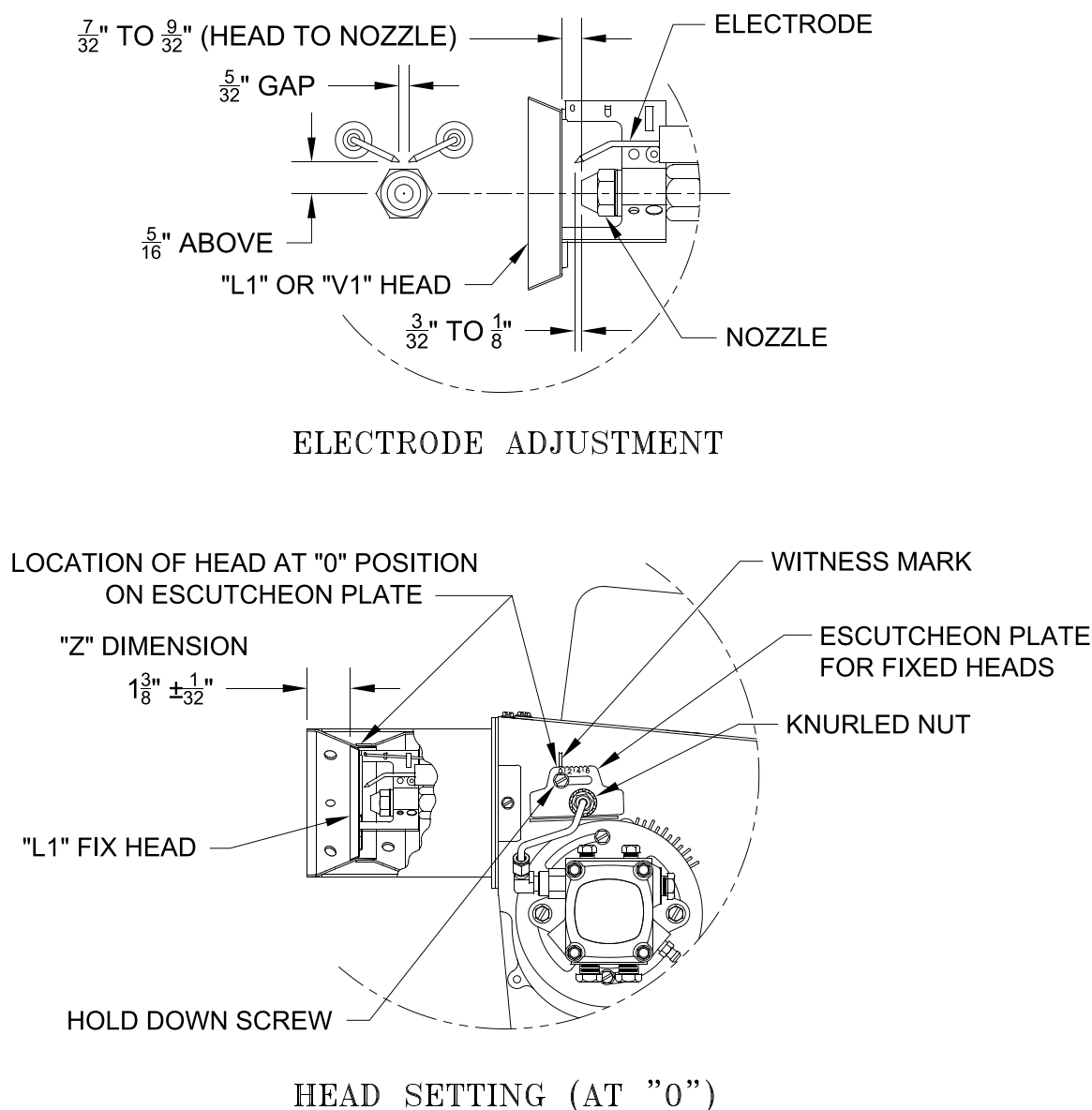
**Table 4: Beckett AFG Burner Specifications**

Boiler Model	Firing Rate (GPH)	Head	Static Disc	Nozzle				Setting			
				Manufacturer	GPH	Angle	Type	Air Shutter	Air Band	Head	Pump Pressure (PSIG)
V13 RO/FO	0.75*	MB(L1)	3-3/8U	Delavan	0.60	60°	W	7	0	Fixed	140

\* Low Firing Rate Baffle Installed

Settings are approximate and must be verified by Smoke and Carbon Dioxide measurement. Readjust where necessary.

## VI: SYSTEM START-UP (continued)



**Figure 17: "L1" Fixed Head Electrode Positioning and Gun Setting (Beckett AFG)**

### F. START OIL BURNER.

1. Open vent fitting on fuel pump.
2. PRESS RED RESET BUTTON on primary control, hold for one (1) second and release to reset primary control.
3. TURN 'ON' BURNER service switch and allow burner to run until oil flows from vent fitting in a SOLID stream without air bubbles for approximately 10 seconds.

**NOTE:** For Primary Control "Pump Priming Cycle" details, see Paragraph I, No. 2., Step a., Item ii.

4. Close vent fitting and burner flame should start immediately after prepurge is completed. Prepurge prevents burner flame until 15

seconds has elapsed after initial power is applied to burner. During prepurge the motor and igniter will operate but the oil valve will remain closed. Refer to Oil Primary Control Instructions for more details.

5. Adjust oil pressure.
  - a. When checking a fuel unit's operating pressure, a reliable pressure gauge may be installed in either the bleeder port or the nozzle port. For Beckett burner refer to Figure 18.
  - b. Locate oil pressure adjusting screw and turn screw to obtain proper pump pressure, refer to Table 4.

## VI: SYSTEM START-UP (continued)

- c. To check the cut-off pressure, deadhead a reliable pressure gauge onto the copper connector tube attached to the nozzle port. Run the burner for a short period of time. Shut the burner off. The pressure should drop and hold.
- d. Turn "OFF" the burner. Remove the pressure gauge and install port/bleeder plug and/or reconnect the nozzle port line and tighten. Start the burner again.

### G. ADJUST OIL BURNER WHILE OPERATING. (flame present)

1. ADJUST DRAFT REGULATOR for a draft of zero to maximum of  $-.03"$  (water gauge) in the breeching after chimney has reached operating temperature and while burner is running. Burner will operate with a positive draft over fire and zero draft in the breeching. Adjust Draft Regulator such that maximum draft of  $-.03"$  is reached in coldest weather.
2. READJUST THE AIR DAMPER SETTING (Air Band/Air Shutter/Air Gate) on burner for a light orange colored flame while the draft over the fire is  $-.02"$  water column (water gauge). Use a smoke tester and adjust air for minimum smoke (not to exceed #1) with a minimum of excess air. Make final check using suitable instrumentation to obtain a  $CO_2$  of 11.5 to 13.0% with draft of  $-.02"$  water column over the fire. These settings will assure a safe and efficient operating condition. If the flame appears stringy instead of a solid fire, try another nozzle of the same type. Flame should be solid and compact. After all adjustments

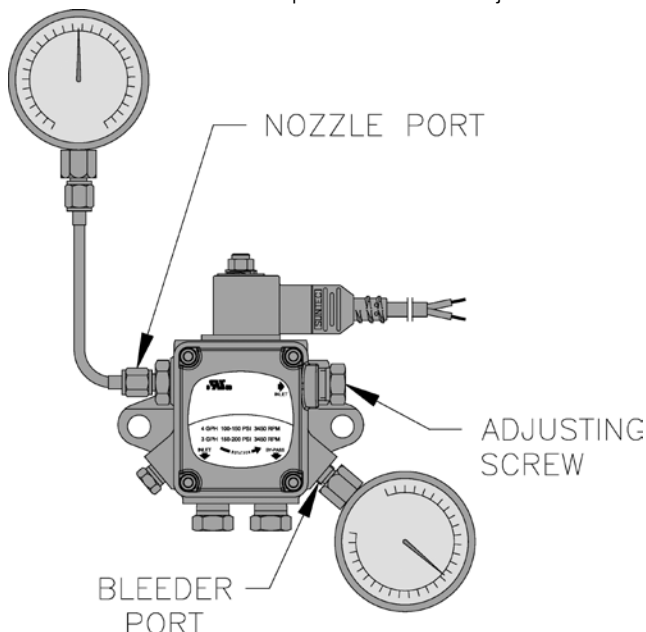


Figure 18: Adjusting Fuel Pump Pressure

are made recheck for a draft of  $-.02"$  water column over the fire.

**NOTE:** Paragraph G, Step 1 **MUST BE** repeated every time the Air Damper Setting is readjusted.

3. ONLY READJUST THE HEAD SETTING, if necessary.

### Beckett AFG Burners

- a. Beckett MB(L1) Head burner has a fixed head which is non-adjustable. Check "Z" Dimension as outlined in Paragraph 2, Step 2c of this section.

NOTE: Step outlined in Paragraph G, Steps 1 and 2 above **MUST BE** repeated every time the Head or air Damper Setting is readjusted.

**WARNING** DO NOT attempt to start the burner when excess oil has accumulated, when the boiler is full of vapor, or when the combustion chamber is very hot.

### 4. FLAME FAILURE

The V1 RO/FO boiler controls operate the burner automatically. If for unknown reasons the burner ceases to fire and the reset button on the primary control has tripped, the burner has experienced ignition failure. Refer to Oil Primary Control features, Paragraph I, Step 2 of this section and Section X, Troubleshooting, Paragraph B. If the failure re-occurs, call your heating contractor immediately before pressing the reset button.

**WARNING** DO NOT attempt to start the burner when excess oil has accumulated, when the boiler is full of vapor, or when the combustion chamber is very hot.

### 5. CAD CELL LOCATION AND SERVICE

The burner is supplied with a cadmium sulfide flame detector mounted at the factory, mounted on the bottom of the electronic ignitor. See Figure 19. To service cad cell or to replace the plug in portion, swing open the ignitor. After service is complete, be sure to fasten down the ignitor.

### H. CHECK FOR CLEAN CUT OFF OF BURNER.

1. AIR IN THE OIL LINE between fuel unit and nozzle will compress when burner is on and will expand when burner stops, causing oil to squirt from nozzle at low pressure as burner slows down and causing nozzle to drip after burner stops. Usually cycling the burner operation about 5 to 10 times will rid oil line of

## VI: SYSTEM START-UP (continued)

this air.

2. IF NOZZLE CONTINUES TO DRIP, repeat Paragraph H, Step 1 above. If this does not stop the dripping, remove cut-off valve and seat, and wipe both with a clean cloth until clean, then replace and readjust oil pressure. If dripping or after burn persist replace fuel pump.

### I. TEST CONTROLS.

1. Check thermostat operation. Raise and lower thermostat setting as required to start and stop burner.

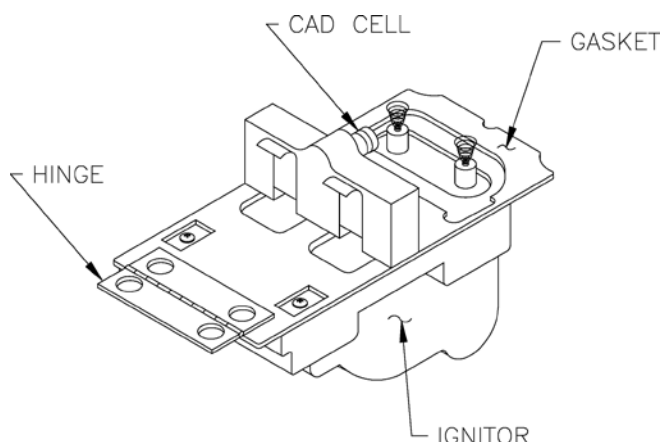


Figure 19 Cad Cell Location

**WARNING** Before installation of the boiler is considered complete, the operation of all boiler controls must be checked, particularly the primary control and high limit control.

### 2. VERIFY OIL PRIMARY CONTROL

**FEATURES** using procedures outlined in Instructions furnished with control or instructions as follows:

- a. **GeniSys 7505 Control Features**, see Figure 20.
  - i. The GeniSys 7505 is a microprocessor-based control. The indicator light provides diagnostic information for lockout, recycling and cad cell status. There is a manual reset button to exit the Lockout Mode.
  - ii. Pump Priming Cycle: To facilitate purging air from the oil lines and filters, the 7505 can be placed in a purge routine by:
    - After the burner starts, press and hold the reset button for 15 seconds until the yellow light turns on. This indicates that the button has been

held long enough.

- Release the reset button. The yellow light will turn off and the burner will start up again.
  - At burner start up, click the reset button while the igniter is still on. This will transition the control to a dedicated Pump Prime mode, during which the motor, igniter, and valve are powered for four (4) minutes. The yellow light will be on.
  - At the end of four (4) minutes, the yellow light will turn off and the control will automatically return to standby mode.
- iii. Limited Recycle: This feature limits the number of recycle trials (for each call for heat) to a maximum of three trials. If the flame is lost three times and does not successfully satisfy a call for heat, the 7505 locks out.
  - iv. Limited Reset (Restricted Mode): In order to limit the accumulation of unburned oil in the combustion area, the control can only be reset three times. The reset count returns to zero each time a call for heat is successfully completed.
  - v. T-T Jumper: Select models have pre-installed T-T jumper. **DO NOT** remove jumper.

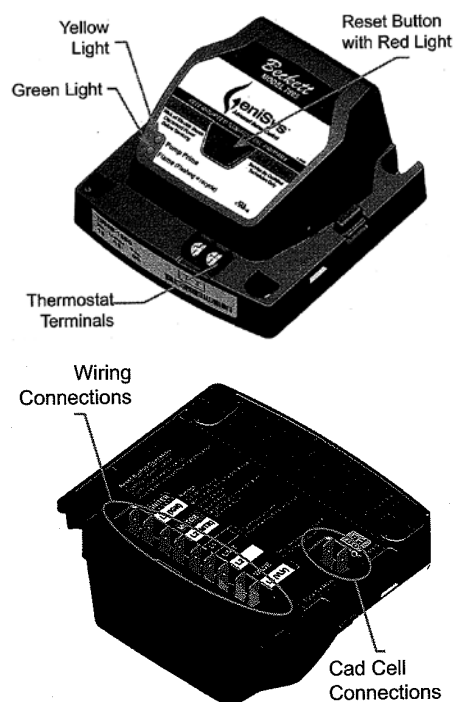


Figure 20: GeniSys 7505 Oil Primary Terminals, LED's and Reset Button



## VI: SYSTEM START-UP (continued)

**Note: DO NOT** remove "T-T" jumper unless wiring diagram indicates a direct connection from thermostat and/or tankless heater aquastat control to the oil burner primary control's "T-T" terminal. Refer to appropriate wiring diagram, see Figure 6.

- vi. Diagnostic LED: The indicator light on oil primary control provides lockout, recycle and cad cell indications as follows:
- Flashing at 1 Hz (½ second on, ½ second off): system is locked out or in Restricted Mode.
  - Flashing at ¼ Hz (2 seconds on, 2 seconds off): control is in Recycle Mode.
  - On: cad cell is sensing flame.
  - Off: cad cell is not sensing flame.
- vii. Cad Cell Resistance Check: For proper operation it is important that the cad cell resistance is below 1600 ohms. During a normal call for heat, the cad cell leads can be unplugged from the control and the resistance measured with a meter in the conventional way. Conduct these tests with flame present, see chart below.

Flame Detection Range
Normal (0 - 1600 ohms)
Limited (1600 ohms to lockout)

### 3. CHECK OIL PRIMARY CONTROL

**⚠ CAUTION** Due to the potential hazard of line voltage, only a trained, experienced service technician should perform the following safety checks.

**This control contains no field-serviceable parts. DO NOT attempt to take it apart. Replace entire control if operation is not as described.**

#### a. Preliminary Steps

- Check wiring connections and power supply.
- Make sure power is on to the controls.
- Make sure limit control is closed.
- Check contacts between ignitor and the electrodes.
- Check the oil pump pressure.
- Check the piping to the oil tank.
- Check the oil nozzle, oil supply and oil filter.

#### b. Check Safety Features

Safe Start:

- Place a jumper across cad cell terminals.
- Follow procedure to turn on burner. Burner must not start, indicator light turns on and control remains in Idle Mode.
- Remove jumper.

#### c. Simulate Ignition or Flame Failure:

- Follow procedure to turn on burner.
- Check cad cell resistance. If resistance is below 1600 OHMS and burner runs beyond safety cut-out time, cad cell is good.
- If safety switch shuts down burner and resistance is above 1600 OHMS, open line switch to boiler. Access cad cell under ignitor, clean face of cad cell and see that cell is securely in socket. Check gasket around perimeter of ignitor lid for proper seal. If gasket is missing or damaged, replace gasket. Room light can effect cad cell resistance. Reset safety switch.
- Close line switch to boiler. If burner starts and runs beyond safety switch cut-off time, cell is good. If not, install new cell.
- Close hand valve in oil supply line.
- Failure occurs, device enters Recycle Mode.
- Device tries to restart system after approximately 60 seconds.
- After third Recycle Mode trial, safety switch locks out within safety switch timing indicated on label and control enters Restricted Mode. Ignition and motor stop and oil valves closes.

- d. Power Failure Check: After Flame is established, turn the power off to the control/burner. The burner should shut down safely. When power is restored a normal ignition sequence should be started.

**⚠ WARNING** Cad Cell Jumper must be removed after this check.

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## VI: SYSTEM START-UP (continued)

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4. CHECK HIGH LIMIT
    - a. Adjust system thermostat(s) to highest setting.
    - b. Allow burner to run until boiler water temperature exceeds high limit setting. The burner should shut down and circulators continue running.
    - c. Allow the temperature to drop below control setting. The burner must restart.
    - d. Boiler installation is not considered complete until this check has been made.
  5. CHECK LOW WATER CUT-OFF CONTROL, if required on this boiler application. See Appendix "A" at the rear of this manual for 'How to Test'.
  6. CHECK OPERATING CONTROL on boiler applications equipped with tankless heater(s). With burner off, draw hot water until burner starts, then turn off hot water and check burner shut-down.
- J. IF CONTROLS MEET REQUIREMENT outlined in Paragraph I.
    1. Allow boiler to operate for approximately 30 minute, confirm the boiler and system have no leaks.
  - K. IF CONTROLS DO NOT MEET REQUIREMENTS outlined in Paragraphs I-1 thru I-6, replace control and repeat checkout procedures.

# VII: OPERATING

## A. WATER BOILERS SEQUENCE OF OPERATION

1. **Water Boilers with Tankless Heaters** (Warm Start), Sequence Of Operation:
  - a. The V1 RO/FO Boiler is equipped with a Warm Start Intelligent Oil Boiler Control (Warm Start Boiler Control). The Warm Start Boiler Control replaces the traditional high and low limit aquastat and circulator relays.
  - b. The boiler's sequence of operation is shown as Status Codes on Boiler Control display. See Table 5 and Figure 21.
  - c. When the thermostat calls for heat the boiler control starts the system circulator and the start sequence continues by energizing the oil primary to operate the following sequence: blower is started and operates for pre-purge time; spark is energized and fuel valve is opened for ignition trial time; burner fires until the thermostat is satisfied. Optionally, the thermal purge (circulator pre-purge time) maybe added adjusting the Circulator Pre-purge time parameter. This feature saves energy by starting the circulator and delaying the burner start

Table 5: Sequence of Operation

Status Codes Displayed in 5LR Mode		
5LR	Status	Description
I	Standby (burner off, pump off)	No call for heat detected
I	Standby (burner off, pump on)	Either condition is true: a. Call for heat detected and boiler temperature higher than operating setpoint. b. Call for heat detected and boiler temperature higher than 140 F and Pump Pre-Purge Time has not expired.
8	Running	The burner runs until the call for heat is satisfied.
I7	Self Test	Control internal checking

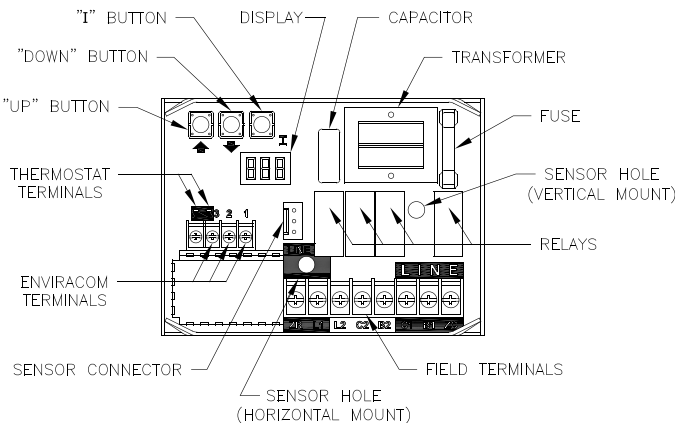


Figure 21: Intelligent Oil Boiler Control (Horizontal Mount Shown)

when there is residual heat available in the boiler

- d. If the thermostat is not satisfied and the Operating Setpoint (SP) is reached the system circulator will continue to operate and the burner will stop. When the boiler water temperature drops below the setpoint less the differential setting the burner will restart.
- e. After the thermostat is satisfied the burner and circulator are stopped.
- f. The Warm Start Boiler Control also includes a low limit control function. When the boiler water temperature falls below the Low Limit Setpoint less the Low Limit Differential the "ZC" terminal and System Circulator outputs are de-energized and the oil primary is energized to start the burner. As temperature rises above the Low Limit Setpoint the burner is stopped, the "ZC" output is energized and the System Circulator is enabled to run in response to a call for heat.
- g. On burner start, if the CAD cell does not see flame within approximately 15 seconds, primary control will shut down the burner and enter into a lockout mode. A lockout is reset by pressing the reset button located on the primary control. If the flame is lost while the burner is firing, the primary control shuts down the burner, enters a 60 second recycle delay, and repeats the ignition sequence. If after three (3) trials for ignition, flame is not detected, primary control will enter into restricted mode. Restricted mode is reset by holding down the reset button for 15 seconds.

## 2. Using Boiler Control

The Boiler Control is located on front of boiler. The Boiler Control display, along with Up ↑, Down ↓, and "I" keys may be used to view

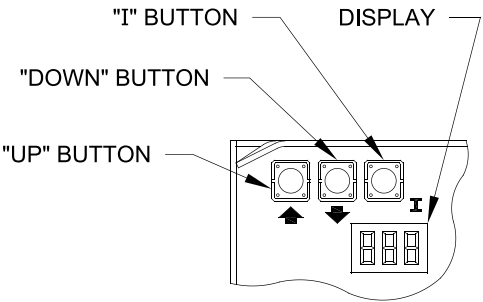


Figure 22: Boiler Control Key Function & Orientation

## VII: OPERATING (continued)

boiler operating status (Figure 22).

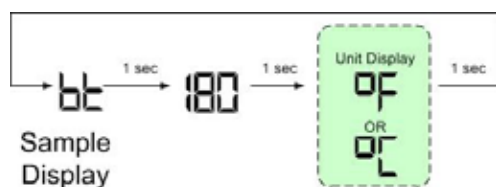
### 3. Viewing the Operating Mode Options

In operating mode the user may view (but not change) boiler operating status, settings and troubleshooting information. To view Boiler Control display information:

Press and release the “**T**” key on the Boiler Control to change from one parameter to the next. Each setting will alternately flash between the relevant display code and its corresponding value.

Operating Mode Options	
<b>StA</b>	Status Numbers: 1 Standby 8 Running 17 Self Test
<b>bE</b>	Boiler Temperature
<b>SP</b>	Operating Setpoint (Outdoor Reset)
<b>HL</b>	High Limit Setting
<b>HdF</b>	High Limit Differential
<b>LL</b>	Low Limit Setpoint (warm start only)
<b>LdF</b>	Low Limit Differential (warm start only)
<b>hr</b>	Heat Request Status
<b>dh</b>	DHW Request Status
<b>Err</b>	Boiler Error

For example, when the “**T**” key is pressed on the Boiler Control until “**bE**” is displayed, it will then flash a three digit number (such as “180”) followed by either “F” (or “C”). This indicates that the boiler water temperature is 180°F. Other operating parameters display the information in a similar fashion.



Please note that in operating mode to hold the display on the value the user can press and hold either the Up ↑ or Down ↓ keys and the value will be continuously shown. This may be helpful in watching a value “live”.

### 4. Changing the Adjustable Parameters

To adjust parameters such as the High Limit Setpoint and High Limit Differential:

- Using the Boiler Control display, access the adjustment mode by pressing and holding the Up ↑, Down ↓, and “**T**” keys simultaneously for three (3) seconds. This procedure is intended to discourage unauthorized changes or accidental

Warm Start Boiler Control Adjustment Mode Options		
<b>HL</b>	140-240°F	Adjust High Limit Setting
<b>LL</b>	110-220°F	Adjust Low Limit Setting
<b>LdF</b>	10-25°F	Adjust Low Limit Differential Setting
<b>ZC</b>	Zr or dh	ZC and ZR Terminal Function
<b>Or</b>	0-10 minutes	Pump Overrun Time
<b>PP</b>	0-20 minutes	Pump Pre-purge Time
<b>St</b>	140 - 180°F	Start Temperature
<b>Pt</b>	On or Off	Priority Time
<b>F-C</b>	F or C	Select degrees F or C Mode
<b>bAc</b>		Back to Operating Mode

changes to limit settings.

- Press the “**T**” key to display available Adjustment Mode options. Select an option.
- Press the Up ↑ and Down ↓ keys to adjust the displayed setpoint to the desired value.
- To return to the normal operating mode from the Adjustment Mode, when the “**bAc**” option is displayed, press either the Up ↑ or Down ↓ key. If no keys are pressed, after five (5) minutes the Boiler Control will automatically return to the Operating Mode.

### 5. More Information about Adjustable Parameters

#### a. High Limit (HL)

The Boiler Control is factory programmed with a High Limit Setpoint of 180°F. The boiler turns “off” when the boiler water temperature (**bE**) is above this value. The High Limit setpoint is adjustable between 140° and 240°F. The Operating Setpoint (**SP**) will equal the High Limit Setpoint.

#### b. High Limit Differential (HdF)

On Warm Start Boiler Control the High Limit Differential is not adjustable and is fixed at 10°F.

#### c. Low Limit (LL)

The Warm Start Boiler Control is factory programmed with a Low Limit Setpoint of 110°F. On falling temperature the boiler turns “on” and the “ZC” terminal and System Circulator outputs are de-energized when the boiler temperature is less than the Low Limit Setpoint less the differential. On a rising temperature when the boiler temperature is above the Low Limit Setpoint the boiler turns “off”, the “ZC” terminal output is energized and the System circulator is enabled to respond to a call for heat. The Low Limit Setpoint is adjustable between 110°F and 220°F.

## VII: OPERATING (continued)

### d. Low Limit Differential (LdF)

The Warm Start Boiler Control is factory programmed with a Low Limit Differential Setpoint of 10°F. The Low Limit Differential is the number of degrees the boiler temperature must decrease below the Low Limit Setpoint before the Warm Start Boiler Control takes actions to warm the boiler. These actions include starting the burner and stopping water flow through the boiler. The Low Limit Differential is adjustable between 10°F and 25°F.

### e. Circulator Overrun Time (Or\_)

Circulator Overrun Time (also called "circulator off delay" or "circulator post purge") continues circulator operation after a call for heat has ended, sending excess heat from the boiler into the priority zone. Ensure system piping and zone panel settings allow water flow to the priority zone after the call for heat ends. The Circulator Overrun Time has a factor setting of 0 minutes and is field adjustable between 0 and 10 minutes.

### f. Circulator Pre-Purge Time (PP\_)

When the boiler is warm [boiler water temperature higher than 140°F (adjustable using Start Temperature parameter)] and there is a thermostat call for heat, the system circulator is started and boiler firing is delayed pre-purge minutes. If the temperature drops below 140°F or there is a DHW Call for Heat the boiler is started without delay. Additionally, the boiler is started without delay if the thermostat call for heat is initiated when the boiler water temperature is less than 140°F. This feature helps save energy by satisfying home heating needs with residual boiler heat rather than cycling the boiler. The Circulator Pre-purge time has a factory setting of 2

minutes and is field adjustable between 2 and 20 minutes. Refer to Table 6.

The Warm Start Boiler Control Pre-purge Time is factor set to 0 minutes.

### g. Start Temperature (St\_)

The amount of "Heat available" is calculated by taking the difference between measured boiler water temperature and the Start Temperature setting. Useful "Heat Available" is dependent on the type of heating emitter installed in the home. Heat emitters require a certain minimum temperature to operate effectively. Our default settings reflect cast iron radiators. Fan Coils may require a start temperature setting of 180°F or 160°F before providing heat to the home. The Start Temperature has a factory setting of 140°F and is field adjustable between 140°F and 180°F.

### h. Priority Time (Pt\_)

When the Priority Time parameter is set to "on" and Domestic Hot Water (DHW) call for heat is "on" the DHW demand will take "Priority" over home heating demand and the system circulator will be forced "off". Priority Time ends and the system circulator is released to service home heating demand when Domestic Hot Water call for heat is over. When Priority Time parameter is set to "Off" the DHW call for heat does not force "off" the system circulator. The Priority Time has a factory setting of "On" and is field adjustable between "On" and "Off" Refer to Table 7.

### i. ZC and ZR Terminal Function (ZC\_)

The boiler control allows configuration of the ZC output functionality to help the V1 RO/FO integrate into each installation more effectively. The ZC output can be connected to a domestic hot water circulator or a second heating zone circulator or be used to enable pumps in a warm start application. These applications are selected as follows:

- i. When ZC\_ is set equal to Domestic Hot Water Demand (dH)  
When there is an Indirect Water Heater (IWH) the boiler control provides a "ZR" input terminal for the IWH Aquastat and "ZC" output terminal for the DHW Circulator. When there is a DHW call for heat, the System Circulator is "forced off", the DHW Circulator terminal is energized and the circulator pre-purge

**Table 6: Circulator Pre-purge Time Example,  
Parameter PP\_ = 2 Minutes**

Call for Heat	ZC and ZR Terminal Function (ZC_)	Boiler Temp.	Boiler Status, (B1 Output)
TT= on	--	< 140	Start with no delay
TT = on	--	>140	Start after 2 minute delay
ZR = on	ZC_ = Zr	<140	Start with no delay
ZR = on	ZC_ = Zr	>140	Start after 2 minute delay
ZR = on	ZC_ = dH	<140	Start with no delay
ZR = on	ZC_ = dH	>140	Start with no delay

## VII: OPERATING (continued)

time delay control logic is bypassed to allow the boiler to fire without delay. When DHW demand ends the System Circulator “force off” is removed, the circulator can respond normally, and the DHW Circulator is de-energized. The DHW call for heat is detected by a voltage on to the “ZR” terminal. When a Priority Time parameter is set to “off” the System Circulator is not forced off for a DHW call for heat. Refer to Table 7.

**Table 7: Domestic Hot Water Demand, (Parameter  $\mathcal{ZC}_- = dH$ )**

Call for Heat		Priority Time ( $Pt_-$ )	Circulator Status	
T-T Input	ZR Input		System Circulator Output	DHW Circulator ZC Output
on	off	On	on	off
on	on	On	off	on
off	on	On	off	on
on	off	OFF	on	off
on	on	OFF	on	on
off	on	OFF	off	on

- ii. When  $\mathcal{ZC}_-$  is set equal to Zone Request ( $\mathcal{Zr}$ )
- When there is no IWH the Cold Start Boiler Control “ZC” output may be configured to control a second heating zone. This is particularly helpful when the home uses only two heating zones. The boiler control replaces the need for a two circulator zone panel. When DHW Terminal Function ( $dH_-$ ) is set to  $\mathcal{Zr}$  the boiler control’s two circulator outputs are used to control two independent heating zones. Refer to Table 8. A “TT” input causes a call for heat and energizes the System Circulator output to service heating zone 1. A second zone’s thermostat may be wired to the “ZR” input to energize heating zone 2 circulator wired to the “ZC” output. Both outputs function independently, “TT” input controls only the System Circulator output and the “ZR” input controls only the “ZC” output. Both inputs cause a boiler call for heat.

**Table 8: Zone Request, Parameter  $\mathcal{ZC}_- = \mathcal{Zr}$**

Call for Heat		Circulator Status	
T-T Input	ZR Input	C1 Output	ZC Output
off	off	off	off
on	off	on	off
on	on	on	on
off	on	off	on

The Warm Start Boiler Control with  $\mathcal{ZC}_-$  set equal to Zone Request ( $\mathcal{Zr}$ ) energizes the “ZC” terminal while the boiler is warm as described earlier in this section (refer to Paragraph A,2,f). The “ZR” input is a call for heat that starts the boiler.

- iii. External Low Limit, Parameter  $\mathcal{ZC}_- = ELL$
- The Cold Start Boiler Control is capable of functioning as a warm start control when external limit control is installed that closes a contact when boiler water temperature falls below a setpoint. When an external limit contact closes (boiler water is cold) the boiler is started and the “ZC” and “C1” output terminals are de-energized. When the “ZR” terminal is de-energized (boiler water temperature is above setpoint) the call for heat is ended and the “C1” terminal is released to operation and the “ZC” terminal is energized. An External Low Limit Request is detected by sensing a voltage on the “ZR” terminal. The Warm Start Boiler Control does not have the External Low Limit Option. Refer to Table 9.

**Table 9: External Low Limit, Parameter  $\mathcal{ZC}_- = ELL$**

Call for Heat		Circulator Status	
T-T Input	ZR Input	C1 Output	ZC Output
off	off	off	on
on	off	on	on
on	on	off	off
off	on	off	off

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## VIII: MAINTENANCE AND SERVICE INSTRUCTIONS

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### A. WATER BOILERS:

#### 1. Filling of boiler and system.

GENERAL — In a hot water heating system, the boiler and entire system (other than the expansion tank) must be full of water for satisfactory operation. Water should be added to the system until the boiler pressure gauge registers 12 psi. To insure that the system is full, water should come out of all air vents when opened.

#### 2. BOILING OUT OF BOILER AND SYSTEM. The oil and grease which accumulate in a new hot water boiler can be washed out in the following manner:

- a. Ideally, shut off valves have been installed between the boiler return manifold and the rest of the system, to minimize the amount of system draining.
- b. Drain the boiler to a level below the relief valve tapping.



**DANGER** Assure that the boiler is at zero pressure before removing the relief valve. Open the safety valve to relieve all internal pressure prior to proceeding. Safety valve discharge piping must be piped such that the potential for burns is eliminated.

- c. Remove relief valve using extreme care to avoid damaging it.
- d. Add an appropriate amount of recommended boil out compound.
- e. Replace relief valve.
- f. Fill the entire system with water.
- g. Start firing the boiler.
- h. Circulate the water through the entire system.
- i. Vent the system, including the radiation.
- j. Allow boiler water to reach operating temperature, if possible.
- k. Continue to circulate the water for a few hours.
- l. Stop firing the boiler.
- m. Drain the system in a manner and to a location that hot water can be discharged with safety.
- n. Remove plugs from all available returns and wash the water side of the boiler as thoroughly as possible, using a high-pressure water stream.

- o. Refill the system with fresh water.

#### 3. Add appropriate boiler water treatment compounds as recommended by your qualified water treatment company.

#### 4. Make pH or Alkalinity Test.

After boiler and system have been cleaned and refilled as previously described, test the pH of the water in the system. This can easily be done by drawing a small sample of boiler water and testing with hydron paper which is used in the same manner as litmus paper, except it gives specific readings. A color chart on the side of the small hydron dispenser gives the reading pH. Hydron paper is inexpensive and obtainable from any chemical supply house or through your local druggist. The pH should be higher than 7 but lower than 11. Add some of the washout chemical (caustic soda), if necessary, to bring the pH within the specified range. With this lower level of protection, care must be exercised to eliminate all of the free oxygen in the system.

#### 5. Boiler is now ready to be put into service.

### B. EXCESSIVE MAKE-UP WATER

A leaky system will increase the volume of make-up water supplied to the boiler, which can significantly shorten the life of the boiler. Entrained in make-up water are dissolved minerals, salts and oxygen. When the fresh, cool make-up water is heated in the boiler, the minerals fall out as sediment, the salts coat the inside of the boiler, and the oxygen escapes as a gas. The accumulation of sediment eventually isolates the water from contacting the steel. When this happens the steel in that area gets extremely hot and eventually cracks. The presence of free oxygen or chloride salts in the boiler creates a corrosive atmosphere which, if the concentration becomes high enough, can corrode the steel through from the inside. More make-up water and higher concentrations of contaminants damage the boiler sooner. **Our warranty does not cover corrosion and sediment-related damage.**

Clearly it is in everyone's best interest to prevent this type of failure. You can do your part by ensuring that your system is leak-free, keeping leakage to less than 2 percent of the boiler water volume each month. Refer to Chart below.

## VIII: MAINTENANCE AND SERVICE INSTRUCTIONS (continued)

### IMPORTANT

IF, DURING NORMAL OPERATION, IT IS NECESSARY TO ADD MORE WATER THAN INDICATED BELOW, CONSULT A QUALIFIED SERVICE TECHNICIAN TO CHECK YOUR SYSTEM FOR LEAKS.

Model No.	Gallons Per Month	Gallons Per Year
V13A RO/FO	0.27	3.2

#### C. ATTENTION TO BOILER WHILE NOT IN OPERATION

**NOTICE** If boiler is not used during winter time, it must be fully drained to prevent freeze damage.

1. Prevent Freeze Damage  
**Important:** If boiler is **NOT** used during winter time, it must be fully drained to prevent freeze damage.
2. Spray inside surfaces with light lubricating or crankcase oil using gun with extended stem so as to reach all corners.
3. Always keep the manual fuel supply valve shut off if the burner is shut down for an extended period of time.
4. To recondition the heating system in the fall season after a prolonged shut down, follow the instructions outlined in Section VI, System Start-Up, Paragraphs A through K.



#### WARNING

This boiler contains controls which may cause the boiler to shut down and not restart without service. If damage due to frozen pipes is a possibility, the heating system should not be left unattended in cold weather; or appropriate safeguards and alarms should be installed on the heating system to prevent damage if the boiler is inoperative.



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## IX: CLEANING OF BOILER


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### A. TO CLEAN FLUEWAYS

1. Free Control Capillary Tubing, see Figure 1. Remove screws from plastic clips securing capillary to jacket. Loosen screw at control well, remove sensing element and place where it will not get damaged.
2. Remove Right Side Jacket Panel by removing screws holding panel to other jacket panels.
3. Loosen nut securing Flue Cleanout Plates and remove plates exercising caution so that Asbestos Rope seals remain in place on plates.
4. Using 1¼" diameter wire or fibre bristle brush (30" handle) and vacuum, clean flueways. Use horizontal and diagonal strokes for best results. DO NOT ALLOW BRUSH TO STRIKE TARGET WALL AT BOTTOM OF REAR SECTION.

### B. TO CLEAN FIREBOX (CROWN AND INSIDE OF WATERLEGS)

1. Disconnect oil line(s) and remove Burner and Burner Mounting Plate, see Figure 1.
2. Gently remove Burner Mounting Plate insulation from burner opening in front section.
3. Using wire or fibre bristle brush and vacuum, clean crown of boiler and inside of water legs. DO NOT ALLOW BRUSH TO STRIKE TARGET WALL AT BOTTOM OF REAR SECTION.


 **WARNING** Any combustion chamber insulation which was damaged must be replaced immediately.

### C. TO CLEAN TOP OF BOILER SECTION

1. Remove smokepipe from flue collar of canopy, see Figure 1.
2. Using wire or fibre bristle brush and vacuum, clean top of boiler through flue collar of canopy.

### D. REASSEMBLY OF PARTS

1. Reinstall smokepipe on canopy and secure to collar with SMS.
2. Gently replace Burner Mounting Plate insulation into burner opening in front section.
3. Bolt burner mounting plate to front section using silastic or furnace cement to seal plate to section.
4. Bolt burner to burner mounting plate and connect oil line(s).
5. Reinstall flue plates (arrow on plates pointing up) making sure gasket on each plate is in place and forms gas tight seal.
6. Reinstall Right Side Jacket Panel and secure with SMS.
7. Place sensing element of control into well and bottom. Tighten screw. Secure capillary to jacket with plastic clips.

 **WARNING** The boiler must be connected to an approved chimney in good condition. Serious property damage could result if the boiler is connected to a dirty or inadequate chimney. The interior of the chimney flue must be inspected and cleaned before the start of the heating season for any obstructions. A clean and unobstructed chimney flue is necessary to allow noxious fumes that could cause injury or loss of life to vent safely and will contribute toward maintaining the boiler's efficiency.

# **Important Product Safety Information**

## **Refractory Ceramic Fiber Product**



The Service Parts list designates parts that contain refractory ceramic fibers (RCF). RCF has been classified as a possible human carcinogen. When exposed to temperatures above 1805°F, such as during direct flame contact, RCF changes into crystalline silica, a known carcinogen. When disturbed as a result of servicing, these substances become airborne and, if inhaled, may be hazardous to your health.

### **AVOID Breathing Fiber Particulates and Dust**

#### **Precautionary Measures:**

Do not remove or replace RCF parts or attempt any service work involving RCF without wearing the following protective gear:

1. A National Institute for Occupational Safety and Health (NIOSH) approved respirator
  2. Long sleeved, loose fitting clothing
  3. Gloves
  4. Eye Protection
- Take steps to assure adequate ventilation.
  - Wash all exposed body areas gently with soap and water after contact.
  - Wash work clothes separately from other laundry and rinse washing machine after use to avoid contaminating other clothes.
  - Discard used RCF components by sealing in an airtight plastic bag. RCF and crystalline silica are not classified as hazardous wastes in the United States and Canada.

#### **First Aid Procedures:**

- If contact with eyes: Flush with water for at least 15 minutes. Seek immediate medical attention if irritation persists.
- If contact with skin: Wash affected area gently with soap and water. Seek immediate medical attention if irritation persists.
- If breathing difficulty develops: Leave the area and move to a location with clean fresh air. Seek immediate medical attention if breathing difficulties persist.
- Ingestion: Do not induce vomiting. Drink plenty of water. Seek immediate medical attention.

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## X: TROUBLESHOOTING

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### A. COMBUSTION

1. NOZZLES — Although the nozzle is a relatively inexpensive device, its function is critical to the successful operation of the oil burner. The selection of the nozzle supplied with the V1 RO/FO boiler is the result of extensive testing to obtain the best flame shape and efficient combustion. Other brands of the same spray angle and spray pattern may be used but may not perform at the expected level of CO<sub>2</sub> and smoke. Nozzles are delicate and should be protected from dirt and abuse. Nozzles are mass-produced and can vary from sample to sample. For all of those reasons a spare nozzle is a desirable item for a serviceman to have.
2. FUEL LEAKS — Any fuel leak between the pump and the nozzle will be detrimental to good combustion results. Look for wet surfaces in the air tube, under the ignitor, and around the air inlet. Any such leaks should be repaired as they may cause erratic burning of the fuel and in the extreme case may become a fire hazard.
3. SUCTION LINE LEAKS — Any such leaks should be repaired, as they may cause erratic burning of the fuel and in extreme cases may become a fire hazard. Whatever it takes, **The Oil Must Be Free of Air**. This can be a tough problem, but it must be resolved. Try bleeding the pump through a clear tube. There must be no froth visible. There are various test kits available to enable you to look at the oil through clear tubing adapted to the supply line at the pump fitting. Air eliminators are on the market that have potential. Also, electronic sight glasses are being used with good success. At times, new tubing must be run to the tank or new fittings put on. Just make sure you get the air out before you leave.  
  
Any air leaks in the fuel line will cause an unstable flame and may cause delayed ignition noises. Use only flare fittings in the fuel lines.
4. GASKET LEAKS — If 11.5 to 12.5% CO<sub>2</sub> with a #1 smoke cannot be obtained in the breeching, look for air leaks around the burner mounting gasket, observation door, and canopy gasket. Such air leaks will cause a lower CO<sub>2</sub> reading in the breeching. The smaller the firing rate the greater effect an air leak can have on CO<sub>2</sub> readings.
5. DIRT — A fuel filter is a good investment. Accidental accumulation of dirt in the fuel system can clog the nozzle or nozzle strainer and produce a poor spray pattern from the nozzle. The smaller the firing rate, the smaller the slots become in the nozzle and the more prone to plugging it becomes with the same amount of dirt.
6. WATER — Water in the fuel in large amounts will stall the fuel pump. Water in the fuel in smaller amounts will cause excessive wear on the pump, but more importantly water doesn't burn. It chills the flame and causes smoke and unburned fuel to pass out of the combustion chamber and clog the flueways of the boiler.
7. COLD OIL — If the oil temperature approaching the fuel pump is 40°F or lower, poor combustion or delayed ignition may result. Cold oil is harder to atomize at the nozzle. Thus, the spray droplets get larger and the flame shape gets longer. An outside fuel tank that is above grade or has fuel lines in a shallow bury is a good candidate for cold oil. The best solution is to locate the tank near the boiler in the basement utility room or bury the tank and lines deep enough to keep the oil above 40°F. Check environmental issues with local authorities having jurisdiction.
8. FLAME SHAPE — Looking into the combustion chamber through the observation port, the flame should appear straight with no sparklers rolling up toward the crown of the chamber. If the flame drags to the right or left, sends sparklers upward or makes wet spots on the target wall, the nozzle should be replaced. If the condition persists look for fuel leaks, air leaks, water or dirt in the fuel as described above.
9. HIGH ALTITUDE INSTALLATIONS — Air openings must be increased at higher altitudes. Use instruments and set for 11.5 to 12.5% CO<sub>2</sub>.
10. START-UP NOISE — Late ignition is the cause of start-up noises. If it occurs recheck for electrode settings, flame shape, air or water in the fuel lines.
11. SHUT DOWN NOISE — If the flame runs out of air before it runs out of fuel, an after burn with noise may occur. That may be the result of a faulty cut-off valve in the fuel pump, or it may be air trapped in the nozzle line. It may take several firing cycles for that air to be fully vented through the nozzle. Water in the fuel or poor flame shape can also cause shut down noises.

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## X: TROUBLESHOOTING (continued)

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**NOTICE CHECK TEST PROCEDURE.** A very good test for isolating fuel side problems is to disconnect the fuel system and with a 24" length of tubing, fire out of an auxiliary five gallon pail of clean, fresh, warm #2 oil from another source. If the burner runs successfully when drawing out of the auxiliary pail then the problem is isolated to the fuel or fuel lines being used on the jobsite.

### B. OIL PRIMARY CONTROL (Oil Primary)

1. Burner (Oil Primary) will not come on.
  - a. No power to Oil Primary.
  - b. Oil Primary is in lockout or restricted mode. Press reset button for one (1) second to exit lockout. If control has recycled three times within the same call for heat, it will enter into restricted mode. To reset from restricted mode, refer to Section VIII, Paragraph I, Step 2 for details.
  - c. CAD cell seeing light.
  - d. CAD assembly defective.
  - e. Control motor relay is stuck closed (see note below).
2. Burner (control) will light, then shut down after a short time, then restart after one (1) minute.
  - a. CAD cell is defective.
  - b. Air leaking into oil line causing flame out.
  - c. Defective nozzle causing flame to be erratic.
  - d. Excessive airflow or draft causing flame to leave burner head.
  - e. Excessive back pressure causing flame to be erratic.
3. Control locks out after Trial For Ignition (TFI).
  - a. No oil to burner.
  - b. Shorted electrodes.
  - c. Nozzle clogged.
  - d. Airflow too high.

- e. Ignitor module defective.
- f. CAD cell defective.
- g. Oil valve stuck open or closed.

**Note:** The Safety Monitoring Circuit (SMC) is designed to provide lockout in the event of a stuck or welded motor relay.

**NOTICE** If flame is not established within 15 seconds of oil valve actuation (known as Trial For Ignition [TFI]) lockout will occur. Lockout is indicated by a red LED solid-on located on the oil primary control.

**Hard Lockout will occur if the Oil Primary Control locks-out three (3) times during a call for heat. This is indicated by red light reset button solid-on.**

### C. INTELLIGENT OIL BOILER CONTROL

- **Cold Start Boiler Control** is used on Boilers without Tankless Heaters.
  - **Warm Start Boiler Control** is used on Boilers with Tankless Heaters
1. When a problem occurs with the boiler operation, the Boiler Control easily provides specific, valuable information to help resolve the issue quickly. The display on the Boiler Control should be the first place to check.
    - a. If an Error Code "Err" **IS NOT** displayed on the Boiler Control: In this circumstance, Table 10 can be used to determine the problem and possible causes.

## X: TROUBLESHOOTING (continued)

**Table 10: Troubleshooting Guide**

System Condition	Diagnostic Condition	Check	Action
Boiler is cold, house is cold.	Display is OFF.	120 Vac System power.	Turn system power on.
	Display is ON.	24 Vac T-T	No 24 V; replace control.
		24 V present; disconnect thermostat, short T-T.	Boiler starts, check wiring and thermostat.
		120 Vac at B1-B2	<ul style="list-style-type: none"> <li>• If no, replace control.</li> <li>• If yes, check burner and wiring.</li> </ul>
		Refer to Err on display.	-----
Boiler is hot, house is cold.	Display is ON.	120 Vac at C1-C2	<ul style="list-style-type: none"> <li>• 120 Vac at C1-C2, check wiring to pump.</li> <li>• Wiring OK, is pump running?</li> <li>• If not, replace the pump.</li> <li>• If pump is running, check for trapped air or closed zone valves</li> </ul>
		Boiler below the Low Limit temperature, wait for boiler to go above Low Limit temperature.	-----
		Boiler above LL? If yes, check for 120 Vac between ZC and L2.	<ul style="list-style-type: none"> <li>• If no 120 Vac, replace control.</li> <li>• If yes, check zone relays, circulators and wiring.</li> </ul>

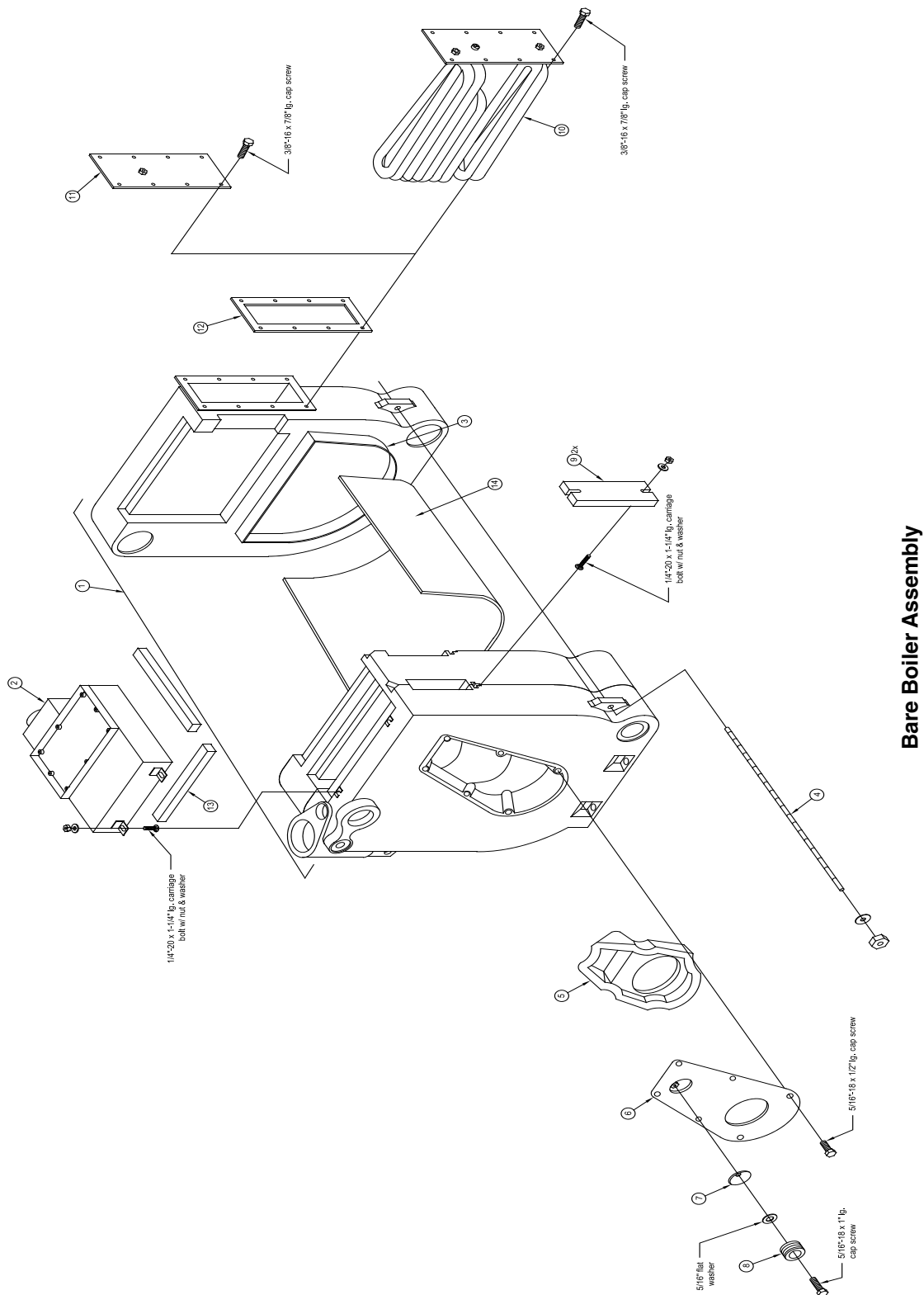
- b. If the Boiler Control detects an error it will flash "Err" (boiler control error) followed by a number. Use this text and number to identify the boiler problem and corrective action in Table 11 below.

**Table 11: Boiler Control Error Numbers**

Display	Status	Recommended Corrective Actions
Err 1	Temperature Sensor Fault	Temperature sensor failure, wire harness loose or shorted connection or control hardware failure: <ul style="list-style-type: none"> <li>- Check sensor is securely attached to boiler control</li> <li>- Check that sensor wire is not damaged</li> <li>- If secure and in good condition, replace sensor</li> <li>- If problem persists, replace control</li> </ul>
Err 2	Communication Fault	EnviraCOM terminal is shorted to ground or line voltage. <ul style="list-style-type: none"> <li>- Check wiring to EnviraCOM terminals 1,2 and 3. Wiring to external EnviraCOM device is incorrect.</li> </ul>
Err 3	Internal Hardware Fault	Error detected with AC power supply frequency or boiler control failure. Cycle power to the control. Replace control if problem persists.
Err 4	Burner Output (B1) Fault	B1 output sensed powered during safety output relay check sequence or un-powered during running, or powered in idle in combination with water temperature above 264°F limit. Cycle power to the control. Replace control if problem persists.
Err 5	Line Voltage Fault (< 80 Vac)	AC voltage out of specification high or low; check L1, L2, 110 VAC.
Err 6	Fuse missing	Internal fuse is blown or missing. The fuse protects the Aquastat from miswiring the L1 and L2 on Oil Primary. When the Oil Primary is correctly wired the fuse is useless and not detected. If Primary is wired incorrectly the fuse is blown out and Aquastat report error 6. EnviraCOM message is sent when the wiring is fixed and the error disappears to indicate the end of the error state. Check wiring and replace fuse.
Err 7	User settings lost, (reset to factory defaults)	Warning: Generated if user adjustments are lost and the device uses factory default values. Error is cleared by entering and exiting the Adjustment mode. Replace control if problem persists.
Err 8	Manual Reset Lockout (resettable)	Set if Err 4 was invoked four times in a row. Check wiring and clear Lockout by pressing all three user keys for 30 seconds.

## XI: REPAIR PARTS

All V1™ RO/FO Series Repair Parts may be obtained through your local U.S. Boiler Company Wholesale distributor. Should you require assistance in locating a U.S. Boiler Company Distributor in your area, or have questions regarding the availability of U.S. Boiler Company products or repair parts, please contact U.S. Boiler Company Customer Service at (717) 481-8400 or Fax (717) 481-8408.



Bare Boiler Assembly

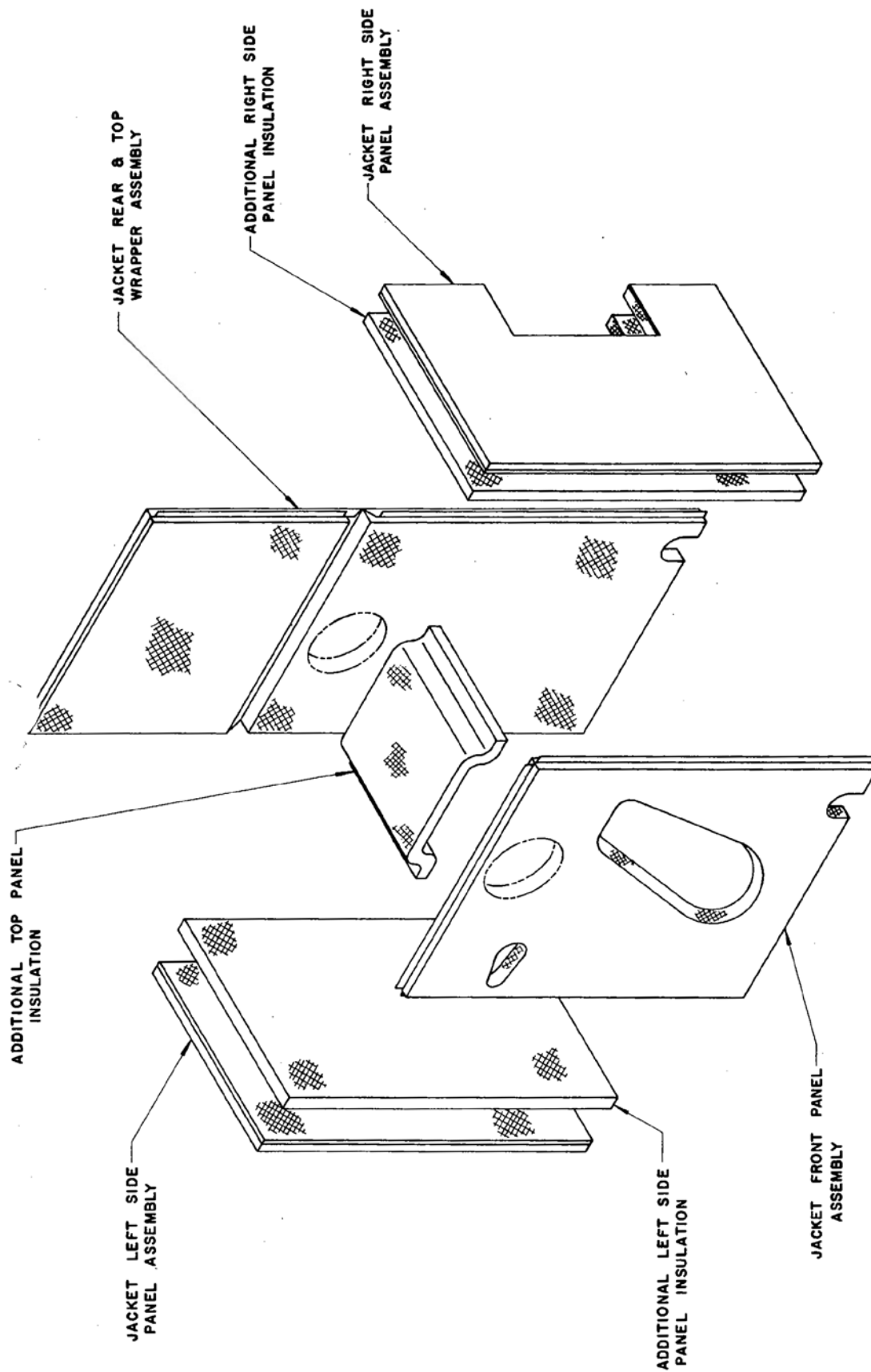
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**XI: REPAIR PARTS (continued)**

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**BARE BOILER ASSEMBLY**

<b>Key No.</b>	<b>Description</b>	<b>Quantity</b>	<b>Part Number</b>
1	Section Assembly	1	6172203
2	Front Outlet Canopy Assembly	1	611220351
	Front Outlet Canopy Assembly	1	61122034
3	Target Wall Insulation	1	Included in Combustion Chamber Insulation Kit
4	3/8"-16 x 12.5" lg Tie Rod	2	80861010
5	Burner Mounting Plate Insulation	1	Included in Combustion Chamber Insulation Kit
6	Burner Mounting Plate	1	6022210
7	Observation Hole Cover	1	7026001
8	3/8" ID x 1/2" Spring	1	8026015
9	Flue Cover Plate Assembly	2	6116039
10	Tankless Heaters, V1-2	1	8032202
11	Tapped Cover Heater Plate	1	7032201
12	Gasket-Tankless Heater or Cover Plate	1	8036058
13	Canopy Sealing Strip, 1/2" x 1-1/4" x 8"	1	6206003
14	Combustion Chamber Liner	1	Included in Combustion Chamber Insulation Kit
	Combustion Chamber Insulation Kit	1	108133-01



Flush Jacket Components



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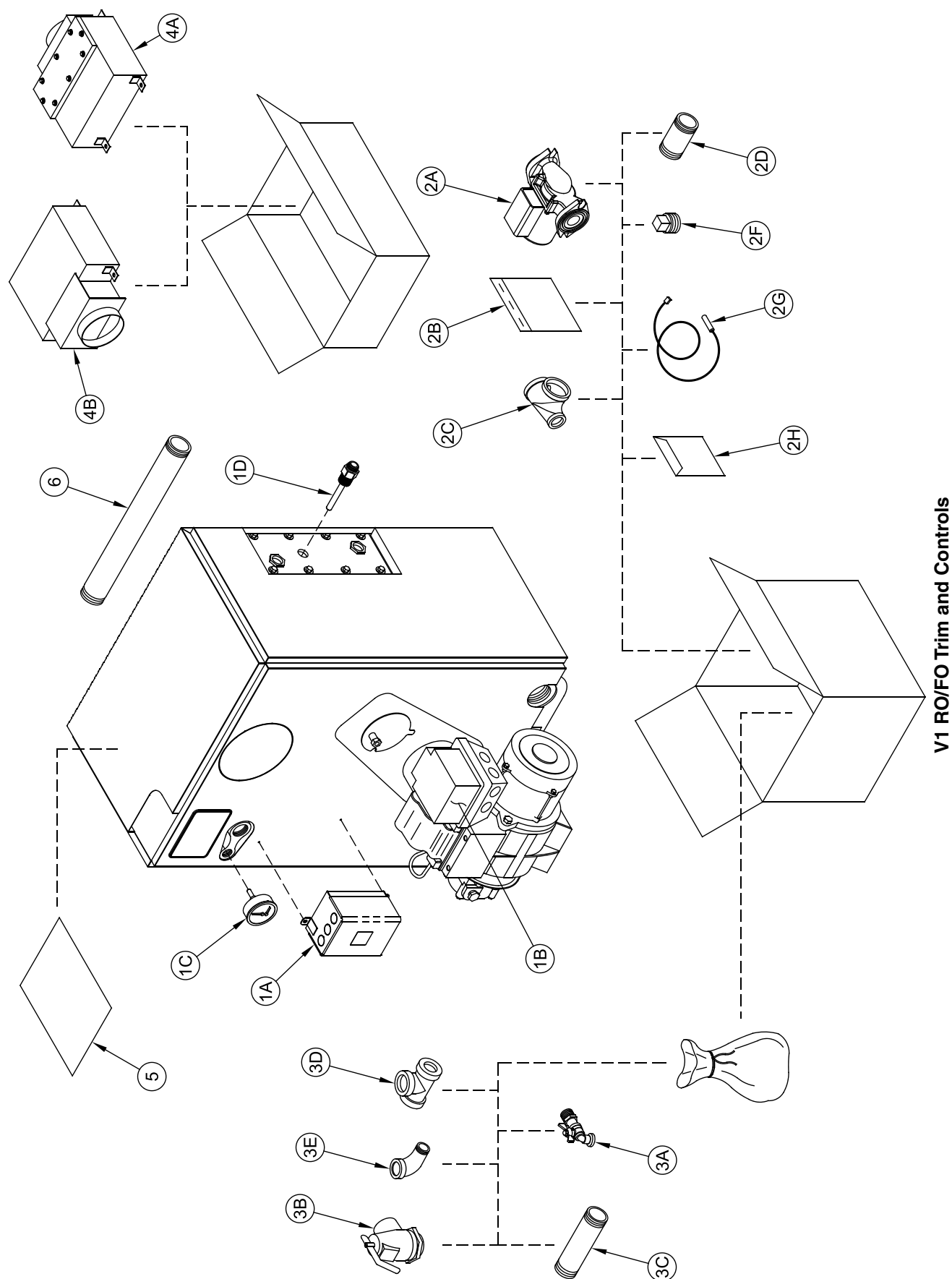
## **XI: REPAIR PARTS (continued)**

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### **FLUSH JACKET COMPONENTS**

<b>Key No.</b>	<b>Description</b>	<b>Size</b>	<b>Part Number</b>
1	Complete Flush Jacket Assembly - Complete with Key Item Nos. 2 thru 5	1	60422035
2 *	Jacket Left Side Panel Assembly	1	60422032
3 *	Jacket RO/FO Top & Rear Wrapper Assembly	1	60422034
4 *	Jacket Right Side Heater Panel Assembly	1	60422033
5 *	Jacket RO/FO Front Panel Assembly	1	6042212
6	Additional Boiler Top Insulation Piece	1	7202215
7	Additional Right Side Panel Insulation Piece	1	72022033
8	Additional Left Side Panel Insulation Piece	1	72022032

\* **NOTE:** Items 2 thru 5 include insulation as part of Assembly

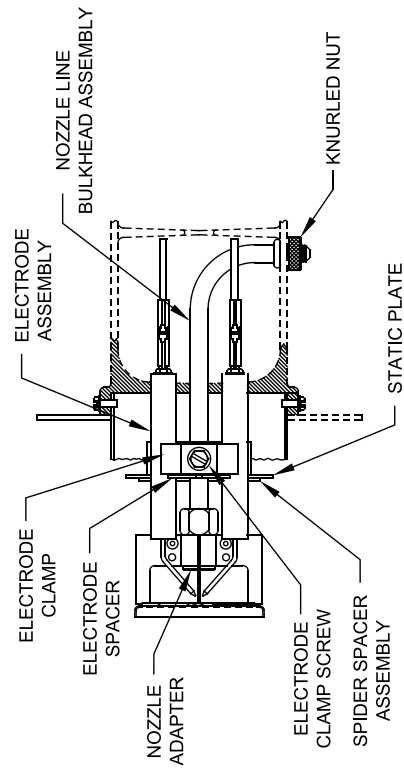
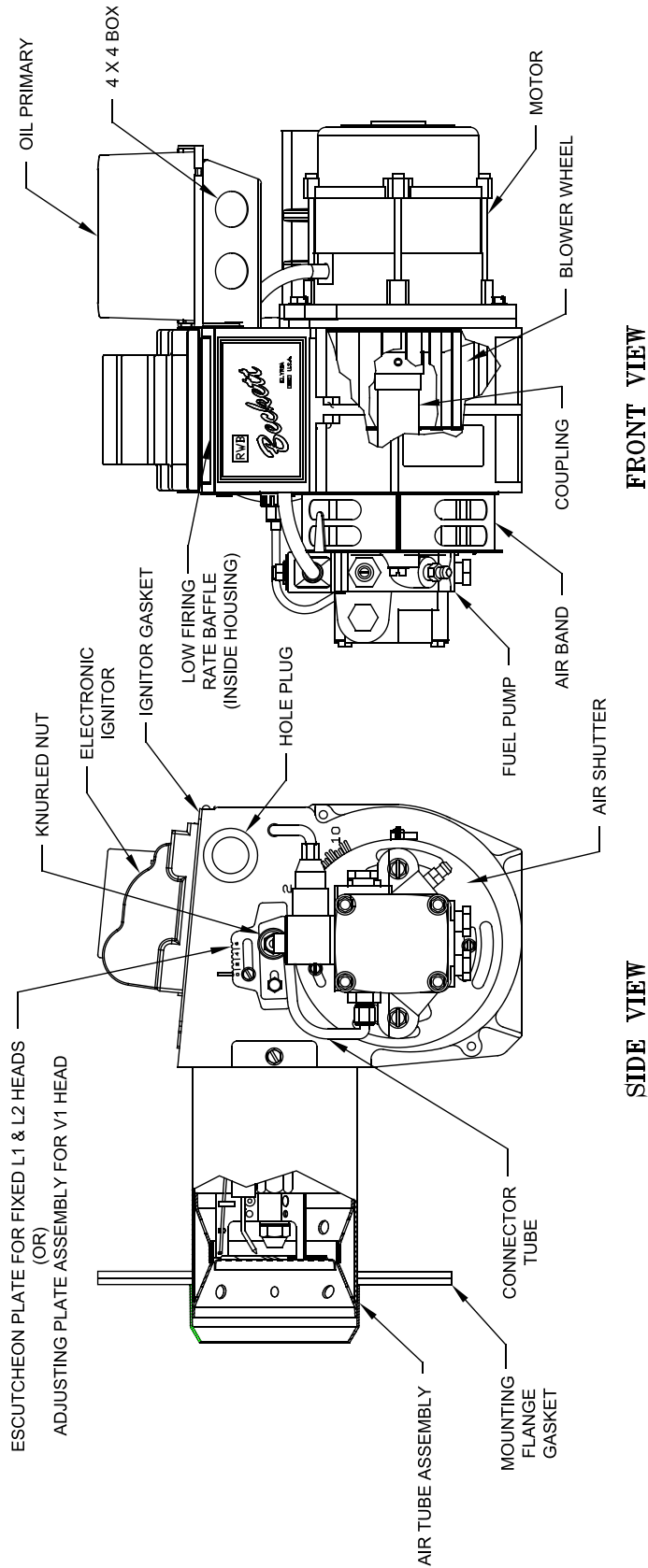


## XI: REPAIR PARTS (continued)

### TRIM AND CONTROLS

Key No.	Description	Quantity	Part Number
1	<b>Trim / Control Group</b>		
1A	L7224A1038 Warm Start Aquastat	1	104389-01
1B	Oil Primary Control, Beckett GeniSys 7505B	1	103447-01
1C	Temperature / Pressure Gauge, 2-1/2" Dia.	1	100282-01
1D	Honeywell 123870 A/T Well, 3/4" NPT x 1-1/2	1	80160426
2	<b>Miscellaneous Parts Carton Group</b>		
2A	Taco 007 Circulator	1	Supply Locally
2B	Circulator Hardware Kit , 1-1/2"	1	6056006
2C	Tee, 1-1/2" x 3/4" x 1-1/2", Black	1	806601003
2D	Nipple, 1-1/2" x 2", Sch40	1	806600008
2F	Pipe Plug, 1-1/2" NPT, Square Head	1	806603515
2G	Limit Sensor, 48" Lg, Honeywell 500011464-005	1	102296-01
2H	<b>Miscellaneous Hardware Envelope, RO/FO, Includes the following:</b>		
	Circulator Gaskets, Taco 00	2	806602006
	Temperature Sensor Clip	1	102422-01
	Cable Clamp, 5/16"	3	8136073
	Sheet Metal Screw, #8 x 1/2	3	80860000
3	<b>Miscellaneous Parts Bag Group</b> (Shipped in Misc. Parts Carton)		
3A	Drain Valve, 3/4 NPT Short Shank	1	806603061
3B	Safety Relief Valve, 3/4" 30 PSI #10-407-05	1	81660363
3C	Nipple, 3/4" NPT x 7" Lg., Black	1	806600195
3D	Tee, 3/4" NPT, Malleable	1	806601052
3E	Street Elbow, 3/4" NPT x 90°, Malleable	1	806601501
4	<b>RO and FO Canopy Cartons</b> (ordered separately as required for the job site)		
4A	Rear Outlet Canopy Carton, V13A	1	611220351
4B	Front Outlet Canopy Carton, V13A	1	61122034
5	<b>Instruction Package</b> - contains the following for <b>all</b> boilers: Installation, Operating and Service Instructions Universal Residential Boiler Warranty Sheet Residential Warranty Registration Card Hydronics Institute Instructions		
6	Nipple, 1-1/2" x 18", Sch40	1	6066005

## XI: REPAIR PARTS (continued)



### NOZZLE DETAIL BECKETT AFG OIL BURNER REPAIR PARTS

FOR REPLACEMENT OIL BURNER PARTS, CONTACT YOUR WHOLESALE OR THE BURNER MANUFACTURER:  
R. W. BECKETT CORP., 38251 CENTER RIDGE RD., P. O. BOX 1289, ELYRIA, OHIO , 1-800-645-2876 44036

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## **XI: REPAIR PARTS (continued)**

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### **BECKETT AFG OIL BURNER PART NOS. FOR V1 RO/FO SERIES BOILERS**

NOTE: When ordering parts always give the serial and model numbers shown on the boiler and burner. Also provide the name of the part(s) and part number as listed below.

Boiler Model	V13A RO/FO
Air Tube Combination	AFG70MMAQN
Beckett's Spec No.	BCB9101
Air Band	3492A
Air Band Nut	4150
Air Band Screw	4198
Air Shutter	3709
Air Shutter Screw	4189
Blower Wheel	2999
Coupling	2454
Low Firing Rate Baffle (Kit)	5880
Spline Nut (Bulkhead)	3666
Connector Tube Assembly	5394
Electrode Clamp	149
Electrode Clamp Screw	4219
Electrode Insulator Assembly (Kit)	5780
Nozzle Line LT Assembly (Less Head / Electrodes)	LT0509B
Escutcheon Plate	3493
Head (with Screws/ Nuts)	5912
Head Screws	4261
Head Square Nuts	4262
Flange Gasket	31420
AFG Housing	5874GY
Motor	21805U
Nozzle Line Electrode Assembly	NLH70MMN
Oil Pump, Clean Cut (Two Stage)	21941U
Static Plate	3384
Ignitor	51771U
Ignitor Hinge Screw	4217
Ignitor Holding Screw	4466
Ignitor Gasket Kit	51304
Ignitor Clamp	31404
Junction Box	3741
Flame Detector	7006U
Oil Solenoid Valve Coil	21755U
Oil Solenoid Valve Cord	21807U

## APPENDIX A: LOW WATER CUT OFF (LWCO) ON HOT WATER BOILERS

**⚠ WARNING** DO NOT ATTEMPT to cut factory wires to install an aftermarket Low Water Cut Off (LWCO).

Only use connections specifically identified for Low Water Cut Off.

### When

A low water cutoff is required to protect a hot water boiler when any connected heat distributor (radiation) is installed below the top of the hot water boiler (i.e. baseboard on the same floor level as the boiler). In addition, some jurisdictions require the use of a LWCO with a hot water boiler.

### Where

The universal location for a LWCO on both gas and oil hot water boilers is above the boiler, in either the supply or return piping. The minimum safe water level of a water boiler is at the uppermost top of the boiler; that is, it must be full of water to operate safely.

It is recommended that the LWCO control is installed above the boiler to provide the highest level of protection. However, where the LWCO control is approved by the LWCO control manufacturer for installation in a high boiler tapping of a water boiler, the use of the listed LWCO control is permitted when it is installed according to the LWCO manufacturer's instructions.

### What Kind

Typically, in residential applications, a probe type LWCO is used instead of a float type, due to their relative costs and the simplicity of piping for a probe LWCO.

### How to Pipe

A "tee" is commonly used to connect the probe LWCO to the supply or return piping, as shown below.

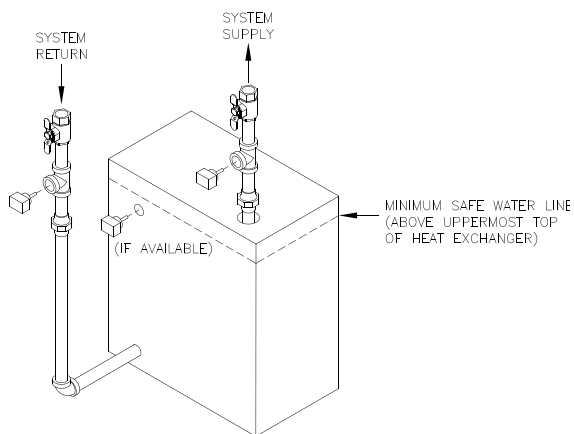


Figure A1: LWCO Location

Select the appropriate size tee using the LWCO manufacturer's instructions. Often, the branch connection must have a **minimum** diameter to prevent bridging between the probe and the tee. Also, the run of the tee must have a minimum diameter to prevent the end of the probe from touching or being located too close to the inside wall of the run of the tee.

Ideally, manual shutoff valves should be located above the LWCO and the boiler to allow for servicing. This will allow probe removal for inspection without draining the heating system. Many probe LWCO manufacturers recommend an annual inspection of the probe.

### How to Wire

LWCO's are available in either 120 VAC or 24 VAC configurations. The 120 VAC configuration can be universally applied to both gas and oil boilers by wiring it in the line voltage service to the boiler (after the service switch, if so equipped).

The presence of water in a properly installed LWCO will cause the normally open contact of the LWCO to close, thus providing continuity of the 120 VAC service to the boiler.

It is recommended to supply power to the probe LWCO with the same line voltage boiler service as shown in Figure A2 below.

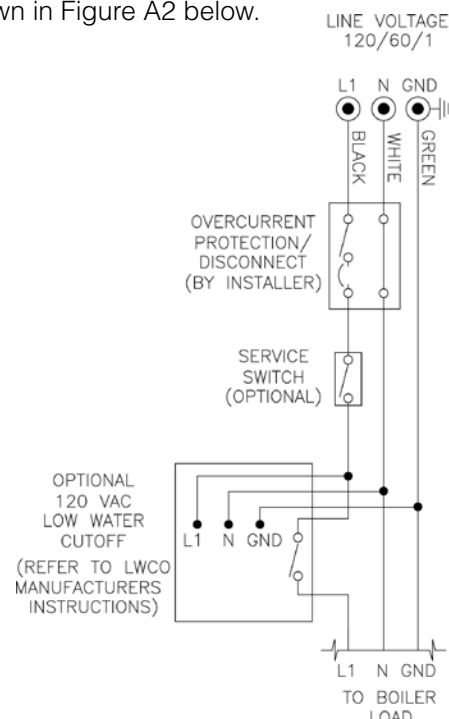


Figure A2: Wiring of Typical LWCO

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## APPENDIX A: LOW WATER CUT OFF (LWCO) ON HOT WATER BOILERS (continued)

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### How to Test

Shut off fuel supply. Close shut-off valves in system supply and return piping located in near boiler piping above LWCO as shown in Figure A1. Open drain valve to lower water level until water is below the LWCO probe. It may be necessary to open relief valve seat to allow air into system for the water to drain, close drain valve

and relief valve once completed. Generate a boiler demand by turning up thermostat. Boiler should not attempt to operate. Open fill valve to increase the water level by filling the system. It may be necessary to open relief valve to allow air to escape during filling process. The boiler should attempt to operate once the water level is above the LWCO.

U.S. Boiler Company, Inc.  
P.O. Box 3020  
Lancaster, PA 17604  
1-888-432-8887  
[www.usboiler.net](http://www.usboiler.net)