

INSTALLATION, OPERATING AND SERVICE INSTRUCTIONS FOR HF SERIES OIL FIRED BOILER

BEFORE INSTALLATION: READ THIS MANUAL

SAVE THESE INSTRUCTIONS



Installing contractor and homeowner should read and be informed as to the proper installation and operation of this unit. The manufacturer will not be responsible for improper installation or operation. This manual and all associated instruction material should be conspicuously posted near the equipment.



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

Boiler Model Number HF ____ - ____	Boiler Serial Number 6_ _ _ _ _	Installation Date
Heating Contractor		Phone Number
Address		



IMPORTANT INFORMATION - READ CAREFULLY

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:

All wiring on boilers installed in the USA shall be made in accordance with the National Electrical Code and/or Local Regulations.

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, Fireplaces, 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.

CANADIAN BOILERS

- A. Current Edition of Canadian Standards Association CSA B139, "Installation Code of Oil Burning Equipment", for recommended installation practices.

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.

CAUTION

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

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death, serious injury or substantial 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 printed on the back of this manual. 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. The warranty for this boiler is valid only if the boiler has been installed, maintained and operated in accordance with these instructions.

DANGER

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

WARNING

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. It is the responsibility of the installing contractor to see that all controls are correctly installed and are operating properly when the installation is completed. Installation is not complete unless a pressure relief valve is installed into the tapping located on top of appliance - See Section III of this manual for details.

This boiler is not suitable for installation on combustible flooring, unless installed with a combustible floor shield (available at extra cost). Do not install boiler on carpeting.

Do not tamper with or alter the boiler or controls. Retain your contractor or a competent serviceman to assure that the unit is properly adjusted and maintained.

Have Firetubes cleaned at least once a year - preferably at the start of the heating season to remove soot and scale. The inside of combustion chamber should also be cleaned and inspected at the same time.

Have Oil Burner and Controls 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.

WARNING

Appliance 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.

This boiler contains very hot water under high pressures. 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.

This appliance must be properly vented and connected to an approved vent system in good condition. Do not operate boiler with the absence of an unapproved vent system.

This boiler needs fresh air for safe operation and must be installed so there are provisions for adequate combustion and ventilation air.

The interior of the venting and air intake systems must be inspected and cleaned before the start of the heating season and should be inspected periodically throughout the heating season for any obstructions. Clean and unobstructed venting and air intake systems are 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.

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) or gaseous fuel (i. e. natural gas, LP/propane). 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.

Do not operate boiler on combustible floor without a factory supplied floor shield. Concrete over wood joists is considered combustible flooring. Do not operate on masonry floors, which may contain moisture.

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I: General Information

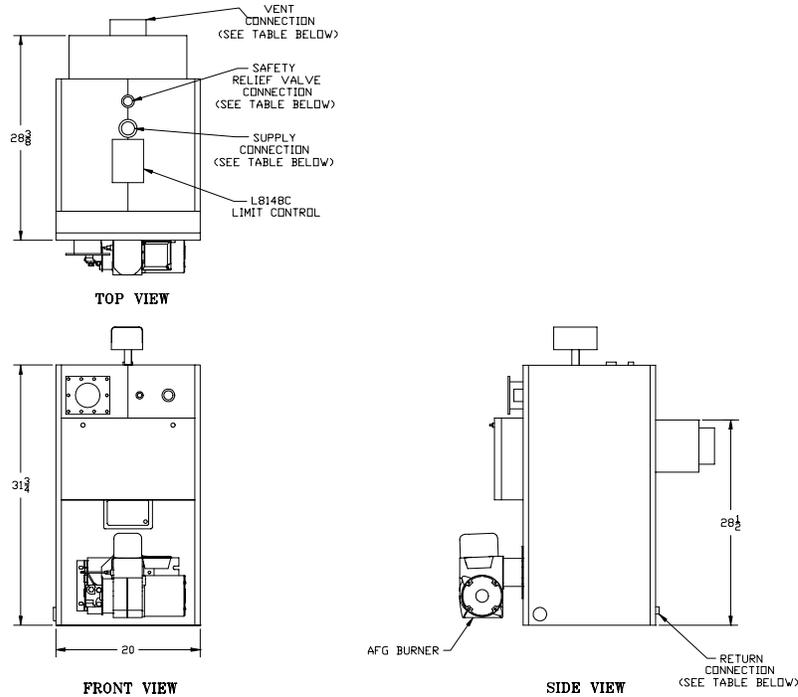


Figure 1: HF Packaged Boiler (HF-98/HF-173)

Table 1: WATER RATINGS AND SPECIFICATIONS

Description	HF-98	HF-122	HF-147	HF-173
DOE Heating Capacity (MBH)	104	132	154	184
IBR Net Water rating (MBH)	90	115	134	160
Firing Rate (gal/hr)	.85	1.10	1.25	1.50
Nozzle Specification	.75 x 45° B	.90 x 45° B	1.00 x 45° B	1.25 x 45° B
Stack Diameter (inch)	6	6	7	7
Number of Tubes	12	12	18	18
Boiler Water Cap. (gal.)	20	20	40	40
Supply Size (FPT)	1 1/4	1 1/4	2	2
Return Size (FPT)	1 1/4	1 1/4	2	2
Tankless Heater Size (gal/min)	4 (5 Optional)	4 (5 Optional)	5	5
Chimney Size (min)	8" x 8" x 15'	8" x 8" x 15'	8" x 8" x 15'	8" x 8" x 15'
Approx. Shipping Wt. (lb.)	450	450	720	720

DIMENSIONS

Max. Working Pressure: 30 PSI (Water Only)

	HF-98	HF-122	HF-147	HF-173
A Overall Width (in.)	18-1/8	18-1/8	24	24
B Overall Length Boiler (in.)	24-1/2	24-1/2	31-3/4	31-3/4
C Jacket Height (in.)	37-3/4	37-3/4	46-3/4	46-3/4
D Jacket Length (in.)	18	18	21-3/4	21-3/4
E Jacket Width (in.)	18-1/8	18-1/8	22	22
F Smoke Outlet Height (in.)	25-1/4	25-1/4	30	30
G Overall Length w/Burner (in.)	33	33	39	39

- Notes:**
1. Firing rates based on 140,000 BTU per gallon of oil
 2. IBR net water ratings based on a pick-up allowance of 1.15
 3. Manufacturer should be consulted before selecting a boiler for installations having unusual piping and pick-up requirements.
 4. Firebox draft setting: -.02 inches water column
 5. Ratings based on 13.0% CO₂

A. INSPECT SHIPMENT carefully for any signs of damage.

1. **ALLEQUIPMENT** is carefully manufactured, inspected and packed. Our responsibility ceases upon delivery of the crated boiler to the carrier in good condition.
2. **ANY CLAIMS** for damage or shortage of shipment must 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.

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 SERVICE CLEARANCE** of at least 48" from the front of the jacket for servicing of burner and removal of tankless heater.

For minimum clearances to combustable materials. See Figure 2.

1. **LOCATE** so that smoke pipe connection to chimney will be short and direct. **BOILER IS NOT SUITABLE FOR INSTALLATION ON COMBUSTIBLE FLOOR** unless combustable floor shield, supplied by Burnham, is used. **DO NOT** install on carpeting.

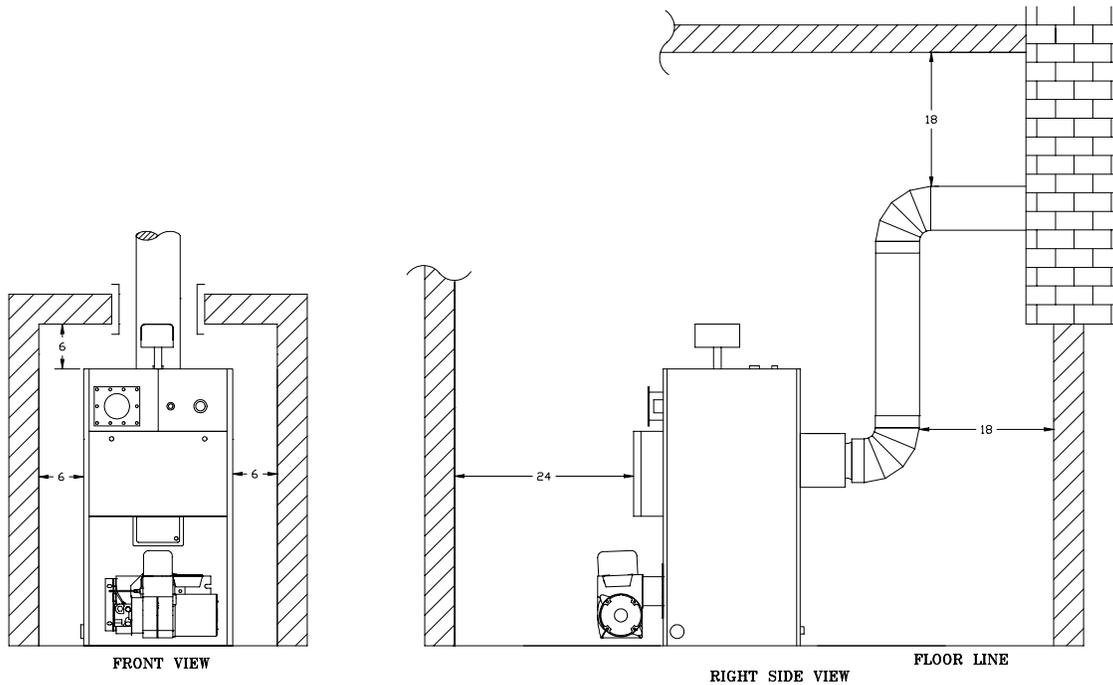


Figure 2: Minimum Clearances to Combustible Materials

NOTE:

1. Listed clearances comply with American National Standard ANSI/NFPA 31, Installation of Oil Burning Equipment.
2. HF boilers can be installed in rooms with clearances from combustable material as listed above. Listed clearances can not be reduced for alcove or closet installations.
3. For reduced clearances to combustable material, protection must be provided as described in the above ANSI/NFPA 31 standard.

C. PROVIDE AIR SUPPLY AND VENTILATION to accommodate proper combustion. If natural ventilation is inadequate, provide a screened opening or duct from the boiler room to the outside. The opening or duct must be sized so the boiler input will not exceed 4,000 BTUH/Sq. In. of free area. If other air consuming appliances are near the boiler, the air inlet should be larger. Consult respective manufacturers.

D. VENTILATION AIR must be provided to maintain the ambient temperature at safe limits. Local and national codes may apply and should be referenced.

1. In unconfined spaces (basement) in buildings of conventional frame, brick, or stone construction, infiltration normally is adequate to provide air for ventilation.
2. In confined spaces, two permanent openings, one near the top of the enclosure and one near the bottom, shall be provided. Each opening shall have a free area of not less than 1 sq. inch per 1000 BTUH of the total input of all appliances in the space.

E. 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.

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 ft³/1000 BTU per hour,

then it is considered an *unconfined space*. If the result is less than 50 ft³/1000 BTU per hour then the space is considered a *confined space*.

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.

II. Installation Instructions

WARNING

Failure to properly pipe boiler may result in improper operation and damage to boiler or structure.

Oxygen contamination of boiler water will cause corrosion of iron and steel boiler components, and can lead to boiler failure. Burnham's Standard Warranty does not cover problems caused by oxygen contamination of boiler water or scale (lime) build-up caused by frequent addition of water.

A. Design a piping system and install boiler which will prevent oxygen contamination of boiler water and frequent water additions.

1. 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.
2. 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.

WARNING

System supply and return piping must be connected to correct boiler pipe.

Burnham recommends sizing the system circulator to supply sufficient flow (GPM) to allow a 20°F temperature differential in the system. When sizing the system circulator, the pressure drop of all radiators, baseboard and radiant tubing and all connecting piping must be considered.

3. Connect System supply and return piping to boiler. See Figures 8 and 9. Also, consult I=B=R Installation and Piping Guides. Maintain minimum ½ inch

clearance from hot water piping to combustible materials.

- a. 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 3. Also, consult I=B=R Installation and Piping Guides.
- b. 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.
- c. If boiler is used with an Alliance™ Indirect-Fired Domestic Water Heater, install the Alliance as a separate heating zone. Refer to the Alliance Installation, Operating, and Service Instructions for additional information.
- d. Use a system bypass 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 bypass should be the same size as the supply and return lines with valves located in the bypass and return line as illustrated in Figure 4 in order to regulate water flow for maintenance of higher boiler water temperature. Set the bypass and return valves to a half throttle position to start. Operate boiler until the system water temperature reaches its normal operating range. Adjust the valves to maintain 180°F to 200°F boiler water temperature and greater the 120°F return temperature. Adjust both valves simultaneously. Closing the boiler return valve while opening the bypass valve will raise the boiler return temperature. Opening the boiler return valve while closing the by-pass valve will lower the boiler return temperature.
- e. A water boiler installed above radiation level must be provided with a low water cutoff device as part of the installation.

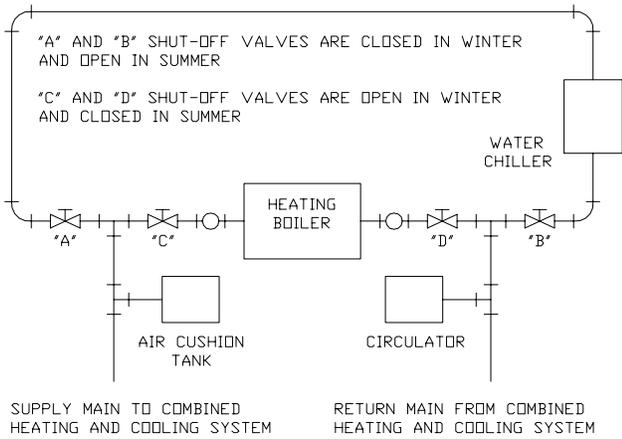


Figure 3: Recommended Piping for Combination Heating and Cooling (Refrigeration) System

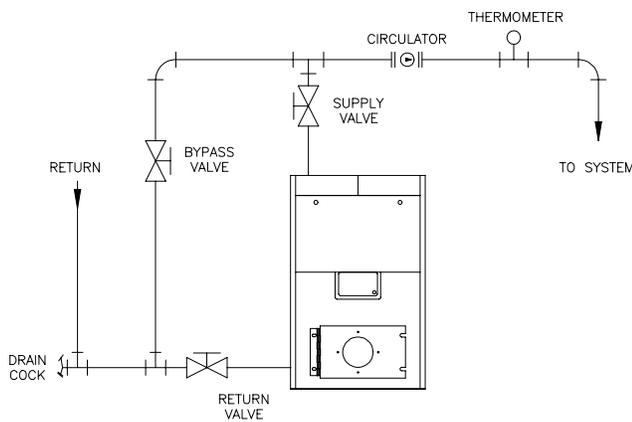


Figure 4: Recommended System Bypass Piping

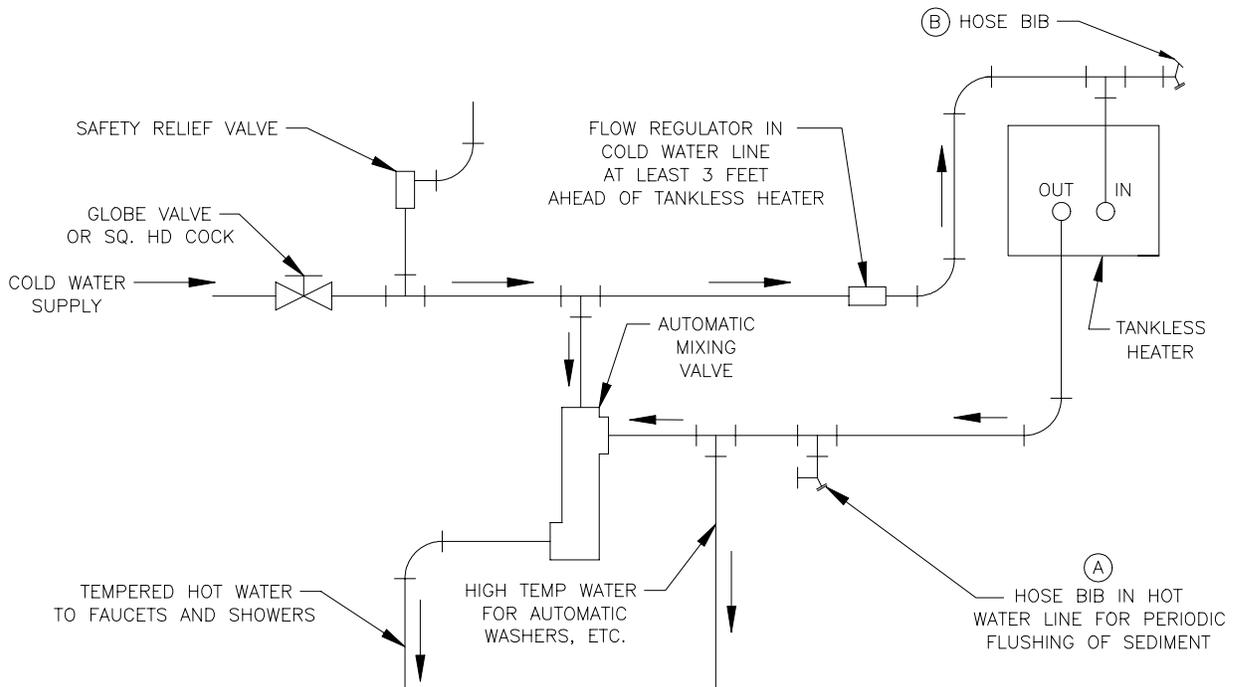


Figure 5: Schematic Tankless Heater Piping

B. Install Pressure Relief Valve. See Figures 8 and 9. Pressure Relief Valve must be installed with spindle in the vertical position. Installation of the relief valve must be consistent with ANSI/ASME Boiler and Pressure Vessel Code, Section IV.

C. Install Drain Valve in return piping. See Figures 8 and 9.

D. Oil, grease, and other foreign materials which accumulate in new hot water and a new or reworked system should be boiled out, and then thoroughly flushed. A qualified water treatment chemical specialist should be consulted for recommendations regarding appropriate chemical compounds and concentrations which are compatible with local environmental regulations.

E. After the boiler and system have been cleaned and flushed, and before refilling the entire system add appropriate water treatment chemicals, if necessary, to bring the pH between 7 and 11.

F. CONNECT TANKLESS HEATER PIPING AS SHOWN IN FIGURE 1. See Table 1 for Tankless Heater Rating.

heater but to piping and fixtures plus the many other benefits derived from soft water.

G. INSTALL SMOKEPIPE— The HF should be vented into a fireclay tile-lined masonry chimney or chimney constructed from type L vent or a factory built chimney that complies with the type HT requirements of UL103. The chimney and vent pipe shall have a sufficient draft at all times, to assure safe proper operation of the boiler. See Figure 6 for recommended installation.

1. Install a draft regulator following the instructions furnished with the regulator. See Figure 7 for alternate draft regulator locations.
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, 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.

A massive chimney on a cold, or exposed outside wall may have produced adequate draft when it was fired with a higher input and greater volumes of heated gases. With reduced input and volume, the draft may be severely affected. In one instance our research showed a new chimney of adequate sizing produced only $-.035''$ W.C. after 30 minutes of continuous firing at 13.0% CO_2 . Outside wall chimneys take longer to heat up and can have $.00''$ W.C. draft at burner startup. You may have to consider a special alloy chimney flue liner with insulation around it and a stabilizing draft cap or even a draft inducing fan in severe cases.

3. For the same reasons as in (2.) above, heat extractors mounted into the breeching are not recommended.

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 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.
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 the possibility of 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 a water temperature. 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. Refer to Figure 5.
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 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** — A water analysis is necessary to determine the hardness of your potable water. This is applicable to some city water and particularly to well water. An appropriate water softener should be installed based on the analysis and dealer's recommendation. This is not only beneficial to the tankless

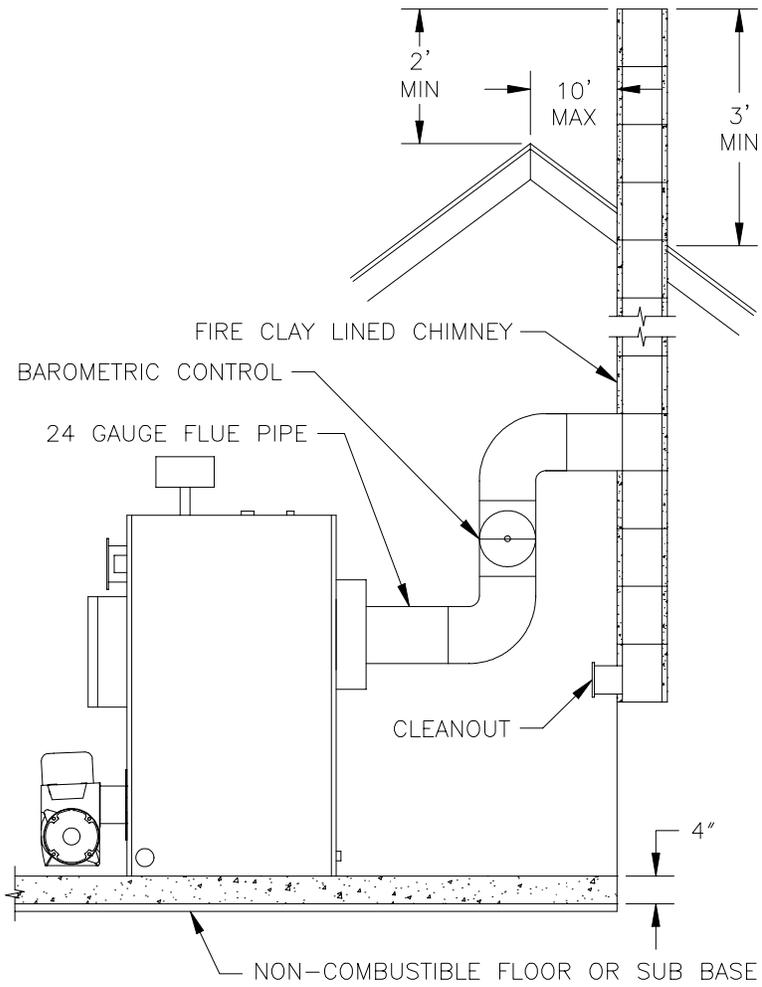


Figure 6: Recommended Smokepipe Arrangement and Chimney Requirements

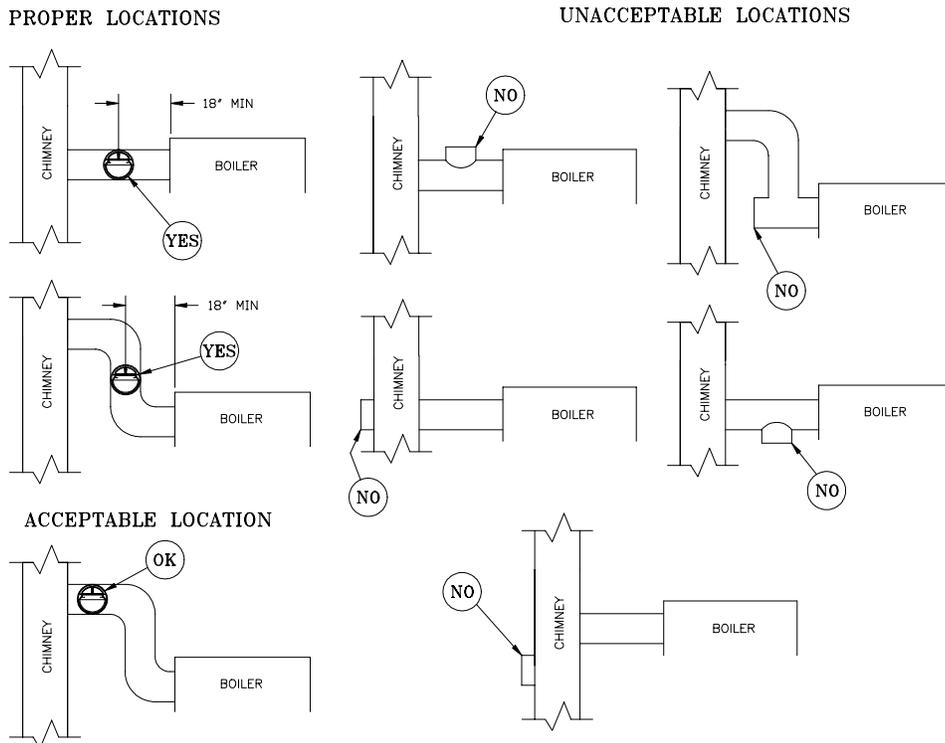


Figure 7: Proper and Improper Locations of Draft Regulator

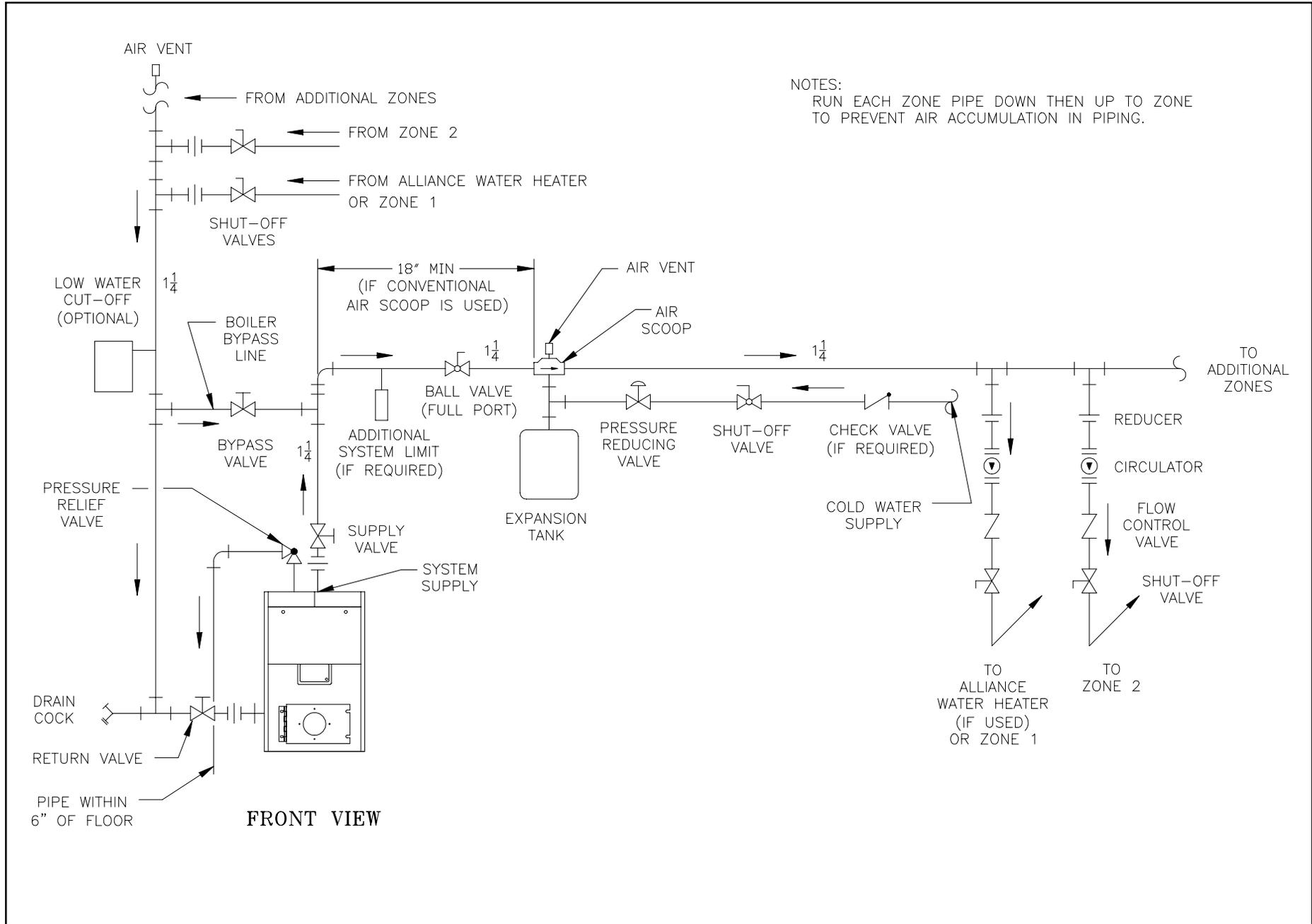
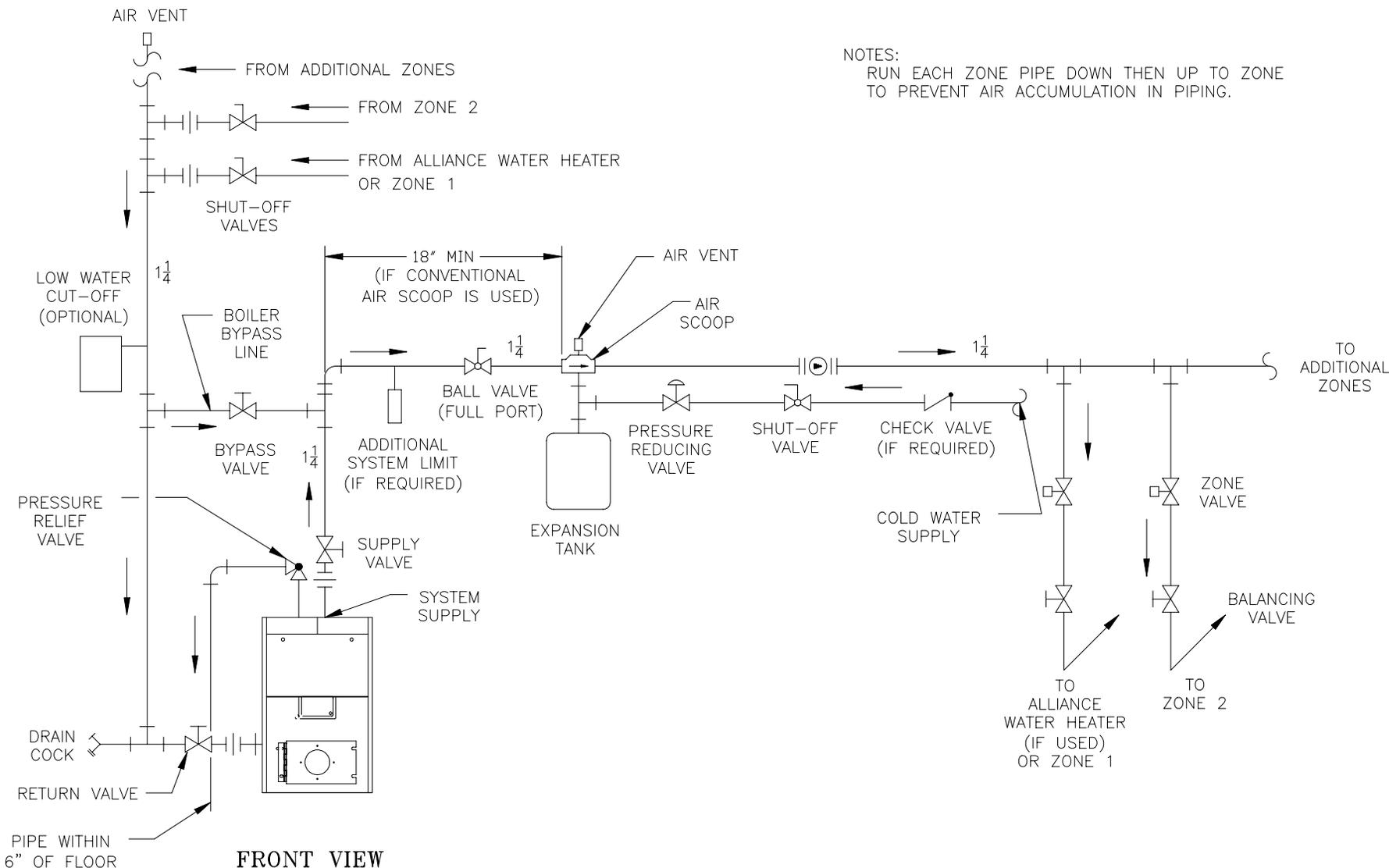


Figure 8: Recommended Boiler Piping for Circulator Zoned Heating Systems



NOTES:
 RUN EACH ZONE PIPE DOWN THEN UP TO ZONE
 TO PREVENT AIR ACCUMULATION IN PIPING.

Figure 9: Boiler Piping for Zone Valve Zoned Heating Systems

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.

H. Electrical

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 should be run from the main electrical service with a fused disconnect switch in the circuit.
3. Wiring should conform to Figure 10 and/or 11.

I. 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 Alliance™ indirect water heater is used, use priority zoning. Do not use priority zoning for Hydro-Air Systems.

5. Single Zone System – Connect the system circulator wire leads to the proper locations on the Aquastat control, L8124C/L8148A. See Figure 10 or 11. Connect the thermostat to the ‘T-T’ terminals on the L8124C/L8148A control. Set thermostat heat anticipator settings to 0.60 amps.
6. Conventional Circulator Zoned System – Read, understand and follow all of the instructions provided with the Honeywell R8888 control.
7. Conventional Zone Valve Zoned System – Locate C1 and C2 inside the L8124C Honeywell control. Connect the two (2) terminals to the system circulator wire leads, supplied with boiler. Connect the H1 and H2 terminals inside the R8889 to the ‘T-T’ terminals in the L8124C Honeywell Control.

Connect the thermostat of each zone and the circulator for that zone to R8889 panel. If an Alliance™ indirect water heater is used, connect the Alliance thermostat and circulator to the Zone 1 terminals of the R8889. Set thermostat anticipator settings to 0.12 amps.

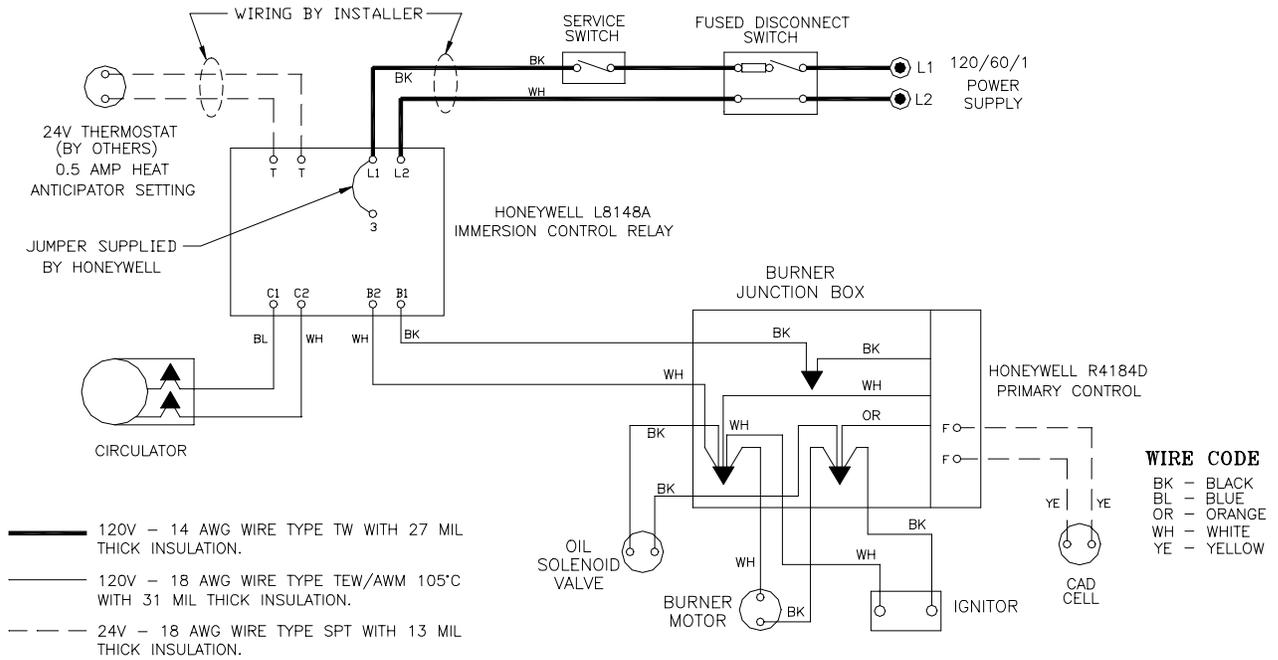


Figure 10: Wiring Diagram for Water Boilers with Beckett AFG Burner and Controls, without Tankless Heater
SEQUENCE OF OPERATION

A call for heat by the thermostat energizes the L8148A control which in turn energizes the R4184D primary control to turn on the burner. If burner ignites within approximately 45 seconds and the cad cell sees flame, the burner will continue to operate until the call for heat is satisfied or the setting of the high limit is reached. The circulator will operate as long as the thermostat is calling for heat. If the thermostat is not satisfied and the high limit is reached, the circulator will continue to operate, and the burner will stop until the high limit is closed by a drop in boiler water temperature.

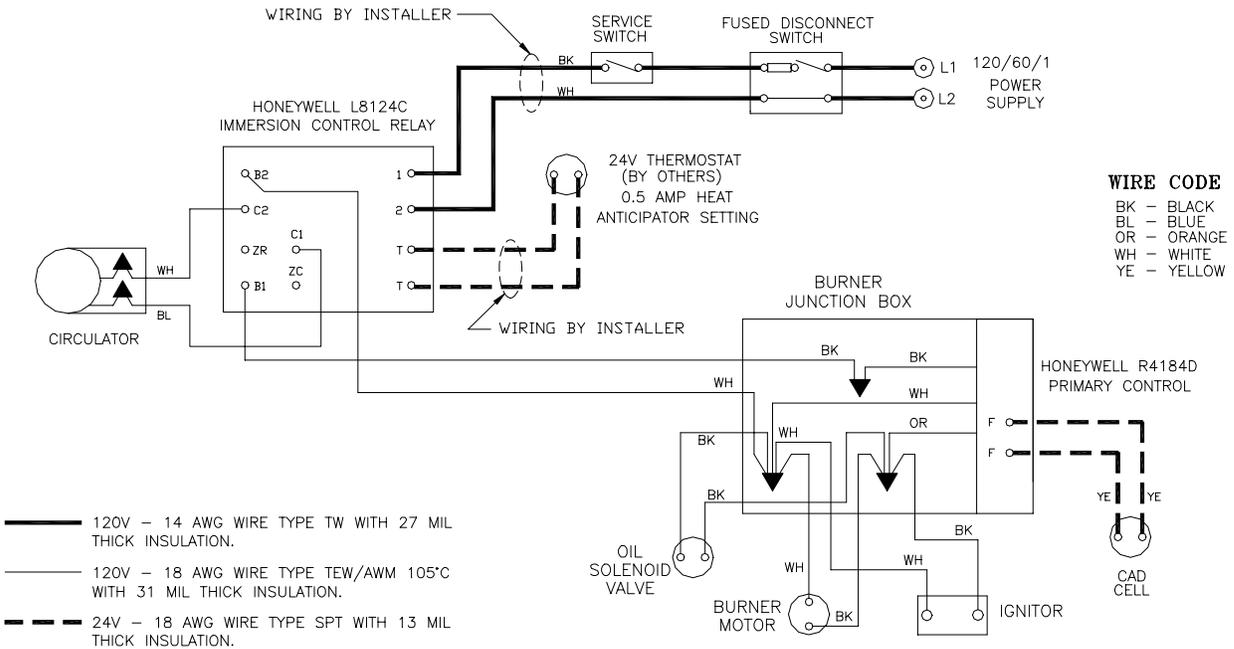


Figure 11: Wiring Diagram for Water Boilers with Beckett AFG Burner and Controls, with Tankless Heater
SEQUENCE OF OPERATION

A call for heat by the thermostat energizes the L8124C control which in turn energizes the R4184D primary control to turn on the burner. If burner ignites within approximately 45 seconds and the cad cell sees flame the burner will continue to operate until the call for heat is satisfied. The circulator will also operate when the thermostat calls for heat if the boiler water temperature is up to the setting of the low limit in the L8124C control. If boiler water temperature is below the low limit setting the burner will operate but the circulator will not, giving preference to the domestic hot water demand.

On call for heat by the thermostat the burner will continue to operate until the thermostat is satisfied or the setting of the high limit is reached. If the thermostat is not satisfied when the high limit is reached the burner will stop but the circulator will continue to operate until the thermostat is satisfied. Any time the boiler water temperature drops below the setting of the low limit the burner will be energized in order to maintain domestic water temperature.

J. Oil Piping

1. Use flexible oil line(s) so that burner can be removed without disconnecting the oil supply.
2. A supply line fuel oil filter is recommended as a minimum for all firing rates but a pleated paper fuel oil filter is recommended for the lowest firing rate application to prevent nozzle fouling.
3. Use Flared fittings only. Do not use compression fittings.
4. Use of a high efficiency micron filter (Garber or equivalent) in addition to conventional filter is highly recommended.

K. Single-pipe Oil Lines

1. Standard burners are provided with single-stage 3450 rpm fuel units with the bypass plug removed for single-pipe installations.
2. The single-stage fuel unit may be installed single-pipe with gravity feed or lift. Maximum allowable lift is 8 feet. See Figure 12.

NOTICE

Oil piping must be absolutely airtight or leaks or loss of prime may result. Bleed line and fuel unit completely.

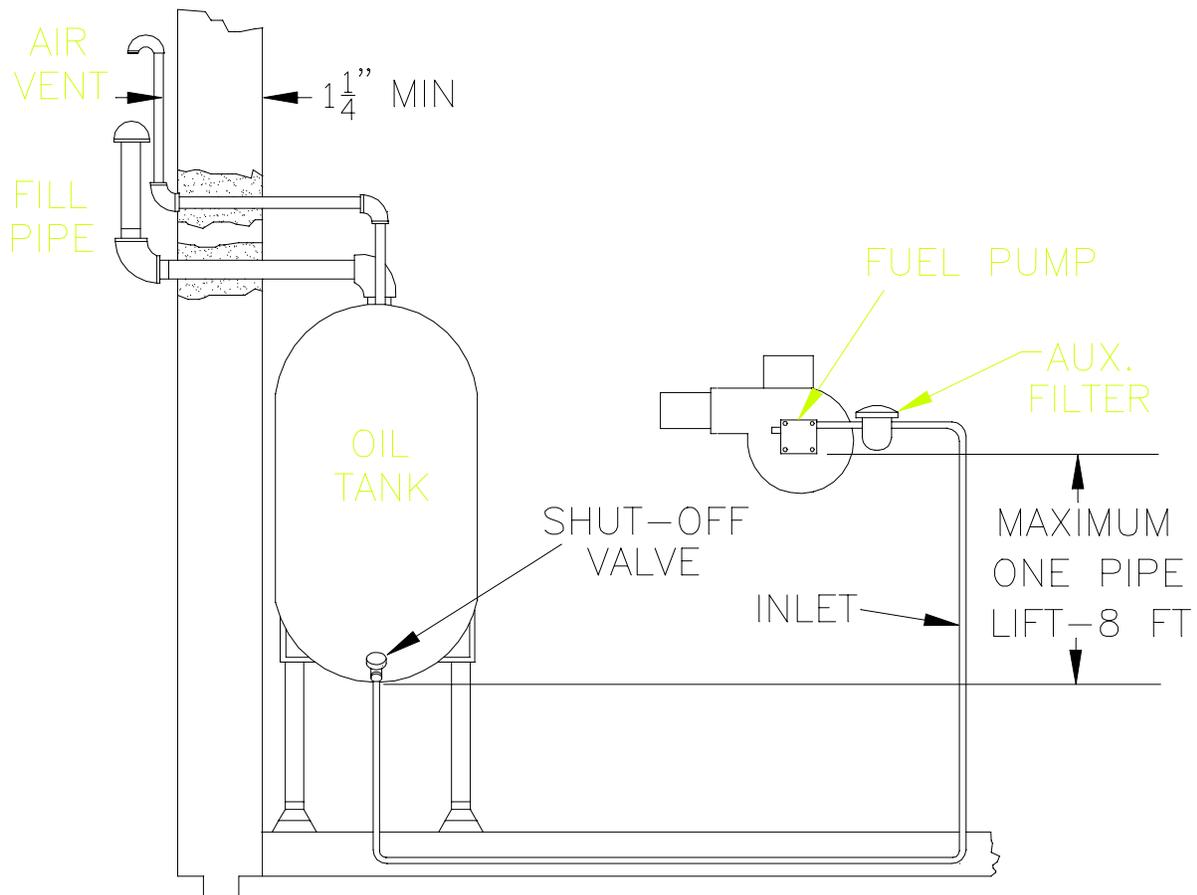


Figure 12: Single-Pipe Installation

TABLE 2: SINGLE STAGE UNITS (3450 RPM) TWO PIPE SYSTEMS		
Lift "H" (See Figure)	Maximum Length of Tubing "H" + "R" (See Figure)	
	3/8" OD Tubing (3 GPH)	1/2" OD Tubing (3 GPH)
0'	84'	100'
1'	78'	100'
2'	73'	100'
3'	68'	100'
4'	63'	100'
5'	57'	100'
6'	52'	100'
7'	47'	100'
8'	42'	100'
9'	36'	100'
10'	31'	100'
11'	26'	100'
12'	21'	83'
13'	---	62'
14'	---	41'

TABLE 3: TWO-STAGE UNITS (3450 RPM) TWO-PIPE SYSTEMS		
Lift "H" (See Figure)	Maximum Length of Tubing "H" + "R" (See Figure)	
	3/8" OD Tubing	1/2" OD Tubing
0'	93'	100'
2'	85'	100'
4'	77'	100'
6'	69'	100'
8'	60'	100'
10'	52'	100'
12'	44'	100'
14'	36'	100'
16'	27'	100'
18'	---	76'

L. Two-Pipe Oil Lines

1. For two-piped systems, where more lift is required, the two-stage fuel unit is recommended. Table 2 (single-stage) and Table 3 (two-stage) show allowable lift and lengths of 3/8 inch and 1/2 inch OD tubing for both suction and return lines. Refer to Figure 13.

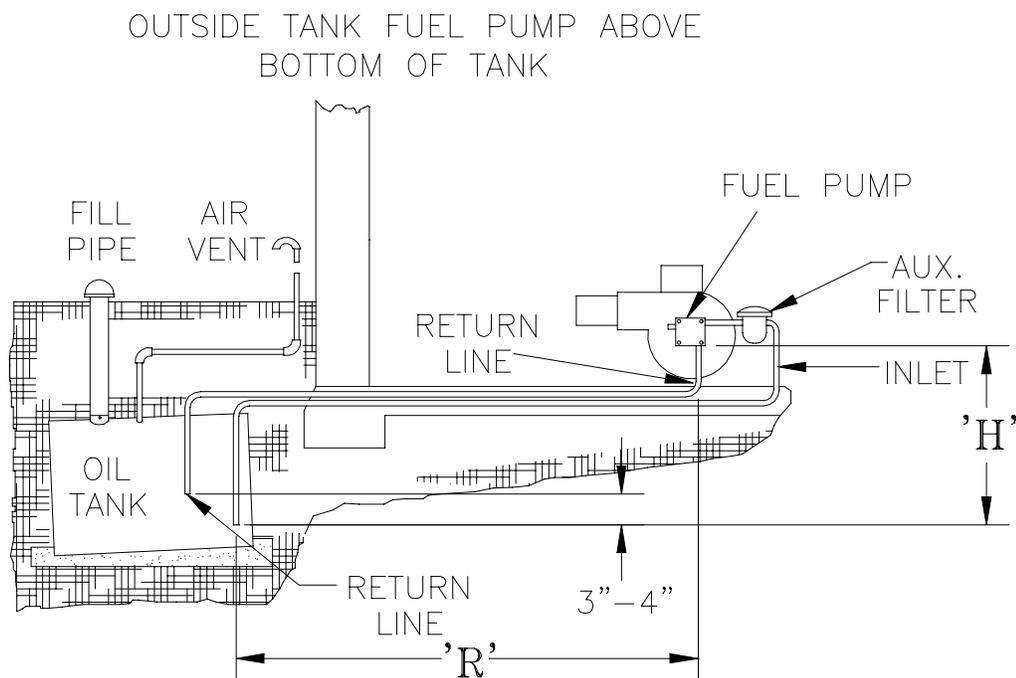


Figure 13: Two-Pipe Installation

III. System Start-Up

- A.** Verify that the venting, water piping, oil piping, and electrical system are installed properly. Refer to installation instructions contained in this manual.
- B.** Confirm all electrical, water and oil supplies are turned off at the source and that the vent is clear from obstructions.
- C.** 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 8 or 9.
1. Close isolation valve in boiler supply piping.
 2. Isolate all circuits by closing zone valves or balancing valves.
 3. Attach a hose to bib cock located just below isolation valve in boiler supply piping. (Note - Terminate hose at a suitable floor drain or outdoor area).
 4. Starting with one circuit at a time, open zone valve or valve.
 5. Open bib cock.
 6. Open fill valve (Make-up water line should be located directly after isolation valve in boiler supply piping between air scoop and expansion tank).
 7. Allow water to flow into drain until discharge from hose is bubble free for 30 seconds.
 8. When zone is completely purged of air, close zone valve or balancing valve. Open the zone valve for the next zone to be purged. Repeat this step until all zones have been purged. At completion, open all zone valves or valves.
 9. Close bib cock, continue filling the system until the pressure gauge reads 12 psig. Close fill valve. (Note - If make-up water line is equipped with pressure reducing valve, system will automatically fill to 12 psig.
 10. Open isolation valve in boiler supply piping.
 11. Remove hose from bib cock.
- D.** CONFIRM that the boiler and system have no water leaks.
- E.** CHECK CONTROLS, WIRING AND BURNER to be sure that all connections are tight and burner is rigid. Verify that all electrical connections have been completed, fuses installed, that the oil tank is filled and oil lines have been tested.
- F.** LUBRICATION. Follow instruction on burner and circulator label to lubricate, if oil lubricated. Most motors currently used on residential type burners employ permanently lubricated bearings and thus do not require any field lubrication. Water lubricated circulators do not need field lubrication.
- G.** SET CONTROLS with burner service switch turned "OFF".
1. SET ROOM THERMOSTAT about 10° above room temperature.
 2. PRESS RED RESET BUTTON on R4184D Oil Primary Control and release.
 3. SET HIGH LIMIT dial on L8124C/L8148A at temperature to suit requirements of installation.
- H.** REMOVE GUN ASSEMBLY
1. Check nozzle size, head size, gun setting, and positioning of electrodes. This information is shown in Figure 14, and Table 4.
 2. Reinstall gun assembly.
- I.** VERIFY OIL BURNER SETTINGS BEFORE STARTING
1. BURNER AIR BAND AND AIR SHUTTER SETTINGS, see Tables 4.
 2. OPEN ALL OIL LINE VALVES.
 3. Attach a plastic hose to fuel pump vent fitting and provide a container to catch the oil.
 4. REMOVE GAUGE PORT PLUG from fuel pump and install pressure gauge.
- J.** START OIL BURNER
1. Open vent fitting on fuel pump.
 2. TURN 'ON' BURNER service switch and allow burner to run until oil flows from vent fitting in a

Table 4: Beckett AFG

Boiler Model No.	Firing Rate (GPH)	Burner	Nozzle Specifications				Static Plate	Air Settings		Head	Head Setting
			Manufacturer	Size	Angle	Type		Shutter	Band		
HF98	.85	AFG	HAGO	.75	45°	B	3-3/8"U	8	0	L1	0
HF122	1.10	AFG	HAGO	.90	45°	B	3-3/8"U	10	2	L1	0
HF147	1.25	AFG	HAGO	1.0	45°	B	2-3/4"U	10	0	V1	0
HF173	1.50	AFG	HAGO	1.25	45°	B	2-3/4"U	10	2	V1	2

SOLID stream without air bubbles for approximately 10 seconds.

3. Close vent fitting and burner flame should start immediately.
4. If the burner does not start immediately, check the manual overload switch on the motor, if so equipped, and the safety switch on the burner primary control.

K. ADJUST OIL PRESSURE

1. Locate oil pressure adjusting screw and turn screw until Pressure Gauge reads the correct pump pressure required for the specific boiler. Refer to Table 4.
2. DO NOT REMOVE PRESSURE GAUGE until later.

L. OTHER ADJUSTMENTS

1. ADJUST THE AIR BAND AND/OR AIR SHUTTER.
Beckett Burners:
 - a. Adjust air supply by loosening lock screws and moving the air shutter and if necessary the air band. Refer to Table 4 preliminary settings.
2. ADJUST DRAFT REGULATOR for a draft of -.02" (water gauge) over the fire after chimney has reached operating temperature and while burner is running.
3. READJUST AIR BANDS on burner for a light orange colored flame while draft over the fire is -.02" w.c. Use a smoke test 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 CO₂ of 11.5 to 12.5% with draft of -.02" w.c. in fire box. These settings will assure a safe and efficient operating condition. If the flame appears stringy instead of a solid flame, try another nozzle of the same type. Flame should be solid and compact. After all adjustments have been made, recheck for a draft of -.02" w.c. over the fire.

4. TURN "OFF" BURNER and remove pressure gauge. Install gauge port plug and tighten. Start burner again.

M. FLAME FAILURE

The HF boiler controls operate the burner automatically. If for unknown reasons the burner ceases to fire and the rest button on the primary control has tripped, the burner has experienced ignition failure. Before pressing the rest button, call your serviceman immediately.

N. 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 this air.
2. IF NOZZLE CONTINUES TO DRIP, repeat step N.1. 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.

O. HINTS ON COMBUSTION

- a. 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 HF 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 CO₂ and smoke. Nozzles are

See Manila folder in file titled “HF”

Figure 14: Electrode / Head Setting

delicate and should 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 carry.

- b. **FLAME SHAPE** — Looking into the combustion chamber through the flame plug hole, the flame should appear straight with no sparklers rolling up toward the top of the chamber. If the flame drags to the right or left, sends sparklers upward or makes wet spots on the combustion chamber, the nozzle should be replaced. If the condition persists look for fuel leaks, air leaks, water or dirt in the fuel as described below.

- c. **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.

- d. **AIR 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.

There may be many possible causes of leaks in oil lines such as:

- i. Fitting leaks due to misflared tubing or damaged fitting.
- ii. Fuel line leak due to crushed or bent tubing.
- iii. Filter connection leaks.
- iv. Tank connection leaks.

The following actions can eliminate air leaks:

- i. Bleed pump as detailed in System Start-Up Section of this manual.
 - ii. Replace flare fittings.
 - iii. Replace oil supply line.
 - iv. Repair oil filter leaks
 - v. Replace or repair tank fittings.
- e. **GASKET LEAKS**— If 11.5% to 12.5% CO₂ with a #1 smoke cannot be obtained in stack, look for air leaks around the canopy seal. Such air leaks will cause a lower CO₂ reading in the stack. The smaller the firing rate the greater effect an air leak can have on CO₂ readings.
- f. **DIRT**— A fuel filter is a good investment. Accidental accumulation of dirt in the fuel system can clog the nozzle strainer and produce a poor spray pattern from the nozzle.
- g. **WATER**— Water in the fuel, in large amounts, will stall the fuel pump. Water in the fuel pump, in smaller amounts, will cause excessive wear on the pump, but more importantly water does not burn. It chills the flame, causes smoke, and allows unburned fuel to pass through the combustion chamber and clog the flueways of the boiler.

- h. **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 buried in the ground above the frost line is a good candidate for cold oil. The best solution is to place the tank and oil lines in the ground below the frost line.

i. HIGH ALTITUDE INSTALLATIONS

Typically, the rule to use for high altitudes is to increase the air supply by 4% per each 1000 ft. above 2000 ft. altitude from sea level. This means that the air setting will have to be higher than the calibration marks in proportion to the altitude. Use instruments and set for 11.5 to 12.5% CO₂.

- j. **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.
- k. **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.

P. TEST CONTROLS

1. **CHECK THERMOSTAT OPERATION.** Raise and lower thermostat setting as required to start and stop burner.
2. **VERIFY PRIMARY CONTROL SAFETY FEATURES** using procedures outlined in Instructions furnished with control (See back of Control Cover) or Instructions as follows:

a. **Simulate flame failure:**

- Follow the starting procedure to turn on the burner.
- Close the hand valve in the oil supply line.
- Safety switch should lock out in approximately 15 seconds. Ignition should stop and oil valve should close. Blower will stop after postpurge period.

- Push red reset button to reset safety switch.

b. **Simulate ignition failure:**

- Follow the starting procedure to turn on the burner, but do not open the oil supply hand valve.
- Safety switch should lock out in approximately 15 seconds. Ignition and motor should stop and oil valve should close.
- Push red reset button to reset safety switch.

c. **Simulate power failure:**

- Follow the starting procedure to turn on the burner.
- With the burner running, turn off the power to the system by tripping the circuit breaker or removing the fuse.
- Burner should stop.
- Restore power. Burner should start.

3. **VERIFY HIGH LIMIT OPERATION.**

- Adjust thermostat to highest setting.
- Observe temperature gauge. When temperature is indicated, adjust limit to setting below observed temperature. Burner should stop.
- Adjust limit to setting above observed temperature. Burner should start.
- Adjust thermostat to lowest setting. Adjust limit to desired setting.

4. **CHECK LOW WATER CUTOFF (if so equipped).**

- Adjust thermostat to highest setting.
- With boiler operating, open drain valve and slowly drain boiler.

- Burner should stop when water level drops below low water cutoff probe. Verify limit, thermostat or other controls have not shut off boiler.

- Adjust thermostat to lowest setting. Refill boiler.

Q. FREQUENT WATER ADDITION

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 and oxygen. When the fresh, cool make-up water is heated in the boiler the minerals fall out as sediment and the oxygen escapes as a gas. Both can result in reduced boiler life. The accumulation of sediment can eventually isolate 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 in the boiler creates a corrosive atmosphere which, if the concentration becomes high enough, can corrode the steel through from the inside. Since neither of these failure types are the result of a manufacturing defect the warranty does not apply. Clearly it is in everyone's best interest to prevent this type of failure. The maintenance of system integrity is the best method to achieve this.

IV. Service and Cleaning

WARNING

All boiler service and cleaning must be completed with burner service switch turned off. Boilers equipped with burner swing door have a potential hazard which can cause severe property damage, personal injury or loss of life if ignored. Before removing burner door, turn off service switch to boiler to prevent accidental firing of burner outside the combustion chamber. Be sure to tighten burner door fasteners completely when service is completed.

NOTICE

BURNER SHUTDOWN: Open Service Switch to turn off burner.

Manual Oil Supply Valve should be closed and Electric Service to boiler turned off if boiler will not be operated for an extended period of time.

A. General. Inspection, service and cleaning should be conducted annually. Turn off electric power and close oil supply valve while conducting service or maintenance.

B. Firetubes and Combustion Chamber.

1. CLEAN THE FIRETUBES

- a. For access to fireside of boiler, remove fasteners holding flue box panel closed.
- b. Using a 1 1/2" diameter wire brush (30" handle), clean firetubes.
- c. Remove fasteners holding burner door. Carefully remove door with burner still attached.

2. CLEAN THE COMBUSTION CHAMBER

Using wire or fiber bristle brush, clean inside of combustion chamber.

3. AFTER CLEANING

- a. Vacuum debris inside combustion chamber and vacuum remaining fireside of boiler as necessary.

BE CAREFUL not to damage insulation piece. Inspect front door insulation board and combustion chamber insulation board for damage. Replace any damaged pieces.

4. REPLACE FIRE DOOR

CAUTION: Do not start burner unless burner door is securely closed. Replace door, install fasteners, and tighten securely. Door should be parallel to tubesheet when viewed from top and sides.

C. Burner.

1. Replace the oil supply line filter.
2. Remove and clean the pump strainer (if applicable).
3. Replace the nozzle with an equivalent nozzle. See Table 4.
4. Clean and inspect the electrodes for damage, replacing any that are cracked or chipped.
5. Clean the combustion head of all lint and soot.
6. Inspect the transformer cables and connectors.
7. Remove and clean the cad cell.
8. Clean the blower wheel and the air control of any lint.
9. Check all wiring for secure connections or insulation breaks.
10. Re-adjust the burner as detailed in Section III: System Start-up, Paragraph I.

D. Controls. Test Controls for proper operation as detailed in Section III: System Start-up, Paragraph G.

V. Repair Parts

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

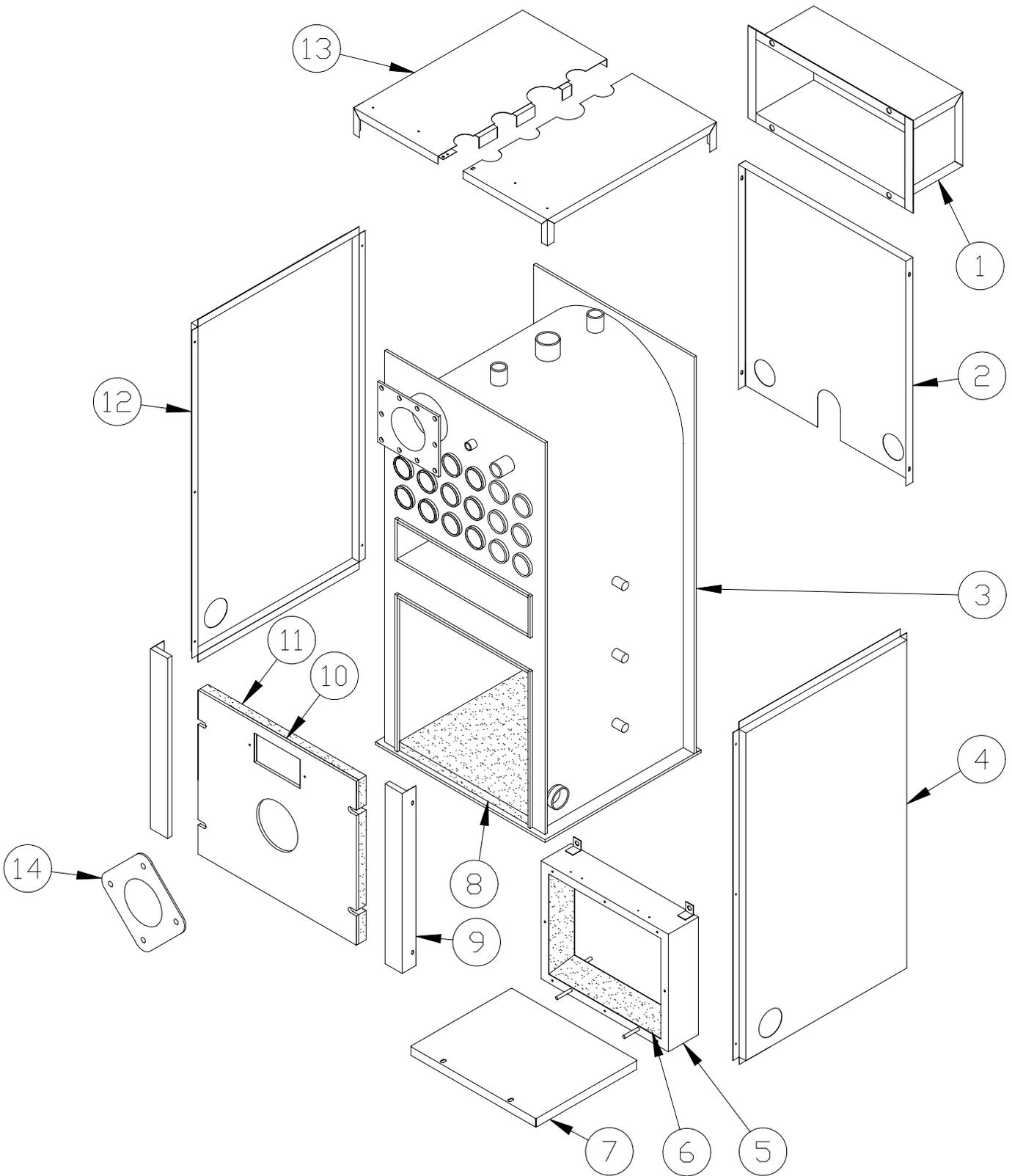


Figure 15: HF Series Bare Boiler

ITEM NO.	DESCRIPTION	PART NUMBER	
1	Rear Smoke box	61137004	61147005
2	Jacket - Lower Rear	70437033	70437042
3	Shell	8103701	8103702
4	Jacket - Right Side Panel	70437031	70437040
5	Front Flue Box	61137009	61137010
6	Flue Box Frame Insulation	61137009	61137010
7	Flue Box Door w/ Insulation	D16850	D16800
		I21350	I21400
8	Combustion Chamber Floor Insulation	I21325	I21400
9	Jacket - Lower Front Panel	70437038	70437047
10	Burner Door	D15700	D15800
11	Burner Door Insulation	I21300	I21375
12	Jacket - Left Side Panel	70437032	70437041
13	Jacket - Top Left Side Panel	604370361	604370451
	Jacket - Top Right Side Panel	704370371	704370461
14	Burner Spacer Plate	70237001	
NOT SHOWN	Jacket - Upper Front	70437034	704370432

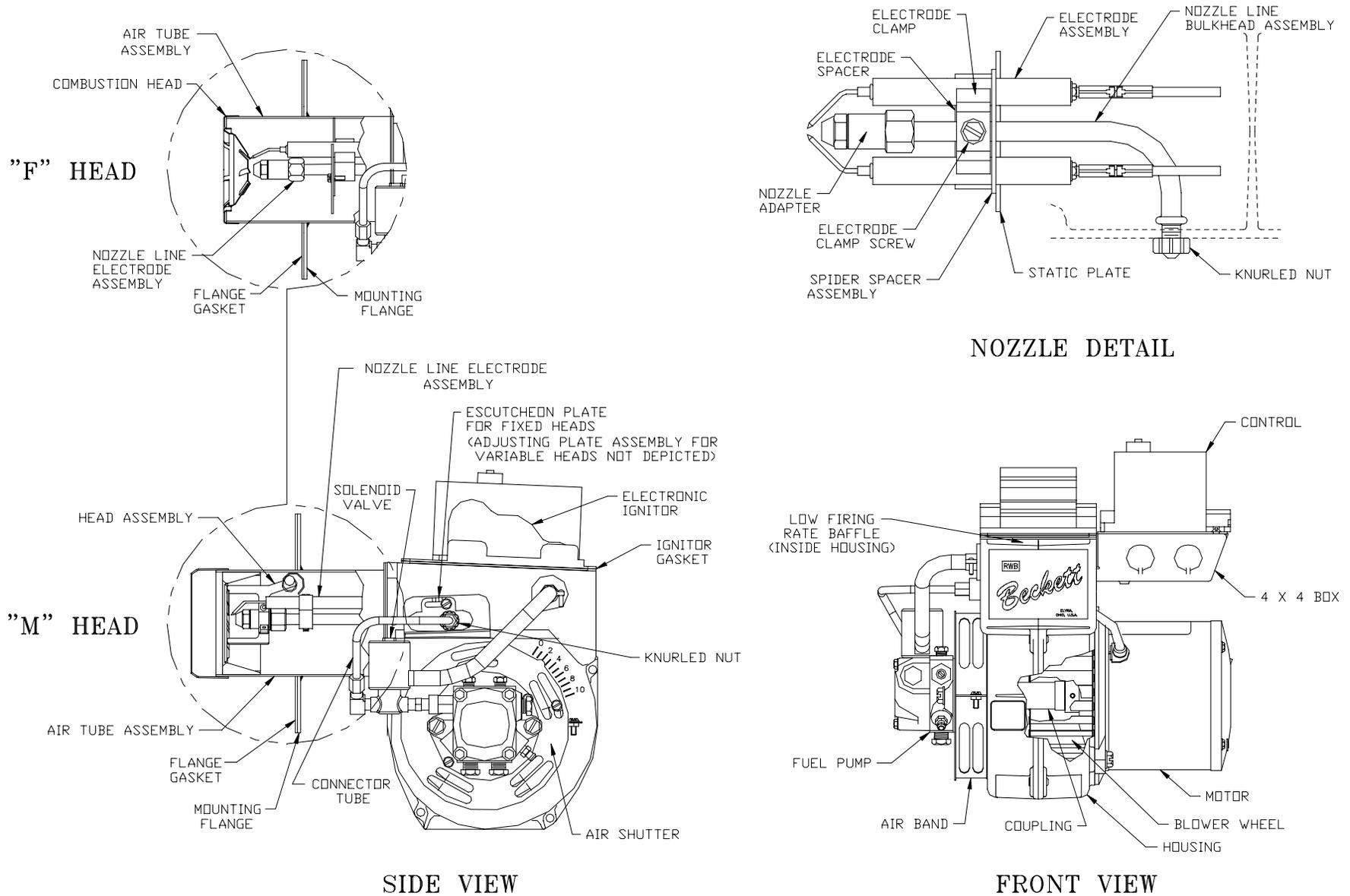


Figure 16: Beckett AFG Oil Burner Repair Part

For replacement oil burner parts, contact your wholesaler or the burner manufacturer: R.W. Beckett Co., P.O. Box 1289, Elyria, OH 44036
 (216) 327-1060 or (800) OIL BURN(645-2876)

BECKETT BURNER PARTS LIST FOR RSA SERIES STEEL BOILERS

FOR REPLACEMENT OIL BURNER PARTS, CONTACT YOUR WHOLESALER OR THE BURNER MANUFACTURER:

R. W. BECKETT CORP.
38251 CENTER RIDGE RD.
P. O. BOX 1289
ELYRIA, OHIO 44036
1-800-645-2876

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(s) number as listed below.

Boiler Model	HF-96	HF-122	HF-147	HF-173
Burner Model	AFG	AFG	AFG	AFG
Air Tube Combination	AFG50MB	AFG50MBI	AFG70MDI	AFG70MDI
Spec. No.	NY1101	NY1101	NY1108	NY1108
1) Air Band	3492BKA	3492BKA	3492BKA	3492BKA
Air Band Nut	4150	4150	4150	4150
Air Band Screw	4198	4198	4198	4198
2) Air Shutter	3709BK	3709BK	3709BK	3709BK
Air Shutter Screw	4198	4198	4198	4198
6) Blower	2999	2999	2999	2999
7) Bulkhead Fitting	3488	3488	3488	3488
8) Bulkhead Fitting Locknut	3666	3666	3666	3666
9) Connector Tube Assembly	5636	5636	5636	5636
10) Coupling	2454	2454	2454	2454
11) Electrode Clamp	149	149	149	149
Electrode Clamp Screw	4219	4219	4219	4219
12) Electrode Insulator Assembly	5780	5780	5780	5780
15) Spider Spacer Assembly	5503	5503	5503	5503
16) Escutcheon Plate	3493	3493	3493	3493
18) Flange and Air Tube Assembly	3146806	3146806	3146806	3146806
Gasket	31498	31498	31498	31498
19) Head	5912	5912	5913	5913
Head Screws	4221	4221	4221	4221
Hole Plug	2139	2139	2139	2139
20) Housing Assembly w/Inlet Bell	5624	5624	5624	5624
21) Motor	2456	2456	2456	2456
22) Nozzle Adapter	213	213	213	213
23) Nozzle Line Electrode Assembly	NL50MB	NL50MB	NL50MD	NL50MD
25) Pump	2460	2460	2460	2460
27) Static Plate	3384	3384	3383P	3383P
28) Ignitor	7440	7440	7440	7440
29) Ignitor Hinge Screw	4217	4217	4217	4217
30) Ignitor Holding Screw	4198	4198	4198	4198
31) Ignitor Gasket Kit	51304	51304	51304	51304
32) Wire Guard	3345	3345	3345	3345
33) Baffle	N/A	N/A	N/A	N/A

