



Model No.

3K0.60

3K0.75

3K1.00

4K.90

4K1.25

4K1.50

5K1.20

5K1.75

5K2.00

KEYSTONE SERIES II
OIL-FIRED
CAST IRON HOT WATER BOILER

INSTALLATION, OPERATION
& MAINTENANCE MANUAL



ECR international
EST. 1928
A Family of Heating & Cooling Brands.

Manufactured by:
ECR International, Inc.
2201 Dwyer Avenue, Utica NY 13501
web site: www.ecrinternational.com

P/N 240009460, Rev. C [03/02/2016]

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**These instructions
must be affixed on or
adjacent to the boiler.**

OIL FIRED BOILERS

These boilers are low pressure, sectional cast iron boilers constructed and hydrostatically tested for a maximum working pressure of 50 psi in accordance with A.S.M.E. (American Society of Mechanical Engineers) Section IV Standards for cast iron heating boilers.

WARNING

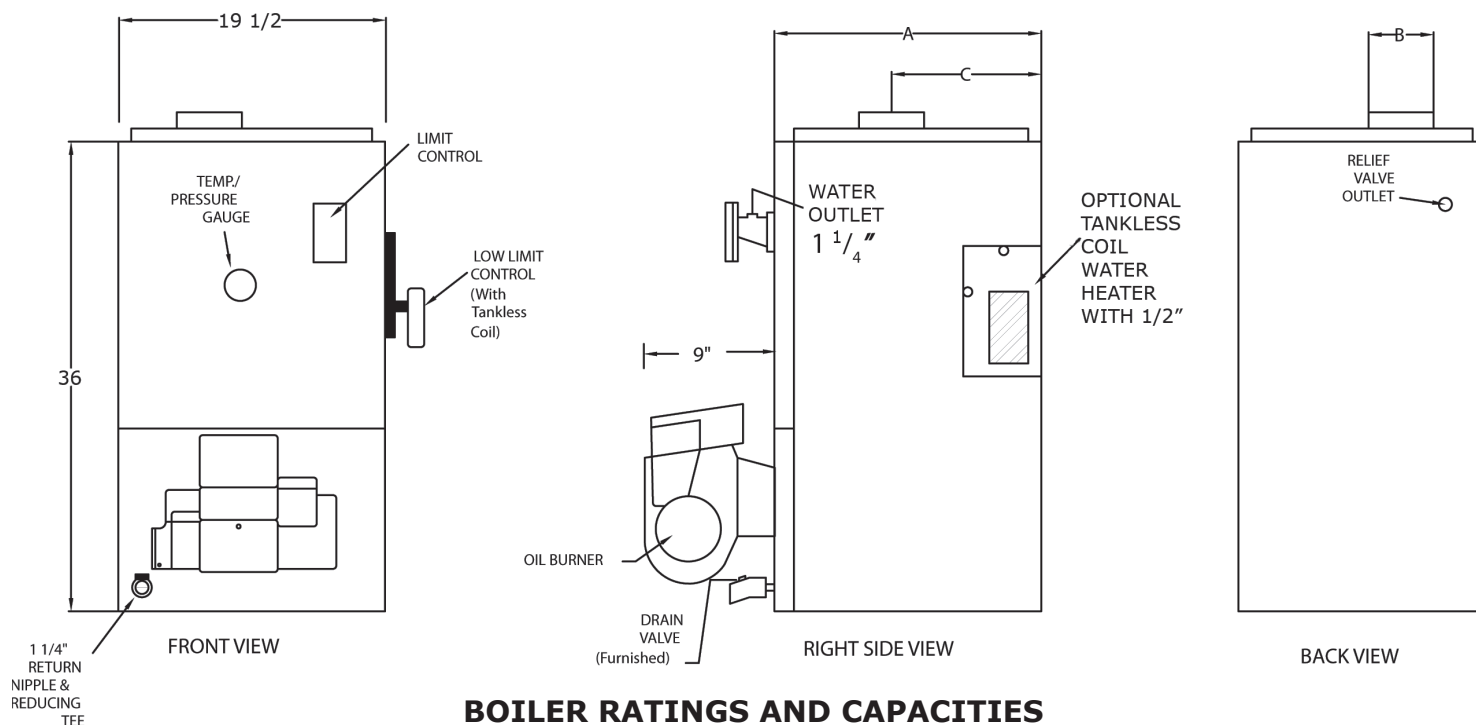
Fire, explosion, asphyxiation and electrical shock hazard. Improper installation could result in death or serious injury. Read this manual and understand all requirements before beginning installation.

***Save this manual
for reference.***


INTRODUCTION

Boiler is a natural draft oil fired hot water boiler comprised of cast iron sections. Boiler is available with 3, 4, or 5 cast iron sections. Sections are held together by cast iron push nipples.

Figure 1 - Dimensions



BOILER RATINGS AND CAPACITIES

<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;">  <p>AHRI CERTIFIED www.ahridirectory.org</p> </div> <div style="text-align: center;"> <p>OIL-FIRED HOT WATER BOILERS RATINGS & CAPACITIES</p> </div> </div>										
BOILER MODEL	No. of Sections	Firing Rate †GPH	Input **MBH	*** Heating Capacity **MBH	Net AHRI Rating **MBH	Minimum Chimney Size/Height	A.F.U.E. ††	Dimensions (Inches)		
								A	B	C
3K0.60 •	3	0.60	84	74	64	8"x8"x15'	86.1	17 3/4	6	9 3/4
3K0.75	3	0.75	105	92	80	8"x8"x15'	85.6	17 3/4	6	9 3/4
3K1.00 •	3	1.00	140	120	104	8"x8"x15'	84.4	17 3/4	6	9 3/4
4K.90 •	4	0.90	126	111	97	8"x8"x15'	86.0	21	6	11 3/8
4K1.25 •	4	1.25	175	153	133	8"x8"x15'	85.9	21	6	11 3/8
4K1.50	4	1.50	210	181	157	8"x8"x15'	85.1	21	6	11 3/8
5K1.20 •	5	1.20	168	147	128	8"x8"x15'	86.1	24 1/4	6	13
5K1.75	5	1.75	245	210	183	8"x8"x15'	85.0	24 1/4	6	13
5K2.00 •	5	2.00	280	239	208	8"x8"x20'	84.0	24 1/4	6	13

• These firing rates available only with alternate firing rate kits.

** MBH = 1,000 Btu Per Hour BTU = British Thermal Unit

*** Heating capacity based on 13% CO₂ with -0.02" W.C. draft over fire, and #1 smoke or less. Testing was done in accordance with D.O.E. (Department Of Energy) test procedure.

† GPH = Gallons Per Hour Of Oil At 140,000 Btu Per Gallon

†† A.F.U.E. = Annual fuel utilization efficiency based upon D.O.E. Test procedure.

Net AHRI Water Ratings based on piping allowance of 1.15. Consult manufacturer before selecting a boiler for installations having unusual piping and pickup requirements, such as intermittent system operation, extensive piping systems, etc.

BOILER RATINGS AND CAPACITIES

These low pressure oil fired hot water boilers are constructed and hydrostatically tested for maximum working pressure of 50 psig (pounds per square inch) in accordance with the latest revision of the A.S.M.E. (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code Section IV Standards for heating boilers.

Heating Capacity indicates amount of heat available after subtracting losses up the stack. Most of this remaining heat is available to heat water. A small portion is heat from the jacket and boiler surface and it is assumed that this heat stays in the structure. Net AHRI Rating represents portion of remaining heat that can be applied to heat radiation or terminal units (i.e. finned tube baseboard, cast iron radiators, radiant floor, etc.). Difference between Heating Capacity and Net AHRI Rating, called piping and pickup allowance, establishes reserve for heating volume of water in the system and off-setting heat losses from system piping. Net AHRI Rating of the boiler selected should be greater than or equal to calculated peak heating load (heat loss) for building or area(s) served by the boiler and associated hot water heating systems. Consult manufacturer before selecting boiler for installations having unusual piping and pickup requirements.

Boilers with same number of sections are identical to each other except for their firing rate. Firing rate is determined by nozzle size in oil burner. For example: Models 3KW0.60Z, 3KW0.75Z and 3KW1.00Z are the same boiler, except for firing rate of oil burner.

These boilers operate on #2 Heating Oil. Alternate firing rate kits are available for 3 section, 4 section and 5 section boilers.

Boiler installation shall be completed by qualified agency.

Become familiar with symbols identifying potential hazards.



This is the safety alert symbol. Symbol alerts you to potential personal injury hazards. Obey all safety messages following this symbol to avoid possible injury or death.

DANGER

Indicates a hazardous situation which, if not avoided, **WILL** result in death or serious injury

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Used to address practices not related to personal injury.

1. Failure to follow rules for safe operation and instructions can cause a malfunction of the boiler and result in death, serious bodily injury, and/or property damage.
2. Check your local codes and utility requirements before installation. Installation must be in accordance with their directives, or follow NFPA 31 Installation of Oil Burning Equipment, latest revision.
3. Before servicing, allow boiler to cool. Shut off any electricity and oil to boiler when working on it.
4. Inspect oil line and connections for leaks.
5. Verify oil burner nozzle is the size required. Over-firing will result in early failure of boiler sections. This will cause dangerous operation.
6. Never vent this boiler into enclosed space. Always vent to outside. Never vent to another room or inside a building.
7. Verify there is adequate air supply for complete combustion.
8. Follow regular service and maintenance schedule for efficient, safe and reliable operation.
9. Keep boiler area clean and free of combustible material, gasoline and other flammable vapors and liquids.
10. Oil burners are not do-it-yourself items. Boiler must be installed and serviced by qualified professionals using combustion test instruments.

WARNING

Burn and scald hazard. Safety relief valve could discharge steam or hot water during operation. Install discharge piping per these instructions.

11. Be aware when piping safety relief valve if system pressure exceeds safe limit of 30 pounds per square inch, safety relief valve will automatically lift open. Lifting of safety relief valve can discharge large quantities of steam and hot water, which may damage surroundings. Before installing safety relief valve read manufacturer's instructions and maintenance section of manual on safety relief valves.
12. Installation and sizing of the expansion tank must consider heating systems total water volume, temperature, boiler initial fill pressure, and system arrangement. Improperly installed and sized expansion tank may result in frequent lifting of safety relief valve or other heating system problems. For proper installation, sizing, and maintenance of expansion tank follow guidelines established by boiler manufacturer and expansion tank manufacturer.
13. Expansion tank performance and life expectancy can be hindered by overfilling the boiler. Boiler manufacturer recommends initial fill pressure of 10-12 psig. For higher fill pressures expansion tank's air charge will need to be increased to match fill pressure. Consult manufacturer's guidelines for sizing and selection.
14. Purging heating system of air and gases when first placing boiler into service is critical for proper circulation and quiet performance. Once air and gases are purged, for boiler installations using float type vents, air vents should be closed for normal operation. If air is heard or noticed by loss of heat, purge system and open vents for short period of time.

NOTICE

This boiler has been designed for residential installations. If used for commercial applications, all jurisdictional requirements must be met. This may require wiring and/or piping modifications. Manufacturer is not responsible for any changes to the original design.

DO NOT USE GASOLINE CRANKCASE DRAININGS OR ANY OIL CONTAINING GASOLINE.

BEFORE YOU START

Complete following prior to installing boiler.

- Verify you have selected right size boiler with proper capacity. AHRI rating of boiler selected should be greater than or equal to calculated peak heating load (heat loss) for building or area(s) served by boiler and associated hot water heating systems. See boiler rating and capacity table previously listed. Any heat loss calculations used should be based on approved methods.
- Supply boiler with proper oil supply and oil piping, sufficient fresh combustion air, and suitable electrical supply.
- Connect boiler to suitable venting system and piping system adequate to distribute heating load.
- Thermostat must be properly located and installed for control of heating system.

If there are any doubts as to requirements, check with local authorities and obtain professional help where needed. Operating Instructions, Checks And Adjustments, And Maintenance sections in this manual are vital to proper and safe operation of heating system. Take time to be sure they are all done.

BOILER LOCATION

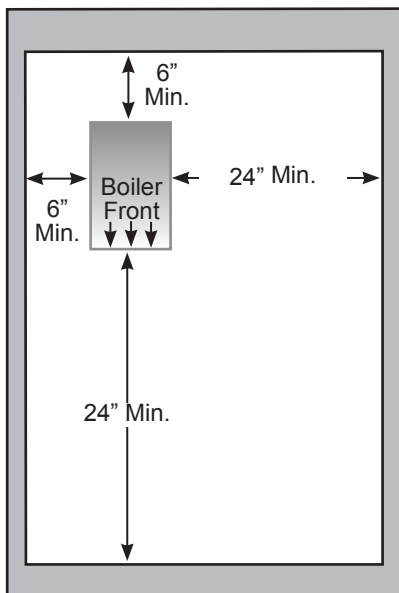
- Place boiler in location centralized with piping system and as close to chimney as possible.
- Boiler must be level. If necessary use metal shims beneath boiler's feet.
- Use raised base if floor can become wet or damp.
- Maintain clearances for fire safety as well as servicing. Maintain 18" clearance at a side where passage is required for access to another side for cleaning, servicing, inspection, or replacement of any parts that normally may require such attention. Boilers must be installed at least 6" from combustible material on all sides and above. Allow at least 24" front clearance for servicing.
- Allow fresh air for combustion at front of boiler. Allow fresh air for ventilation to front **and** rear of boiler. Air passages must be free of obstructions at all times. Ventilating and combustion air must enter boiler room without restrictions.

⚠ WARNING

Fire hazard. Do not install boiler on combustible flooring or carpeting. Failure to follow these instructions could result in death or serious injury.

- Floor supporting boiler must be noncombustible and sufficiently stable. If flooring is combustible, place boiler on 2" concrete patio blocks or 2" Cladlite Pad™. Blocks or pad must be under entire boiler to protect floor.
- Be sure installation is in accordance with the requirements of the local authorities having jurisdiction. Compliance with these regulations is required. In the absence of local codes, follow NFPA 31 Installation of Oil Burning Equipment, latest revision.

Figure 2 - Clearances



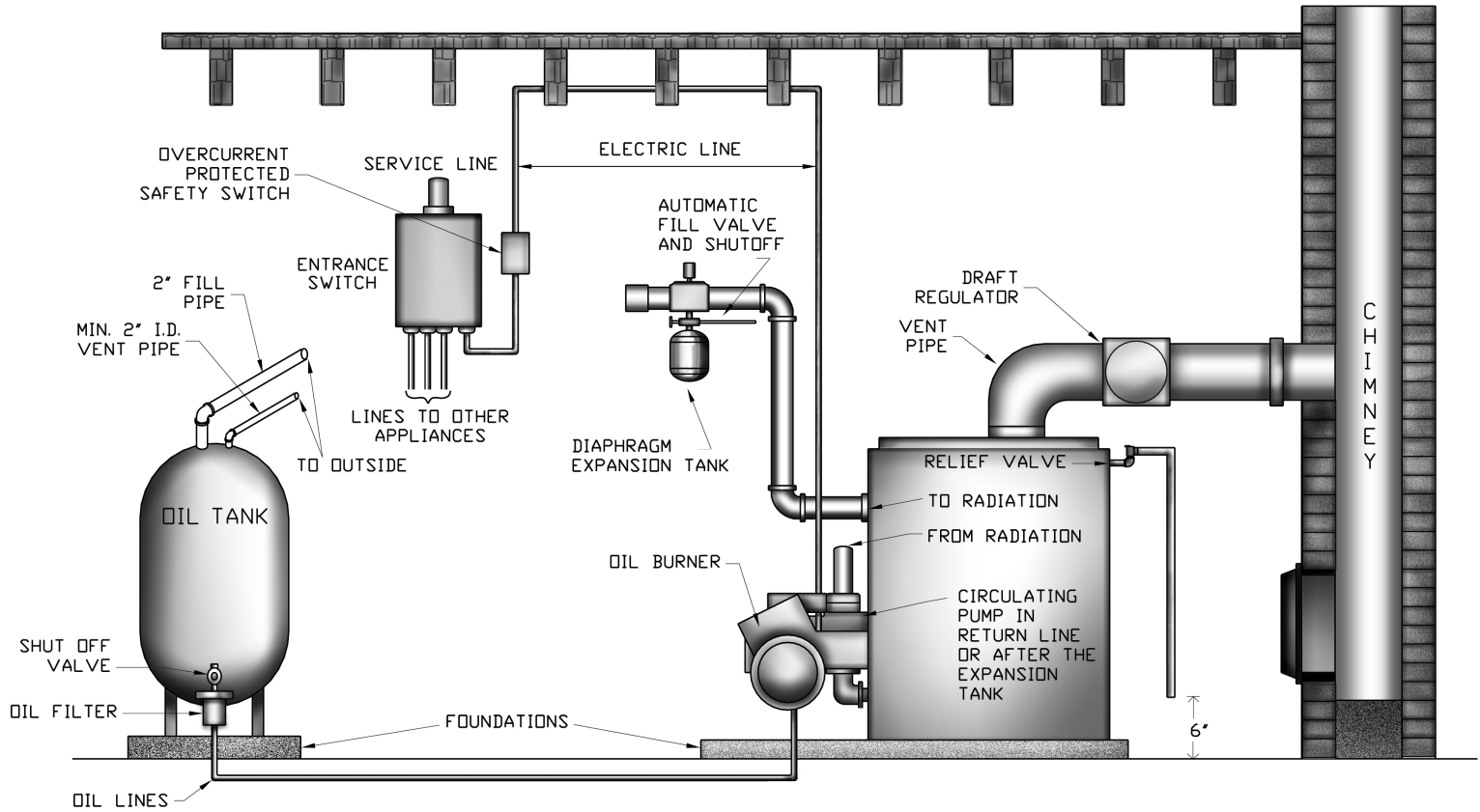
MINIMUM CLEARANCE DIMENSIONS

BOILER CLEARANCES			
Unit	Combustible Clearance	Accessibility, Cleaning, and Servicing	Flue to Combustible Clearance
Top	6"	18"	18"
Right Side	24"	24"	
Left Side	6"		
Base	Non-combustible		
Front	24"		
Back	6"		

All distances measured from the cabinet of the boiler.

Figure 3 - Boiler With Piping System

**ALWAYS KEEP MANUAL FUEL SUPPLY VALVE SHUT OFF IF
BURNER IS SHUT DOWN FOR EXTENDED PERIOD OF TIME.**



GENERAL PRINCIPAL REQUIREMENTS FOR A TYPICAL INSTALLATION

⚠ WARNING

Asphyxiation, fire hazard. Do not obstruct air openings to combustion area. Follow instructions below, to maintain adequate combustion air.

NOTICE

Install outside air intake if you use fireplace or kitchen or bathroom exhaust fan. These devices rob boiler and water heater of combustion air.

Provide enough fresh air to assure proper combustion. Fire in the boiler uses oxygen. It must have continuous supply. Air in the house contains only enough oxygen to supply burner for short time. Outside air must enter house to replace air used by the burner. Study following examples 1 and 2 to determine your fresh air requirements.

EXAMPLE 1: Boiler Located in Unconfined Space

If your boiler is in open area (non partitioned basement) in conventional house, air that leaks through cracks around doors and windows will usually be adequate to provide air for combustion. Doors should not fit tightly. Do not caulk cracks around windows.

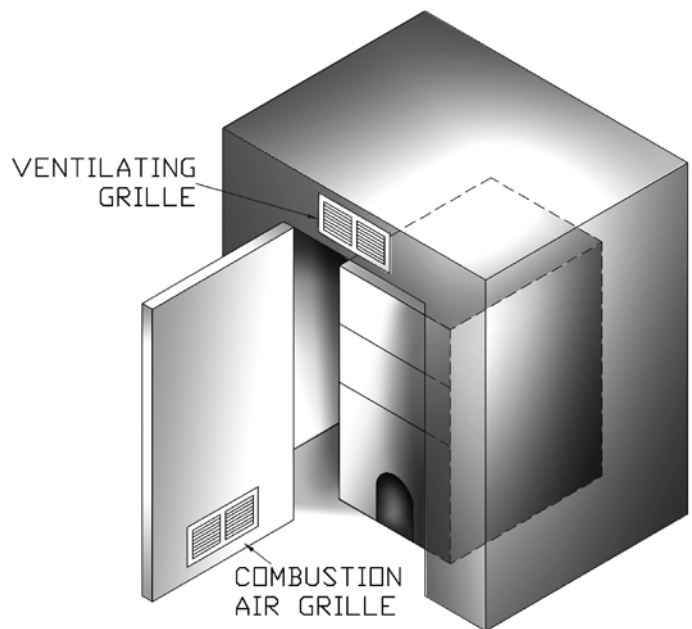
Unconfined space is defined as space whose volume is not less than 50 cubic feet per 1,000 Btu per hour of total input rating of all appliances installed in that space.

EXAMPLE 2: Boiler Located in Confined Space

A. All Air from Inside the Building: Confined space shall be provided with two permanent openings communicating directly with additional room(s) of sufficient volume so that combined volume of all spaces meets criteria for unconfined space. Total input of all combustion equipment installed in combined space shall be considered in making this determination. Each opening shall have minimum free area of one square inch per 1,000 Btu per hour of total input rating of all combustion equipment in confined space, but not less than 100 square inches. One opening shall be within 12 inches of top and one within 12 inches of bottom of the enclosure.

Example: Your boiler is rated at 100,000 Btu per hour. Water heater is rated at 30,000 Btu per hour. Total is 130,000 Btu per hour. You need two grilles, each with 130 square inches of **FREE** opening. Metal grilles have about 60% **FREE** opening. To find louvered area needed, multiply free opening required by 1.7 ($130 \times 1.7 = 221.0$ sq. in. louvered area). In this example, two grilles each having 8" x 30" (240 sq. in.) louvered area would be used.

Figure 4 - Air Openings For Boiler Located In Confined Space (Utility Room)

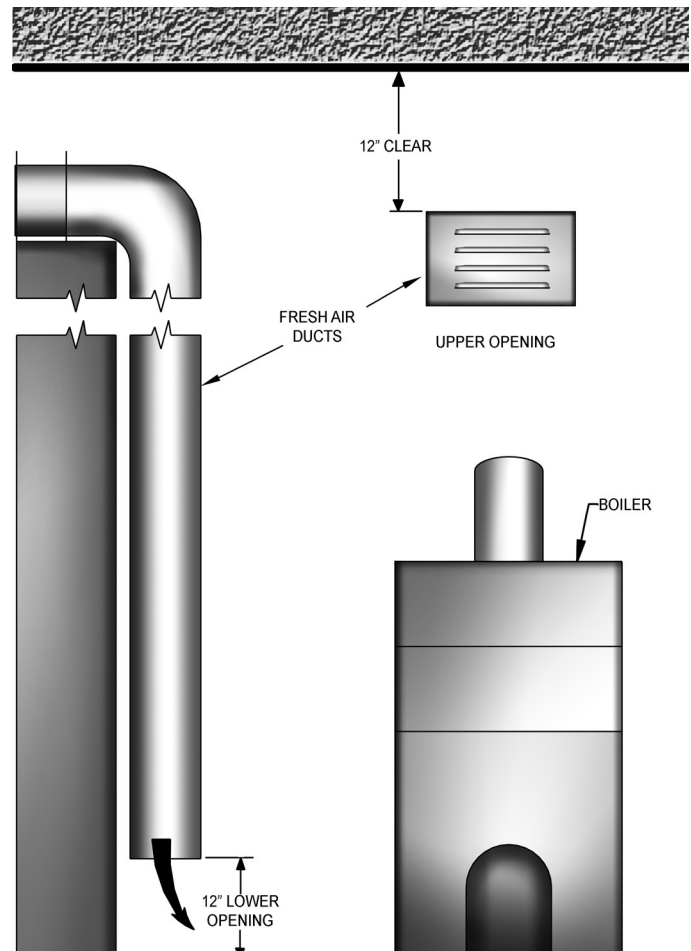


- B. All Air from Outdoors:** Confined space shall be provided with two permanent openings, one commencing within 12 inches of top and another commencing within 12 inches of bottom of enclosure. Openings shall communicate directly, or by ducts, with outdoors or spaces (crawl or attic) that freely communicate with outdoors.
1. When directly communicating with outdoors, each opening shall have minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure.
 2. When communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the enclosure.
 3. When communicating with outdoors through horizontal ducts, each opening shall have minimum free area of one square inch per 2,000 Btu per hour of total input rating of all equipment in the enclosure.
 4. When ducts are used, they shall be of same cross sectional area as free area of openings to which they connect. Minimum dimension of rectangular air ducts shall be not less than three inches.

Figure 5 - Fresh Air Duct Capacities For Ducts Supplying Fresh Air To Boiler In Tightly Constructed Houses

FRESH AIR DUCT CAPACITIES THROUGH LOUVERS			
Fresh Air Duct Size	1/4" Mesh Screen	Wood Louvers	Metal Louvers
	(Btuh)*	(Btuh)*	(Btuh)*
3 1/2" x 12"	144,000	36,000	108,000
8" x 8"	256,000	64,000	192,000
8" x 12"	384,000	96,000	288,000
8" x 16"	512,000	128,000	384,000

*Btuh = British Thermal Units per hour based on opening covered by 1/4" mesh screen, wood louvers, or metal louvers.



1. **Installation of boiler for new heating system,**
Install all of radiation units (panels, radiators, baseboard, or tubing) and supply and return mains first. After all heating system piping and components have been installed, make final connection of system piping to boiler. It is recommended to mount circulating pump on supply side piping, such that it pumps away from expansion tank. Refer to figures on next pages.
2. Equip hot water **boiler installed above radiation level** with low water cut off device. Periodic inspection is necessary, as is flushing of float type devices, per low water cut off manufacturer's specific instructions.
3. **Packaged boiler is set up with 1¼" NPT supply and return piping** from front of boiler. Boiler supply and return piping can be moved to rear of boiler. Boiler should not be piped return line to front, supply line to rear, or vice versa, will cause boiler water to short circuit heat exchanger. Piping connections may require additional fittings and parts.
4. **Install drain valve** provided with boiler in return tee. See figure on page 3.
5. **Install Safety Relief valve** in rear section using ¾" nipple and street elbow provided with boiler. See figure 6.
 - A. Install safety relief valve with spindle in vertical position.
 - B. Do not install shutoff valve between boiler and safety relief valve.
 - C. Install discharge piping from safety relief valve.
 - Use ¾" or larger pipe.
 - Use pipe suitable for temperatures of 375°F (191°C) or greater.
 - Individual boiler discharge piping shall be independent of other discharge piping.
 - Size and arrange discharge piping to avoid reducing safety relief valve relieving capacity below minimum relief valve capacity stated on rating plate.
 - Run pipe as short and straight as possible to location protecting user from scalding and properly drain piping.
 - Install union, if used, close to safety relief valve outlet.
 - Install elbow(s), if used, close to safety relief valve outlet and downstream of union (if used).
 - Terminate pipe with plain end (not threaded).

6. **Verify clean cold water supply is available** when connecting to pressure reducing valve. Use sand strainer or pump strainer when water supply is from well.

Low Design Water Temperature Systems (Below 140° F) And Large Water Content Systems

Significant condensation may form in this boiler and/or venting system if boiler is operated with return temperatures of less than 120° F.

Condensation is corrosive and can eventually cause damage to boiler and venting system. Minimum design return water temperature to prevent this condensation in boiler and venting is 120°F.

Boiler used in heating system where design water temperatures below 140°F are desired (e.g. radiant floor heating), a 3-way or 4-way mixing valve or suitable alternative (e.g. Bypass Piping Arrangement shown in diagram on following page) is required to prevent low temperature (below return 120°F) return water from entering boiler. When using mixing valve, follow manufacturer's installation instructions.

Boiler connected to system having large water content (such as former gravity system), use of Bypass Piping Arrangement shown in diagram on following page is suggested.

Figure 6 - Safety Relief Valve Installation

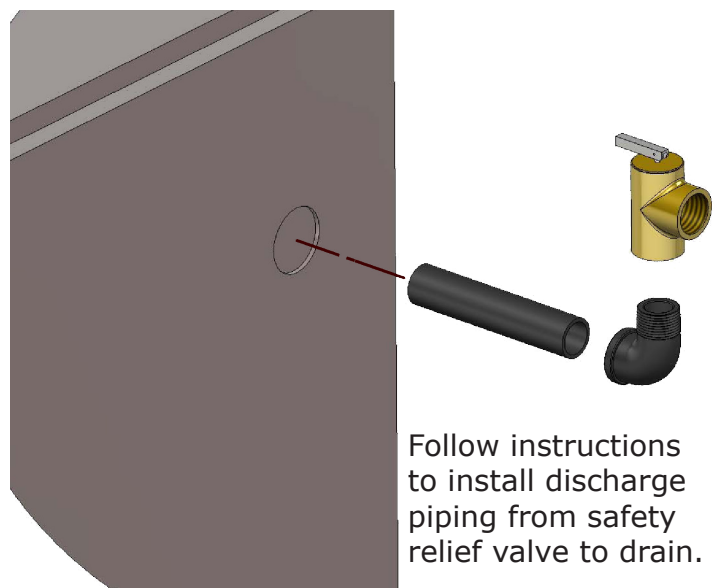


Figure 7 - Bypass Piping Arrangement Diagram

- > LOW DESIGN WATER TEMPERATURE SYSTEMS
- > LARGE WATER CONTENT SYSTEMS
- > PIPING ARRANGED FOR "POWER PURGING" AIR OUT OF THE SYSTEM PIPING, REFER TO THIS MANUAL'S SECTION ON "FILLING THE SYSTEM WITH WATER" OPTION #1

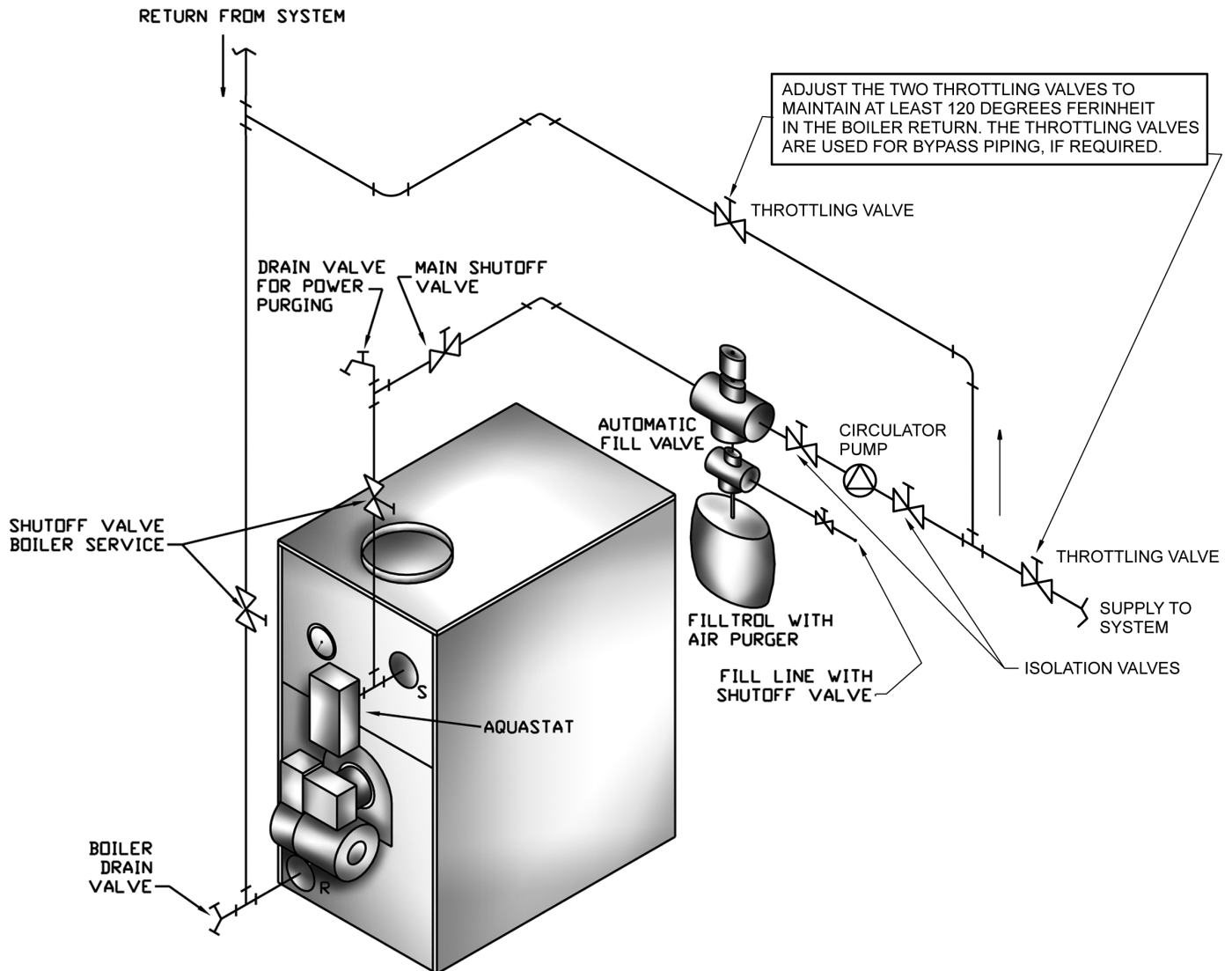


Figure 8 - System Piping Arrangement Zoning With Zone Valves

> **CIRCULATOR ON SUPPLY PIPING PUMPS AWAY FROM EXPANSION TANK**

NOTE: CIRCULATOR CAN ALSO BE INSTALLED ON RETURN PIPING.

> **PIPING ARRANGED FOR "POWER PURGING" AIR OUT OF SYSTEM PIPING, REFER TO THIS MANUAL'S SECTION ON "FILLING THE SYSTEM WITH WATER" OPTION #1**

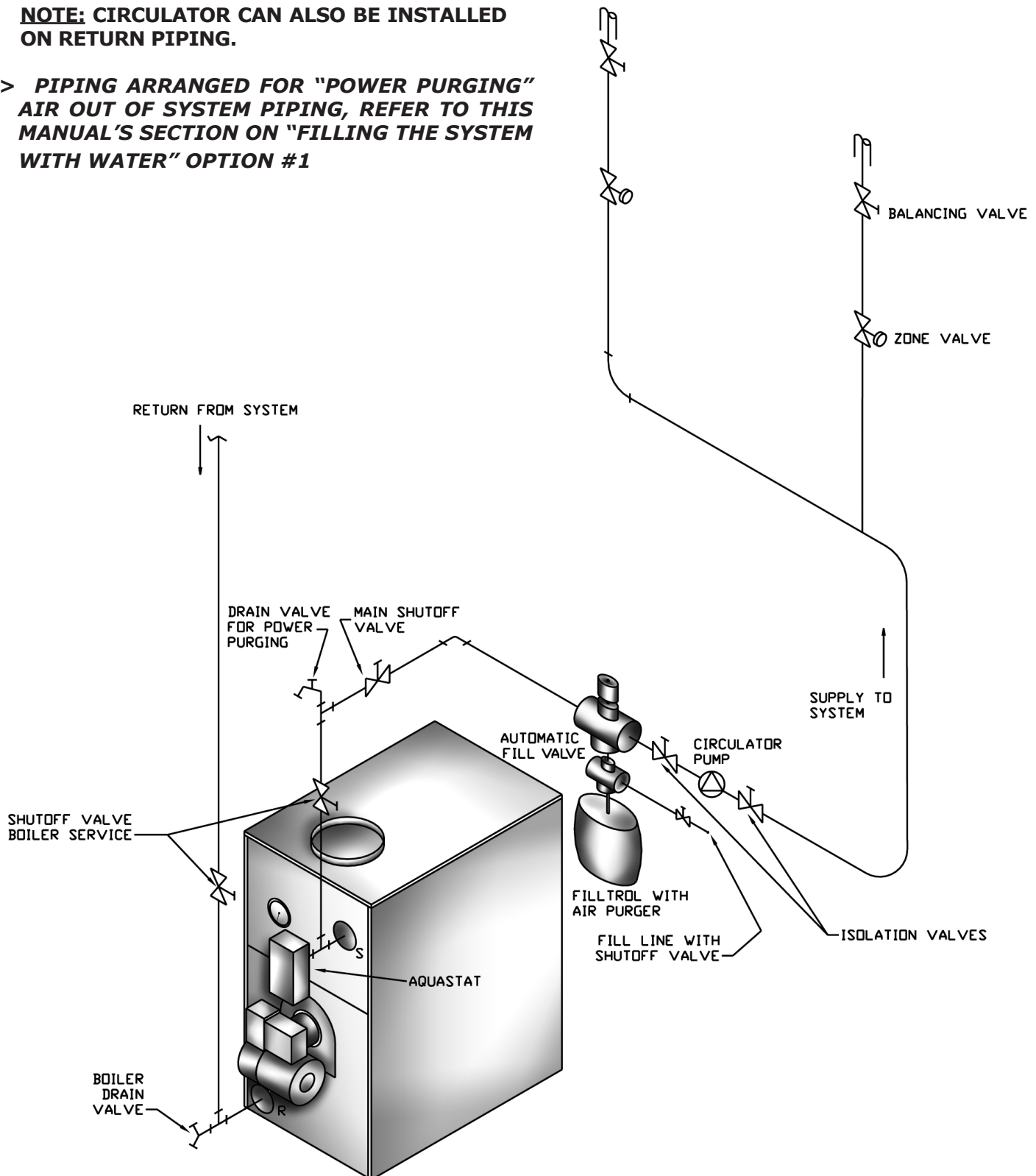
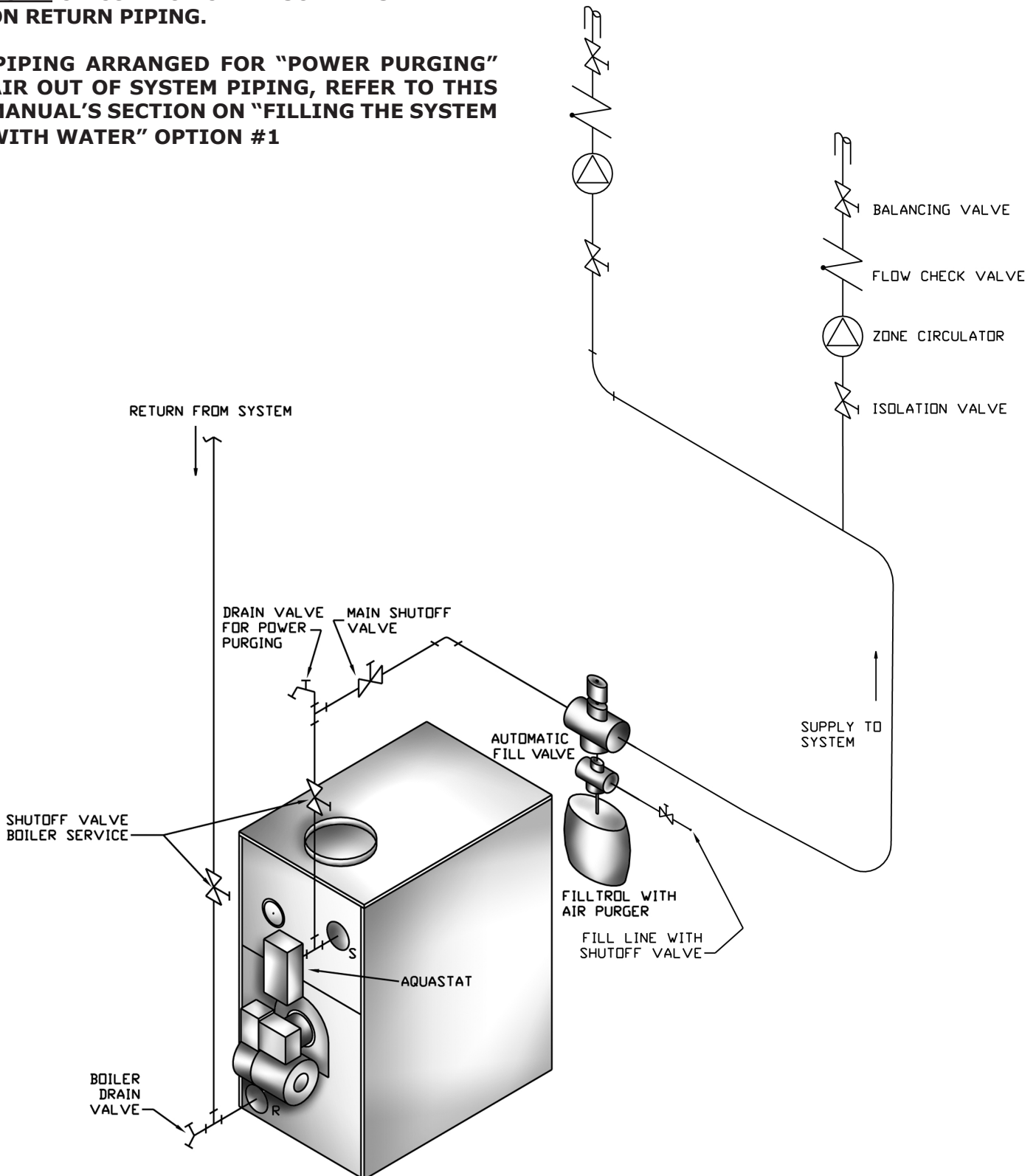


Figure 9 - System Piping Arrangement Zoning With Circulators

- > **CIRCULATOR ON SUPPLY PIPING PUMPS AWAY FROM EXPANSION TANK.**

NOTE: CIRCULATOR CAN ALSO BE INSTALLED ON RETURN PIPING.

- > **PIPING ARRANGED FOR "POWER PURGING" AIR OUT OF SYSTEM PIPING, REFER TO THIS MANUAL'S SECTION ON "FILLING THE SYSTEM WITH WATER" OPTION #1**



Tankless Coil Piping Arrangement

Boilers may be factory **packaged with tankless heater coil** see figure below. Coil provides instantaneous heating of water for domestic use if proper burner and water supply line controls are used. Tankless coils are meant to provide domestic hot water for intermittent draws, not continuous flow.

NOTICE

Do not use tankless coil if your water is excessively hard with lime or other deposits which will accumulate inside the coil.

Boiler configured so Honeywell L4006A Low Limit mounts on control well (provided). Mount factory-wired low limit control on tankless coil. Tempering valve (mixing valve) is also recommended as shown in figure below. Flow restrictor may be required on tankless coil inlet piping so flow rates are matched to boiler heat input (see table).

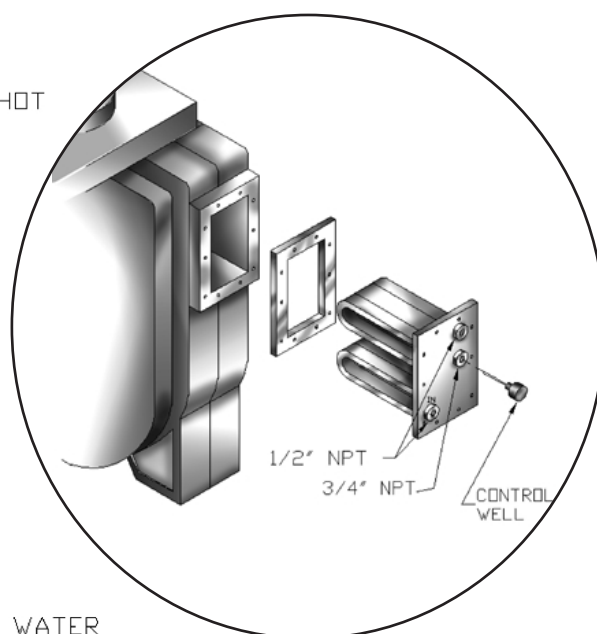
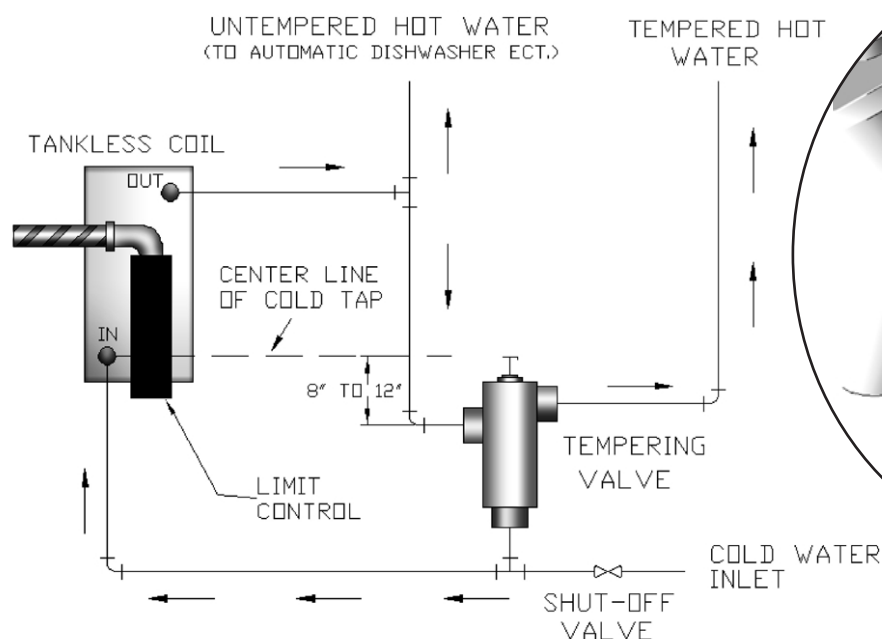
DANGER

Water temperatures exceeding 125°F will cause severe burns instantly or death by scalding.

Boiler Model	Burner Firing Rate (gph)	Input (MBH)	Tank less Rating (gpm)‡
3K0.60C	0.60	84	2.85
3K0.75C	0.75	105	3.00
3K1.00C	1.00	140	3.25
4K.90C	0.90	126	3.15
4K1.25C	1.25	175	3.50
4K1.50C	1.50	210	3.75
5K1.20C	1.20	168	3.45
5K1.75C	1.75	245	4.00
5K2.00C	2.00	280	4.25

‡ Gallons of water per minute heated from 40°F to 140°F with 200°F boiler water temperature, intermittent draw

Figure 10 -Tankless Coil Piping Arrangement



ANTIFREEZE IN THE SYSTEM

Antifreeze must be nontoxic, type specifically intended for use in closed hydronic heating systems. Under no circumstances should automotive antifreeze be used. Antifreeze used in any boiler may reduce capacity by 10% or more and increase fuel consumption. Tankless coil performance will fall as concentration of antifreeze is increased. Refer to boiler and piping water volumes tables in this manual.

BOILER WATER VOLUMES	
Number of Boiler Section	Total Volume (Gallons)
3	9.6
4	11.6
5	13.7

PIPING WATER VOLUMES		
PIPE SIZE	COPPER PIPE FACTOR	STEEL PIPE FACTOR
1/2"	82.5	63.5
3/4"	40.0	36.0
1"	23.3	22.2
1 1/4"	15.3	12.8
1 1/2"	10.8	9.5
2"	6.2	5.8

Divide total length of piping in feet by appropriate factor in table to determine volume in gallons.

CHIMNEY AND CHIMNEY CONNECTIONS

For oil fired boilers for connections to vents or chimneys, vent installations shall be in accordance with applicable provisions of INSTALLATION OF OIL BURNING EQUIPMENT, NFPA31 latest revision, and applicable provisions of local building codes.

NOTICE

Fresh air (ventilation) is important to proper venting. Ventilation and venting are two parts of the same system. Inadequate ventilation will result in inadequate venting. Always be sure to have enough ventilation to support proper venting.

For additional chimney design and sizing information, consult latest revision of the ASHRAE HVAC Systems and Applications Handbook, Gas Vent and Fireplace Systems; or the National Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, ANSI/NFPA 211.

This is a very important part of your heating system. Check your chimney to make certain that it is right size, properly constructed and in sound condition.

Following chart shows recommended minimum chimney sizes.

RECOMMENDED MINIMUM CHIMNEY SIZES				
FIRING RATE (gph)	CHIMNEY HEIGHT (ft)	NOMINAL CHIMNEY	ROUND LINER INSIDE	SQUARE LINER INSIDE
0.60 1.30	15	8" x 8"	6"	6 3/4" x 6 3/4"
1.35 1.80	15	8" x 8"	7"	6 3/4" x 6 3/4"
1.85 2.00	20	8" x 8"	8"	6 3/4" x 6 3/4"

For elevations above 2,000 feet above sea level, add 3 feet to the chimney heights.

CHIMNEY AND CHIMNEY CONNECTIONS

CHIMNEY CONNECTOR AND DRAFT REGULATOR

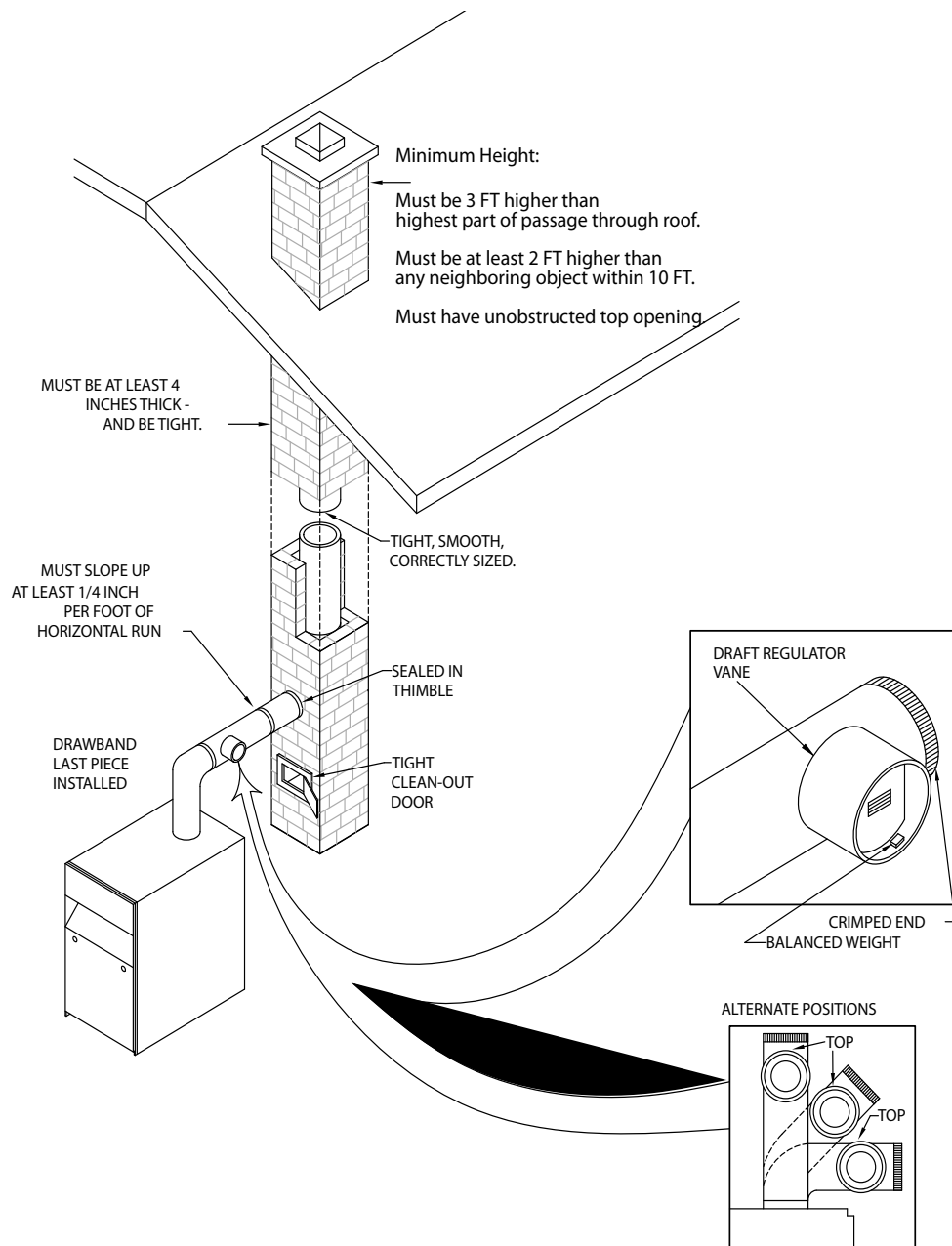
Boiler venting requires 6" diameter chimney connector pipe and use of draft regulator packed with boiler. Regulator controls draft automatically. Preferred installation is in horizontal section of pipe, may also install in angled or vertical section of pipe. Verify "top" of regulator is at top and short pipe section which holds vane is horizontal. Install draft regulator as close as practicable to boiler.

Chimney connector installation, start at boiler with vertical pipe and elbow. Install draft regulator making it horizontal. Slope horizontal pipe up toward chimney at least 1/4 inch per linear foot of venting. Chimney connector must not leak and must be firmly supported. Join each section with at least two sheet metal screws. Support every second section with stove-pipe wire.

⚠ WARNING

Fire Hazard. Maintain minimum vent pipe clearance of 18" from surface of vent to wood and other combustible materials. Failure to comply may result in death or serious injury.

Figure 11 -Typical Chimney Connection



WARNING

Electrical shock hazard. Turn OFF electrical power supply at service panel before making electrical connections. Failure to do so could result in death or serious injury.

THERMOSTAT

Install 24 Volt thermostat (not provided) in proper location. Location of thermostat has effect on boiler system operation. Follow instructions included with thermostat.

GROUNDING

Permanently ground boiler according to local codes and latest revision of the National Electrical Code. Run 14 gauge or heavier copper wire from boiler to grounded connection in service panel or properly driven and electrically grounded ground rod.

ELECTRIC POWER SUPPLY

Installation must comply with the latest revision of the National Electrical Code, any other national, state, or local codes or regulations.

Connect 115 volt electrical supply to L1 and L2 terminals on limit and two thermostat wires to T and T terminals on same limit. See wiring diagrams, pages 28 & 29.

Run separate circuit from separate over current protection device in your electrical service entrance panel. Minimum 15 ampere circuit. Locate shutoff switch at boiler. Turn off during any maintenance. Solder and tape or securely fasten connections with wire nuts.

OIL BURNER WIRING

For boilers packaged with oil burners, burners are factory wired.

⚠ WARNING

Burn and scald hazard. Safety relief valve could discharge steam or hot water during operation. Install discharge piping per these instructions.

RELIEF VALVE (provided)

Each low pressure hot water heating boiler is provided with a safety relief valve for over pressure protection of boiler and heating system. Safety relief valve opens when pressure in boiler rises to 30 psig. Safety relief valve is provided with lifting device for testing and should be tested monthly during heating season. Provide discharge piping from outlet side of safety relief valve to prevent scalding or other hazardous situations. Discharge piping must remain full size and terminate at safe point.

CONVENTIONAL EXPANSION TANK (not provided)

Size expansion tank correctly an improperly installed or sized expansion tank may result in frequent lifting of safety relief valve or other heating system problems. Install tank higher than top of boiler. Connecting pipe from boiler to expansion tank shall rise continuously up to expansion tank so that air can rise into expansion tank.

Expansion tank is partially filled with air. Air compresses as water expands, thus forming air pressure cushion. This "spring-like" cushion serves to maintain correct operating water pressure regardless of water temperature. This assures "full measure" of water, even in highest radiation unit of system. Tank also serves as trap for excess air in system. Air causes noises in pipes and inefficient circulation in radiators if left in piping system.

It is possible for a tank to become "waterlogged" (filled with water). It can also become overfilled with air when filling system with new water. Fittings provided on tank and in line to tank are for bleeding off excess air and water.

DIAPHRAGM EXPANSION TANK (not provided)

Diaphragm type expansion tank takes the place of conventional expansion tank. Read instructions packed with your tank assembly. Size and correctly install expansion tank, an improperly installed or sized expansion tank may result in frequent lifting of safety relief valve or other heating system problems.

Tank typically comes with 10-12 psig air charge. Same as pressure produced in system by automatic fill valve set to fill boiler to 10-12 psig with fresh water. When system is first filled, tank fills partially with water. As water is heated, and system pressure increases, water expands into tank and compresses air in tank. Compressed air cushion permits system water to expand as temperature changes and assures "full measure" of water, even in highest system radiation.

Mount diaphragm type expansion tank on air purger fitting or any other convenient place in supply or return line. Recommend locating diaphragm type expansion tank in supply line with circulator located after expansion tank. Configuration allows circulator to "pump away" from expansion tank for improved air elimination and system performance. Air eliminator fitting or air purger is not provided. Use air eliminator fitting or air purger to help remove air from system before it reaches radiators. Install in supply line. Air left in system can cause noises in pipes and inefficient circulation in radiators.

MAIN AIR VENT: (not provided)

Before filling system with water, there is air in the pipes and radiation units. Some air is trapped as system filled. Eliminate most of this air through air vents on radiation units. Main air vent speeds and simplifies process. Install main air vent on highest point in supply main.

AUTOMATIC FILL VALVE (not provided)

For safe, efficient operation, fill hot water system with water. Adding new water, when needed can be done manually (by use of hand valve in water supply line). Requires regular attention to system's needs. Automatic fill valve or pressure reducing valve accomplishes this without attention. Install in supply line on hot water boilers only. Valve operates through water pressure differentials. Does not require electrical connection.

BURNER SOLENOID VALVE (provided)

Beckett oil burners use standard solenoid valve. Upon burner shut down, standard solenoid valve stops flow of oil to nozzle. Without solenoid valve, oil pump continues to pump oil to burner nozzle until burner motor winds down below pumps cutoff speed.

LIMIT CONTROL (provided) Refer to manufacturer instructions provided with limit control

Water temperature limit control in limit is adjustable and may be set: as low as 140°F, as long as return water temperatures to boiler are no less than 120°F, or as high as 220°F and as long as boiler and heating system have adequate circulation to remove heat from boiler otherwise steam may be created in boiler. Refer back to **SYSTEM**

PIPING section for more information.

DRAIN VALVE (provided)

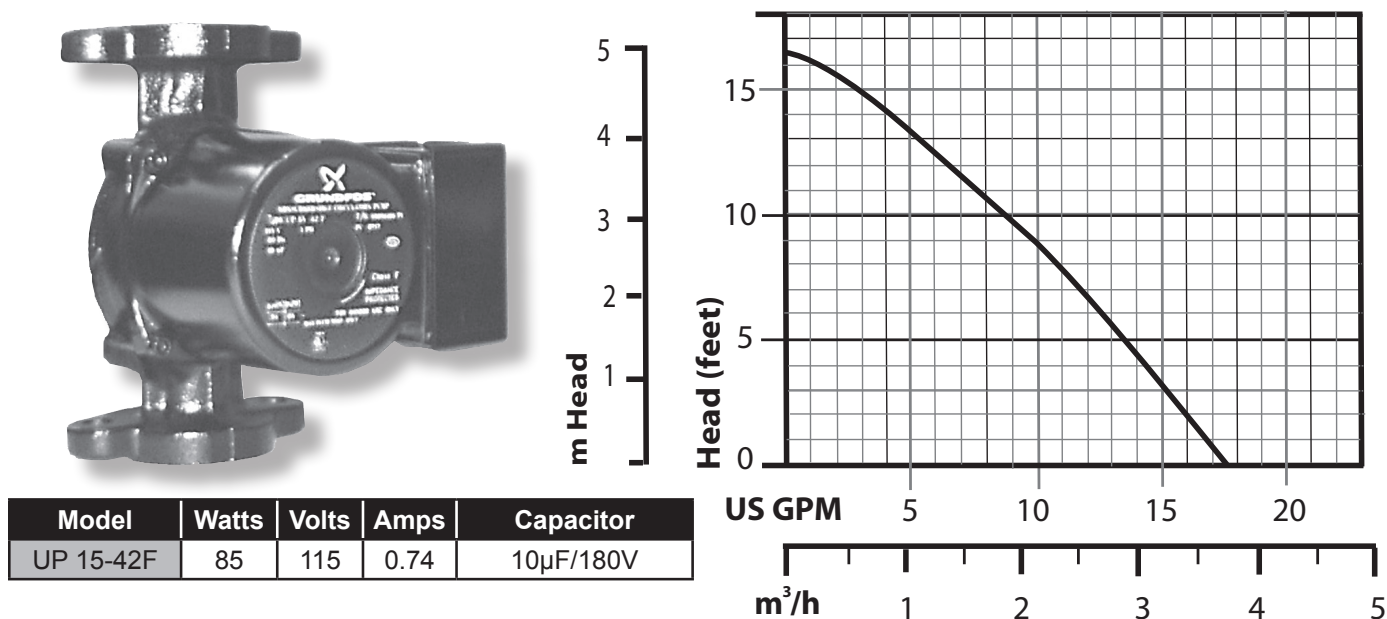
Drain valve is manually operated valve, provides means of draining all water from boiler and heating system. Install in reducing tee where return line enters boiler.

CIRCULATOR (provided)

Forced hot water system requires circulator. Separate circulator or zone valve is required for each zone, if there are two or more zones. Circulator must have capacity to provide circulation required by heating system. Connect circulator to supply main and wired into boiler's electrical system. See System Piping section for piping configurations with circulator located on supply main piping using zone circulators or zone valves. Piping arranged with zone circulators and no bypass piping, circulator provided with boiler may be used as zone circulator. Both piping arrangements allow circulator to pump away from expansion tank and show how piping should be arranged to allow heating system to be easily purged of air. Circulator can be installed on return side of boiler if preferred.

Figure 12 - Grundfos Pump

The pump curve for the furnished Grundfos UP 15-42 F pump is shown below:



HOT WATER SYSTEM OPERATION

Entire heating system (boiler, piping, and radiation units) is filled with water. As boiler water boiler is heated, it is circulated from top of boiler through supply main to radiation units. Cooler water in radiation units flows back through return piping through return main into boiler. This arrangement provides positive and rapid response to the thermostat.

FILLING SYSTEM WITH WATER

OPTION #1 Method utilizes boiler piping as shown in figures in the “**System Piping**” section.

- a) **Close** main shutoff valve, isolation valves, and zone valves (if applicable). If bypass piping is installed, also close two throttling valves. Leave boiler service shutoff valve (if installed) and balancing valves to each heating zone **fully open**.
- b) **Open** following valves in order: drain valve for power purging, isolating valves before and after boiler circulator (if applicable), both throttling valves (if applicable), and then open fill line shutoff valve. Water will fill bypass piping and push air through piping and out power purging drain valve. When power purging drain valve runs air free, close bypass piping throttling valve (leaving throttling valve to supply piping fully open).
- c) Next, **open** isolation valve (or zone valve) to first zone. Water fills piping and pushes any air out power purging drain valve. When power purging drain valve runs air free, close isolation valve (or zone valve). Repeat this procedure for remaining heating zones.
- d) Once all zones are filled with water and purged of air, **close** power purging drain valve and fill line shut off valve, **open** main shutoff valve, and **adjust** throttling valves and balancing valves as required.

OPTION #2 Close air vents on all radiation units.

Open valves to radiation units. Verify boiler drain valve, expansion tank drain cock, and air bleed screw on expansion tank drain fitting are closed. Open fill valve on piping to expansion tank. Open water inlet to boiler and leave open. Open air vent on lowest radiation unit. When all air has escaped and water starts to flow from vent, close it. Go to next radiation unit, and repeat this process finishing with highest radiation unit. If heating system has automatic vents, manual venting is unnecessary but will speed up proper filling of system.

If system is closed expansion tank system, automatic fill valve is needed. Leave automatic fill valve open to refill system automatically as needed. Note initial fill pressure on boiler's temperature/pressure gauge should be 10-15 psig. Any lowering of pressure from its initial fill pressure indicates loss of water due to leakage. Automatic fill valve should compensate for this water pressure loss. If it does not, manually open this valve to refill system until needle is again pointing to same pressure reading. Instructions are packaged with valve.

DO NOT TAMPER WITH THE UNIT OR CONTROLS

IMPORTANT: *Installer follow these instructions carefully.*

STARTING: Fill system with water. Vent all air from system following section "**FILLING THE BOILER**".

FUEL UNITS AND OIL LINES: Install oil line(s) to oil burner. Use heavy wall copper tubing and flared fittings, do not use compression fittings. All connections and joints must be airtight. Use appropriate non-hardening thread sealing compound on threaded connections, not Teflon tape. See fuel unit data sheet furnished with burner for sizing, lift, and length of tubing recommendations.

Original equipment oil burner (when furnished) is equipped with single stage fuel unit with bypass plug removed for single pipe installation. This is satisfactory where fuel supply is on same level as, or above burner, permitting gravity flow of oil. Per NFPA31 requirements, never exceed 3 psig pressure to inlet side of fuel unit. When necessary to lift oil to burner, two-pipe installation is required. Run return line between fuel unit and oil supply. When two-pipe installation is used, bypass plug (furnished with burner) must be installed in fuel unit. Refer to fuel unit instructions furnished with burner for specific instructions on installing bypass plug. Do not exceed fuel unit manufacturer's recommendations for running vacuum.

NOTE: *If lift exceeds 14 feet for Beckett burners, two stage fuel unit is required with return line.*

Install oil filter of adequate size inside building between tank shutoff valve and oil burner. For ease of servicing, locate shutoff valve and filter near oil burner.

AIR SUPPLY FOR COMBUSTION: Do not install boiler in rooms with insufficient air, unless corrective steps are taken. It may be necessary to install windows or cut holes in door to rooms used for supply air to obtain sufficient combustion air and prevent less than atmospheric air pressure in that room. If there is lack of combustion air, burner flame will be dark orange and formation of soot will occur in heating unit. In buildings of conventional frame, brick, or stone construction that do not have utility rooms, basement windows, or stair doors, air infiltration is normally adequate to provide enough air for combustion and for operation of barometric draft control. Room used for supplying combustion air should be isolated from any area served by exhaust fans. Refer back to the section on "**FRESH AIR FOR COMBUSTION**" for additional sizing guidelines.

DRAFT REGULATORS: Barometric draft regulator is required for controlling draft through boiler. Barometric draft regulator is mounted in chimney connector. Refer back to section on "**CHIMNEY AND CHIMNEY CONNECTIONS**". Once draft regulator is installed, use draft gauge to adjust to proper opening: combustion chamber over fire draft will be approximately -0.01" WC to -0.02" WC and stack draft will be approximately -0.02" WC to -0.04" WC. On larger installation, greater draft may be required in stack to obtain desired over fire draft.

NOZZLES AND ELECTRODES: Use proper size, spray angle, and spray pattern nozzle. Refer to recommended nozzle selection charts at end of this manual. To install nozzle, remove nozzle line electrode assembly, if necessary remove retention ring assembly, and install and tighten nozzle. Take care not to damage electrode insulators or bend electrode tips. After installing nozzle, reassemble nozzle line electrode assembly and set electrode tip spacing. Electrode tip spacing may need to be set prior to reassembling nozzle line electrode assembly. Refer to figures on following pages for setting electrode tip spacing on Beckett.

FINAL BURNER ADJUSTMENTS: Final burner adjustments must be made using combustion test instruments. Initial settings for burner are shown at back of this manual.

Set burner accordingly. Check draft over fire to verify it is between -0.01" WC and -0.02" WC, adjust draft as necessary. After operating 10 minutes to warm up boiler, use combustion test equipment to take smoke reading in flue pipe between boiler and draft regulator. Smoke reading should be zero to trace (Shell Bacharach Scale). A new boiler may require more than 10 minutes to burn clean due to oil film on new heat exchanger. If smoke reading is zero, gradually close burner's air adjustment to obtain smoke reading showing trace smoke reading. Once smoke reading is trace, measure CO₂ and as insurance margin increase air to sufficiently reduce CO₂ by 1/2% to 1%.

If clean fire cannot be obtained, it will be necessary to verify burner head and electrode alignment. Proper electrode alignment figures are presented on following pages. If fire continues to be smoky, replace nozzle with correct replacement.

Once burner is completely adjusted, burner should be started and stopped several times to assure good operation with no fluttering or rumbling. Verify there are no oil leaks and record nozzle size, oil pressure, combustion readings, and air settings on tag or label that can be attached to burner or, boiler.

Figure 13 - Beckett AFG Burner Electrode Adjustments Variable (V1, L1) Heads

Boiler Model	Dimension "N" (electrode to nozzle)	Dimension "H" (head to nozzle)
All	1/16"	7/32" - 9/32"

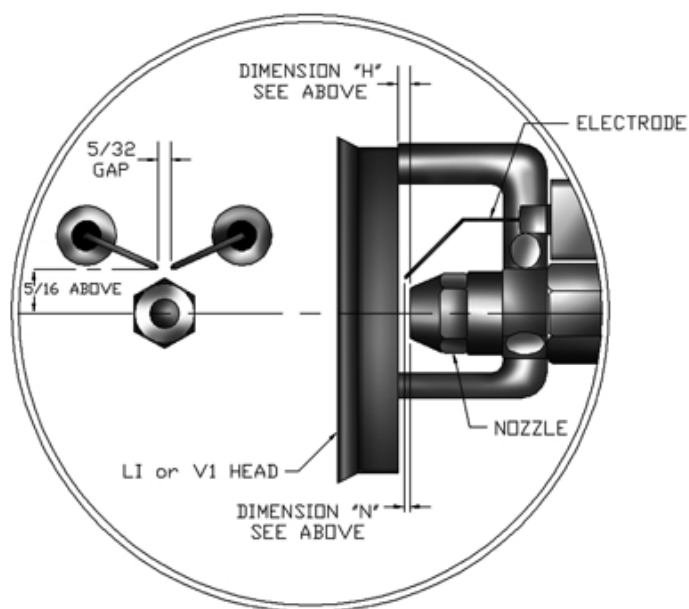
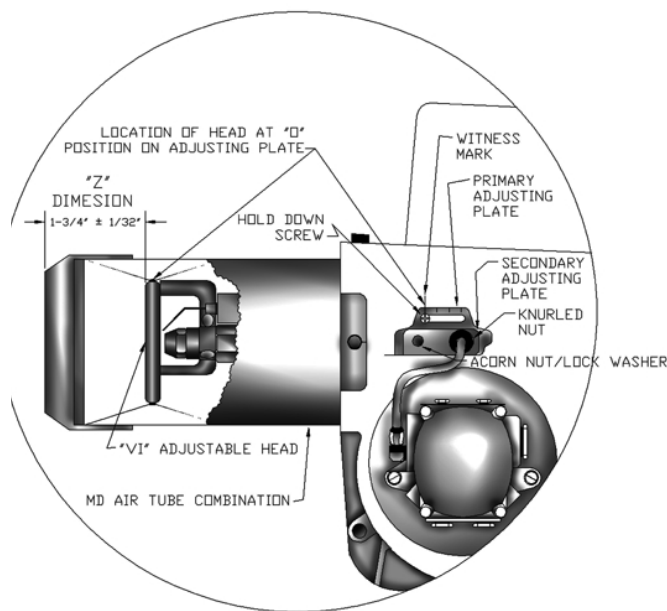


Figure 14 - Beckett AFG Variable (V1) Head Adjustments and Settings

Dimension "Z" For L1, V1 Heads

1 3/4"



CHECKING AND ADJUSTING CONTROLS

Instructions for Limit control provided are included with boiler.

IMPORTANT: Installer follow these instructions carefully.

ADJUST OPERATING CONTROLS: Use following settings for first adjustment:

High Limit:

Baseboard and Convectors 180°F
Standing Radiators 180°F

Low Limit (when used) 140° (increase if hotter domestic water is required, but low limit set point must be at least 20°F less than high limit set point).

When low limit is used:

- With Honeywell L7248L control, set ELL parameter on L7248L control to ON.
- With Hydrolevel 3250 control, Set Z-I switch on 3250 control to I position.

Boilers factory equipped with tankless coil are factory set.

ADJUST THERMOSTAT HEAT ANTICIPATOR PER LIMIT INSTRUCTIONS.

Do not attempt to start burner when excess oil has accumulated, when unit is full of vapor, or when combustion chamber is very hot.

VERIFY THERMOSTAT OPERATION: Thermostat location has important effect on operation of boiler system. Follow instructions included with your thermostat. Thermostat is located typically about five feet above floor on inside wall. Locate thermostat to sense average room temperature, so avoid the following:

When temperature on thermostat is set above indicated thermostat temperature, boiler's burner should start. Verify that once room temperature reaches selected temperature setting, boiler's burner shuts off, and once room temperature falls few degrees boiler starts operating again. ***Do not start burner unless all cleanout doors are secured in place.***

THERMOSTAT LOCATIONS TO AVOID		
DEAD SPOTS	HOT SPOTS	COLD SPOTS
<i>Behind doors</i>	<i>Concealed pipes</i>	<i>Concealed pipes or ducts</i>
	<i>Fireplace</i>	
	<i>TV sets</i>	<i>Stairwells drafts</i>
<i>Corners & alcoves</i>	<i>Radios</i>	<i>Doors drafts</i>
	<i>Lamps</i>	<i>Unheated room on other side of wall</i>
	<i>Direct sunlight</i>	
	<i>Kitchens</i>	

ANNUALLY: Recommend flue passages, combustion chamber area (target wall, fire door insulation, durablanket), burner adjustment, operation of controls, and boiler seals (fire door gasket or silicone seal, cast iron sectional seals, flue collector) checked once each year by competent Service Technician. **Before start of each heating season** (or when system has been shut down for extended periods of time) recheck whole system for water, oil, and vent piping leaks. Replace or patch any leaks or seals that are faulty.

VENT PIPE: Visually inspect entire venting system once a month for any signs of leakage, deterioration, or soot build up. If vent pipe shows any signs of leaking or deterioration, replace it immediately. If it shows any signs of soot build up, clean vent pipe and have burner settings and combustion checked by competent professional.

SAFETY RELIEF VALVE: Valve should open automatically when system pressure exceeds pressure rating (usually 30 psi) of safety relief valve. Should valve ever fail to open under this condition, shut down the system. Drain system until system pressure is reduced below safety relief valve pressure rating. Contact competent Service Technician to replace valve and inspect heating system and determine cause, this problem may indicate equipment malfunction. Test safety relief valve monthly during heating season. Prior to testing, verify discharge pipe is properly connected to valve outlet and arranged to safely dispose of boiler discharge. Hold trip lever fully open for at least five seconds in order to flush free any sediment lodged on valve seat. Permit valve to snap shut. Refer to valve manufacturer's instructions packaged with valve for more details.

CONVENTIONAL EXPANSION TANK: As noted in **"EQUIPMENT AND ACCESSORIES"** section, this tank may become water logged or may receive excess of air. Frequent automatic opening of safety relief valve indicates water logging. High boiler temperature accompanied by unusually low radiation unit temperature (and "knocking" noises) indicates excess air in the tank. To correct either condition, close valve between boiler and tank. Drain the tank until empty. Check all tank plugs and fittings, tighten as necessary. Open valve between boiler and tank. Water will rise to normal height in tank if system has automatic fill valve, otherwise manually refill system.

DIAPHRAGM EXPANSION TANK: As noted in **"EQUIPMENT AND ACCESSORIES"** section, tank may become water logged. Frequent automatic opening of safety relief valve indicates water logging. High boiler temperature accompanied by unusually low radiation unit temperature (and "knocking" noises) indicates excess air in the tank. To correct this condition, replace diaphragm expansion tank.

WATER SYSTEM: If system is to remain out of service during freezing weather, always drain it completely (water left in the system will freeze and crack pipes and/or boiler).

TANKLESS COIL (OR COVER PLATE) GASKET: This Check gasket at least twice a year for leakage and replace if necessary. If gasket is replaced, make sure when coil plate (or cover plate) is reattached the ten nuts are torqued in alternating pattern to ensure equal force is applied to entire gasket creating a good seal.

Torque nuts to 23 ft-lbs so gasket does not squeeze out from behind plate.

OIL BURNER: Oil burner maintenance is listed in this manual under **OPERATING THE BOILER**.

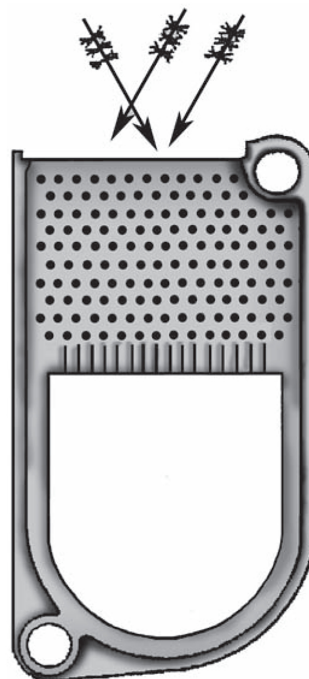
Never burn garbage or paper in the unit, never leave combustible material around it.

OIL BOILER CLEANING:

1. Shut off all electrical power to boiler / burner and shut off fuel oil supply.
2. Remove vent pipe from boiler top. Inspect pipe and chimney for signs of corrosion and deterioration. Clean out base of chimney. If vent pipe shows any signs of corrosion or deterioration, replace immediately. If chimney damage or deterioration is discovered, contact competent professional.
3. Remove top jacket panel screws (5), brass wing nuts (2) holding flue collector top, and flue collector top. Inspect gasket on underside of flue collector and replace as necessary.
4. Before beginning to clean flue passageways, ensure combustion chamber blanket is covered. If blanket is not covered prior to cleaning, replace blanket once cleaning is completed.
5. With access to flue passageways, remove soot from fireside surfaces by brushing diagonally through flue passages. Brushing is easier by cutting end of flue brush off and inserting into a drill. When brushing, take care not to damage target wall with flue brush. See figure 15.
6. Carefully vacuum soot accumulations from combustion chamber area, be careful not to damage any refractory or blanket insulation. To gain access to combustion chamber first double check the shut off valve on fuel oil line is closed and disconnect fuel oil line. Remove oil burner from fire door. Remove fire door.
7. Inspect target wall, fire door refractory, and combustion chamber blanket (when included) for cracking and deterioration. If there is signs of cracking or deterioration, replace refractory or blanket before reassembling burner / front plate.
8. Inspect door's braided gasket for wear and damage. Replace when necessary with braided gasket of same material and size. See repairs parts manual.
9. Inspect and clean oil burner.

Important operating and maintenance requirements:

- **Keep boiler and area around it clean**
- **Never burn refuse or any material other than specified fuel in your boiler**
- **Have your boiler checked each year by qualified technician**

Figure 15 - Brush Diagonally Through Flue Passages

OIL BURNER MAINTENANCE: For Beckett AFG, following preventative maintenance items should be performed annually, preferably prior to heating season.

1. **Fuel Filter** Replace to prevent contaminated fuel from reaching nozzle. Partially blocked fuel filter can cause premature failure of fuel pump.
2. **Fuel Pump Unit** Replace pump screen and clean pump unit to maintain fuel delivery to nozzle.
3. **Ignition Electrodes** Clean and adjust as per manufacturer's recommendations, to maintain reliable ignition of oil.
4. **Nozzle** Replace to maintain safe and reliable combustion efficiency. Always replace with exact nozzle as required in charts in back of this manual.
5. **Fan and Blower Housing** Keep clean, free of dirt, lint and oil to maintain proper amount of air fuel requires to burn.
6. **Check burner settings and adjust as needed.**

NOTE: *If component parts must be replaced, use parts recommended by burner manufacturer.*

These are general instructions for cleaning an oil burner.

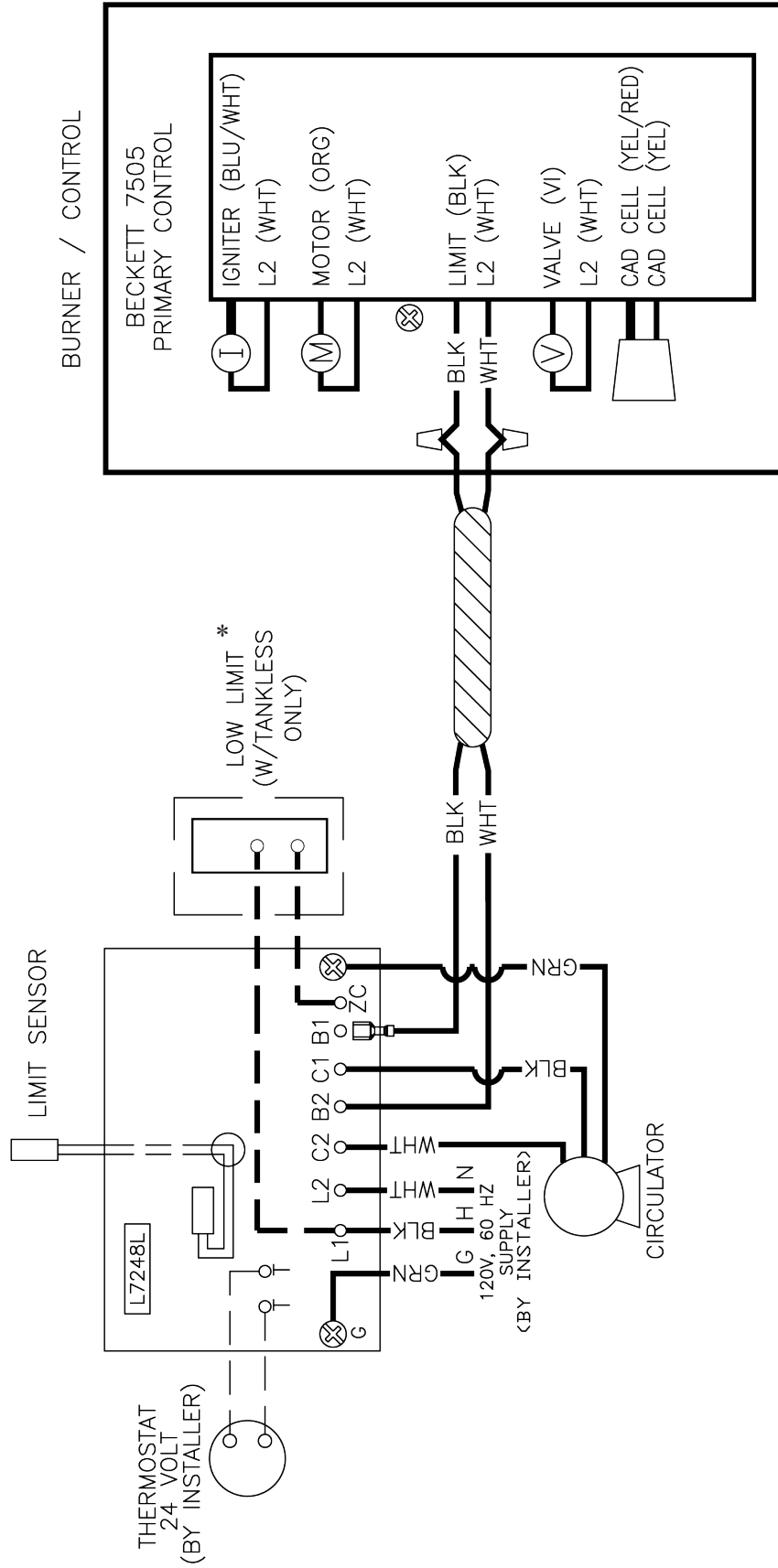
For specifics, consult burner manufacturer's instructions.

1. Verify all electrical power to boiler / burner and fuel supply to burner are shut off.
2. With oil burner removed from fire door, clean any soot accumulations from end of burner and if applicable burner head.
3. Remove burner drawer assembly, clean electrodes and reset electrode spark gap per manufacturer's recommendations. Refer to section on **OPERATING THE BOILER** Nozzles and Electrodes.
4. Replace oil nozzle with same size and type recommended for use on this boiler.
5. Install burner drawer assembly making sure head location (and size if applicable) are per manufacturer's recommendations. If burner being used has damaged head, replace head with same head recommended for use on this boiler.
6. Inspect and clean oil burner blower wheel.
7. Remove oil pump cover and clean / replace pump screen. Carefully reassemble ensuring pump cover makes proper seal.
8. Securely fasten oil burner to fire door.
9. Replace fuel filter (if applicable).
10. Reconnect electrical and fuel supplies.
11. Fire burner, checking for proper combustion using combustion test equipment and making adjustments as necessary. Refer to section on **OPERATING THE BOILER** Final Burner Adjustments.
12. Insure all safety controls and operating controls are functioning properly.

You may avoid inconvenience and service calls by checking these points before you call for service:

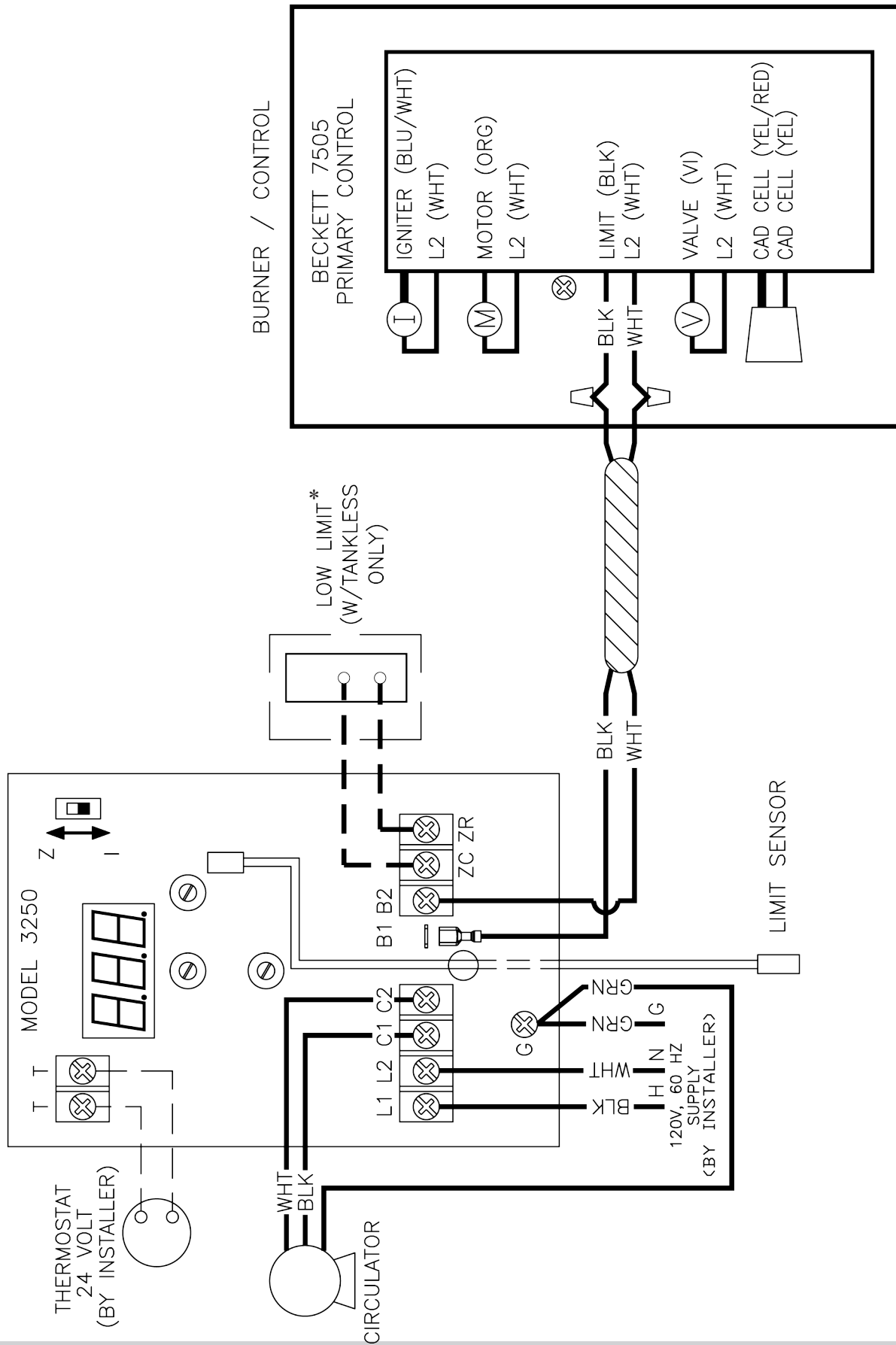
IF YOUR SYSTEM IS NOT HEATING OR NOT GIVING ENOUGH HEAT . . .	
POSSIBLE CAUSE	WHAT TO DO
Thermostat is not set correctly	Reset thermostat
Burner is not operating properly	Check flame. If it is yellow, the burner is not getting enough air. Or, if flame is blue and noisy and seems to lift off the burner, the burner is getting too much air. Contact your service technician.
No electric power to boiler	Check over-current protection. Check to be sure electric power supply circuit is "ON".
Controls out of adjustment	Reset according to instructions.
Radiators not heating	Open radiator vents to excess air. Check flow control valve (if used). It may be in closed position.
Circulating pump not running	Check over-current protection. Check relay operation.
Poor electrical contact	Check all control terminals and wire joints.
Chimney flue is blocked	Have the chimney professionally cleaned.
Circulator running when boiler water temperature is below low limit set point (tankless coil boilers only)	<u>Honeywell L7248L control</u> - confirm ELL parameter on L7248L control set to ON. <u>Hydrolevel 3250 control</u> - confirm Z-I switch on 3250 control set to I position. Refer to control instructions furnished with boiler.
RELIEF VALVE LEAKING . . .	
POSSIBLE CAUSE	WHAT TO DO
Corrosion and/or deposits on seat.	Open valve manually. Allow water to run and clear valve seat.
Water logged expansion tank	Drain tank, see instructions.
<u>HAVE YOUR SERVICE TECHNICIAN CHECK ANY PROBLEM YOU ARE UNABLE TO CORRECT.</u>	

Figure 16 - Boiler Honeywell L7248L Control



* When low limit is used, set ELL parameter on L7248L Honeywell control to ON. Boilers factory equipped with tankless coil are factory set to ON.

Figure 17 - Boiler With Hydrolevel 3250 Control



* When low limit is used, set Z-I switch on 3250 Hydrolevel control to I position. Boilers factory equipped with tankless coils are factory set to I position.

Sequence of Operation

- Thermostat calls for heat.
- Circulator turns on.
- Limit checks boiler water temperature. Burner ignition delayed until limit determines call for heat cannot be met by residual heat in boiler and heat distribution system.
 - A. See limit literature for additional information.
 - B. Burner delay by-passed for tankless heat call for heat. Burner ignition begins immediately.
- Burner and circulator operation continues until thermostat stops call for heat.

BECKETT OIL BURNER, NOZZLE, AND AIR SETTING

BOILER MODEL	FIRING RATE (GPH)	BURNER MODEL	HEAD	HEAD ADJUSTMENT	LOW FIRE BAFFLE	AIR BAND	AIR SHUTTER	STATIC PLATE	NOZZLE**	PUMP PRESSURE (PSI)
3K0.60*	0.60	AFG50MB	L1	FIXED	Yes	0	4	3 3/8"	0.60 x 70W	100
3K0.75	0.75	AFG50MB	L1	FIXED	Yes	0	8	3 3/8"	0.75 x 70B	100
3K1.00*	1.00	AFG50MB	L1	FIXED	No	0	10	3 3/8"	1.00 x 70B	100
4K.90*	0.90	AFG50MD	V1	0	No	0	5	2 3/4"	0.75 x 60B	140
4K1.25*	1.25	AFG50MD	V1	0	No	1	10	2 3/4"	1.25 x 70B	100
4K1.50	1.50	AFG50MD	V1	2	No	3	10	2 3/4"	1.50 x 60B	100
5K1.20*	1.20	AFG50MD	V1	1	No	1	8	2 3/4"	1.20 x 70B	100
5K1.75	1.75	AFG50MD	V1	3	No	3	10	2 3/4"	1.75 x 60B	100
5K2.00*	2.00	AFG50MD	V1	4	No	3	10	2 3/4"	2.00 x 60B	100

* "Alternate Firing Rate Kits" are needed in order to achieve these firing rates

** All nozzles are Delavan

NOTE: All burners use insertion depth of 2 1/4" and fired at over-fire draft of -0.02 inches w.c. Burner settings provided are intended for initial start up only. Final adjustment must be made using combustion test instruments.



PENNCO BOILERS

2201 Dwyer Avenue, Utica NY 13501
web site: www.ecrinternational.com