



KEYSTONE

OIL-FIRED
CAST IRON HOT WATER BOILER

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Model

3KWC0.80(T)

4KWC1.00(T)

4KWC1.25(T)

5KWC1.35(T)

5KWC1.55(T)



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Introduction

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

Keystone Water boiler is capable of firing #2 fuel oil from 0.80 gph up to 1.55 gph. All packaged boilers include a swing door, Hydrolevel limit control with built-in low water cutoff, temperature and pressure gauge, safety relief valve, drain valve, flue brush, and extra boiler tap for expansion tank or air elimination.

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 (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.

These boilers operate on #2 Heating Oil.

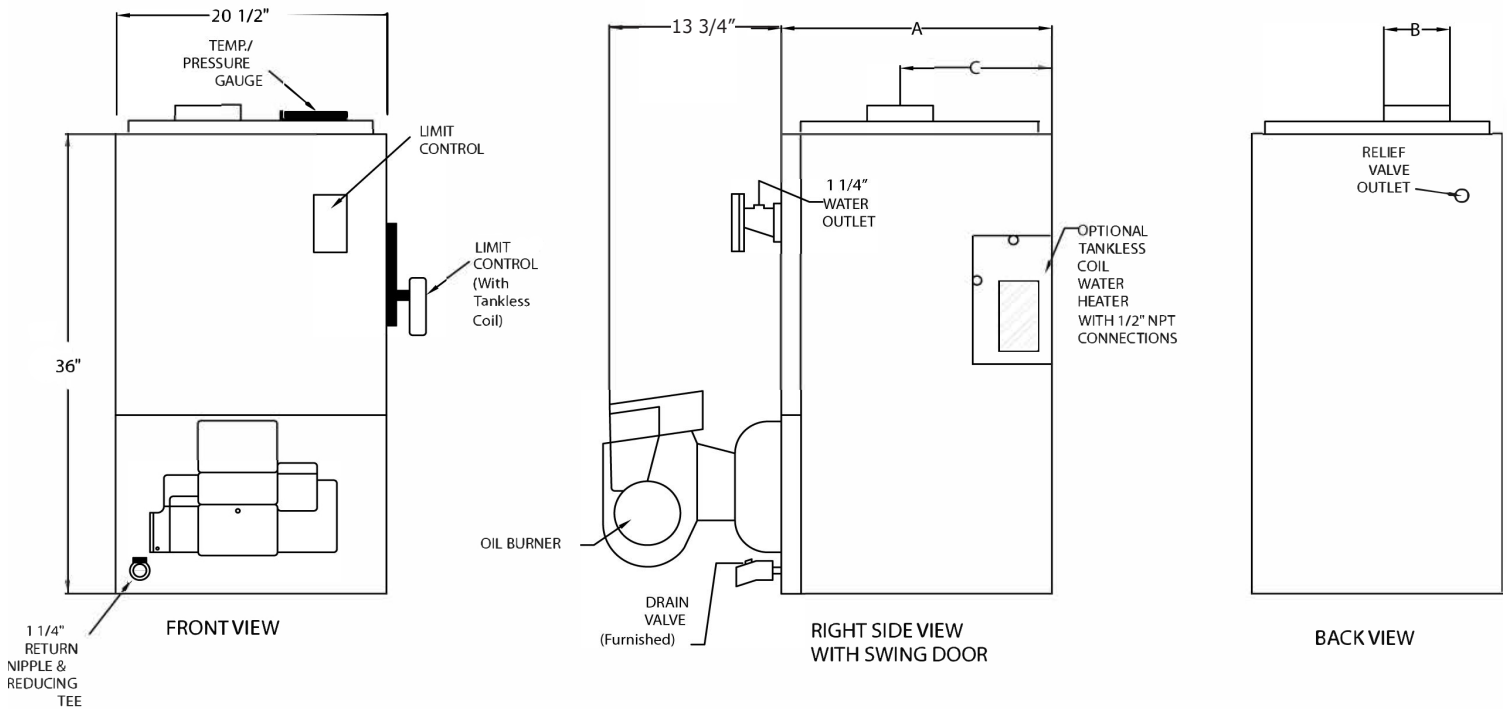
Save this manual for reference.

For Parts lists see manual 240013446 included with your boiler literature package.



BOILER RATINGS AND CAPACITIES

Figure 1 - Dimensions



Boiler Ratings and Capacities


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
3KWC0.80(T)		3	0.80	112	98	85	8"x8"x15'	86.0	14½	6	8
4KWC1.00(T)		4	1.00	140	122	106	8"x8"x15'	86.2	17¾	6	9⅝
4KWC1.25(T)		4	1.25	175	152	132	8"x8"x15'	86.0	17¾	6	9⅝
5KWC1.35(T)		5	1.35	189	167	145	8"x8"x15'	86.0	21	6	11½
5KWC1.55(T)		5	1.55	217	189	164	8"x8"x15'	86.0	21	6	11½

** MBH = 1,000 Btu Per Hour BTU = British Thermal Unit
 *** Heating capacity based on 13.1% 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.



SAFETY NOTICES

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.

Boiler installation shall be completed by qualified agency.

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.

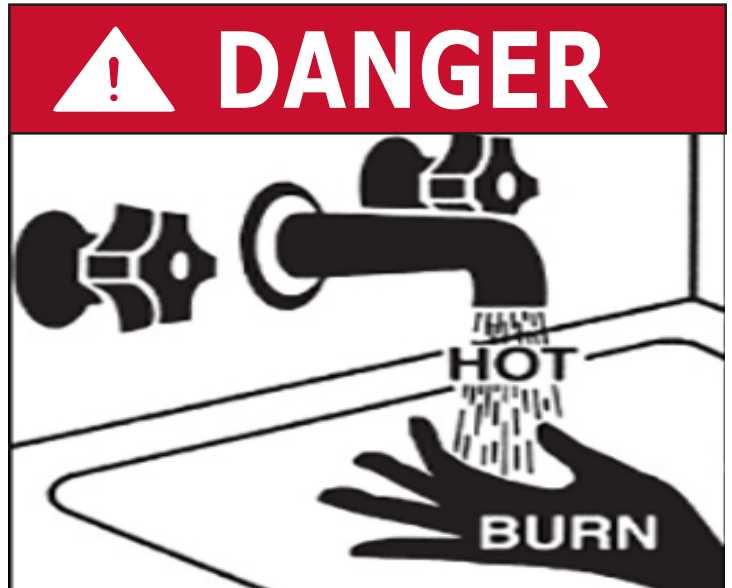
WARNING

Fire, Explosion, Asphyxiation, Electrical shock hazard! Flooding will result in damages such as electrical problems, corrosion, inoperative parts, mold and other unforeseen issues which can occur over time. Any equipment determined by a professional as damaged by a flood, defined as excess of water or other liquid, shall be replaced. Failure to follow these directions will result in a Hazardous Situation.

WARNING

Do not tamper with or use this boiler for any purpose other than its intended use. Failure to follow these instructions could result in death or serious injury. Use only manufacturer recommended parts and accessories.

FOR YOUR SAFETY READ BEFORE OPERATING



Hot Water Can Scald!

Water heated to temperature for clothes washing, dish washing and other sanitizing needs can scald and cause permanent injury.

Children, elderly, and infirm or physically handicapped persons are more likely to be permanently injured by hot water. Never leave them unattended in bathtub or shower. Never allow small children to use a hot water tap or draw their own bath.

If anyone using hot water in the building fits the above description, or if state laws or local codes require certain water temperatures at hot water taps, you must take special precautions:

- Use lowest possible temperature setting.
- Install some type of tempering device, such as an automatic mixing valve, at hot water tap or water heater. Automatic mixing valve must be selected and installed according to manufacturer's recommendations and instructions.
- Water passing out of drain valves may be extremely hot. To avoid injury:
 - Make sure all connections are tight.
 - Direct water flow away from any person.

Water Temperature Setting	1st Degree Burn Exposure Time For An Adult	2nd and 3rd Degree Burn Exposure Time For An Adult
120° F	1 minute	5 minutes
130° F	5 seconds	30 seconds
140° F	2 seconds	5 seconds
150° F	1 second	1.5 seconds
160° F	Instantaneous	0.5 seconds

Note: Warning for Infants, Children, and Elderly: Great care must be taken when exposing the aforementioned groups to warm or hot water as they can be badly burned in exposure times less than half of the time for an adult.

SAFETY NOTICES

WARNING

This product contains Fibrous glass. Fibrous glass is a synthetic fiber made from tiny particles of glass. Fibrous glass has been classified as a possible human carcinogen. When disturbed as a result of servicing or repair, fibrous glass becomes airborne and, if inhaled, may be hazardous to your health. It can harm the eyes, skin, and the lungs. Airborne fibers from these materials have been listed by the State of California as a possible cause of cancer through inhalation. Adhere to the following precautions and procedures. Avoid breathing dust and contact with skin and eyes. Use NIOSH certified dust respirator (e.g., N95). Other types of respirators may be needed depending on the job site conditions. Current NIOSH recommendations can be found on the NIOSH website <https://www.cdc.gov/niosh/>. Approved respirators, manufacturers, and phone numbers are also listed on this website. Wear appropriate personal protective clothing to prevent skin contact, as well as gloves and eye protection. Wash skin daily at end of each work shift, and prior to eating, drinking, smoking, etc. Workers whose clothing may have been contaminated should change into uncontaminated clothing before leaving the work premises. Wash potentially contaminated clothes separately from other clothing. Rinse clothes washer thoroughly. Follow all Local, State and Federal guidelines for disposal.

NIOSH stated First Aid. Eye: Irrigate immediately.
Breathing: Fresh air.

WARNING

Combustion chamber insulation in this product contains ceramic fiber material. Ceramic fibers can be converted to cristobalite in very high temperature applications. The International Agency for Research on Cancer (IARC) has concluded, Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group1). Avoid breathing dust and contact with skin and eyes. Use NIOSH certified dust respirator (N95). This type of respirator is based on the OSHA requirements for cristobalite at the time this document was written. Other types of respirators may be needed depending on the job site conditions. Current NIOSH recommendations can be found on the NIOSH website <https://www.cdc.gov/niosh/topics/silica/>. approved respirators, manufacturers, and phone numbers are also listed on this website. Wear long-sleeved, loose fitting clothing, gloves, and eye protection. Apply enough water to the combustion chamber lining to prevent dust. Wash potentially contaminated clothes separately from other clothing. Rinse clothes washer thoroughly.

NIOSH stated First Aid. Eye: Irrigate immediately.
Breathing: Fresh air.

CAUTION

Laceration, burn hazard. Metal edges and parts may have sharp edges and/or may be hot. Use appropriate personal protection equipment to include safety glasses and gloves when installing or servicing this boiler. Failure to follow these instructions could result in minor or moderate injury.

SAFE INSTALLATION AND OPERATION

WARNING

Fire, Explosion, burn, scald hazard. Use only number 2 fuel oil. Do not use gasoline, kerosene, crankcase oil or any oil containing gasoline. Failure to follow these instructions could result in death or serious injury.

NOTICE

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

1. Check your local codes and utility requirements before installation. Installation shall be in accordance with their directives, or follow *NFPA 31 Installation of Oil Burning Equipment*, latest revision.
2. Before servicing, allow boiler to cool. Shut off any electricity and oil to boiler when working on it.
3. Inspect oil line and connections for leaks.
4. Verify oil burner nozzle is the size required. Over-firing will result in early failure of boiler sections. This will cause dangerous operation.
5. Never vent this boiler into enclosed space. Always vent to outside. Never vent to another room or inside a building.
6. Verify there is adequate air supply for complete combustion.
7. Follow regular service and maintenance schedule for efficient, safe and reliable operation.
8. Keep boiler area clean and free of combustible material, gasoline and other flammable vapors and liquids.
9. 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.

10. 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.

11. 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.
12. 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.
13. 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.

LOCATING THE BOILER

Complete Prior To Installing Boiler.

- A. Verify you have selected the 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 in this manual. Any heat loss calculations used should be based on approved methods.
- B. Boiler must be supplied with proper oil supply and oil piping, sufficient fresh combustion air, and suitable electrical supply.
- C. Boiler must be connected to suitable venting system and piping system adequate to distribute heating load.
- D. Properly locate and install thermostat for heating system control.

Any doubts as to requirements, check with local authorities and obtain professional help where needed. OPERATING INSTRUCTIONS, FINAL CHECKS AND ADJUSTMENTS, and MAINTENANCE sections in this manual are vital to the proper and safe operation of the heating system.

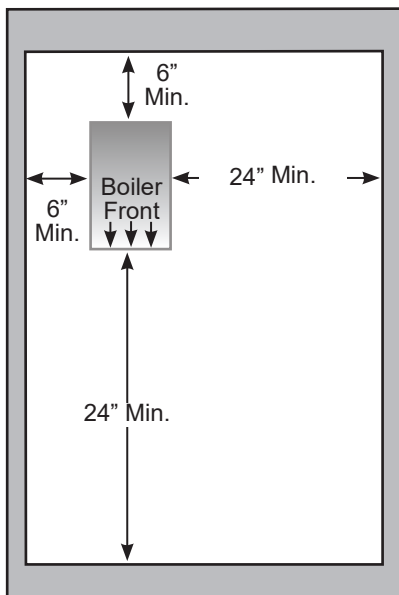
1. Place boiler in location centralized with piping system and as close to chimney as possible.
2. Boiler must be level. If necessary use metal shims beneath boiler's feet.
3. Use raised base if floor can become wet or damp.
4. Maintain clearances for fire safety as well as servicing. Maintain 18" clearance 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 left side, rear and above, and at least 24" on right side and front. Allow 24" accessibility clearance above for servicing.
5. Fresh air for combustion must be available at front of the boiler. Fresh air for ventilation must be available 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 directly on combustible flooring or carpeting. Failure to follow these instructions could result in death or serious injury.

6. Floor supporting boiler must be noncombustible and stable. Boiler is permitted to be placed over combustible floor provided the floor is protected in accordance with the requirements of accepted building code practice and approved by the *Authority Having Jurisdiction*. In absence of local codes, follow NFPA-31 *Standard for the Installation of Oil-Burning Equipment*.
7. Installation shall be in accordance with the requirements of the authority 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



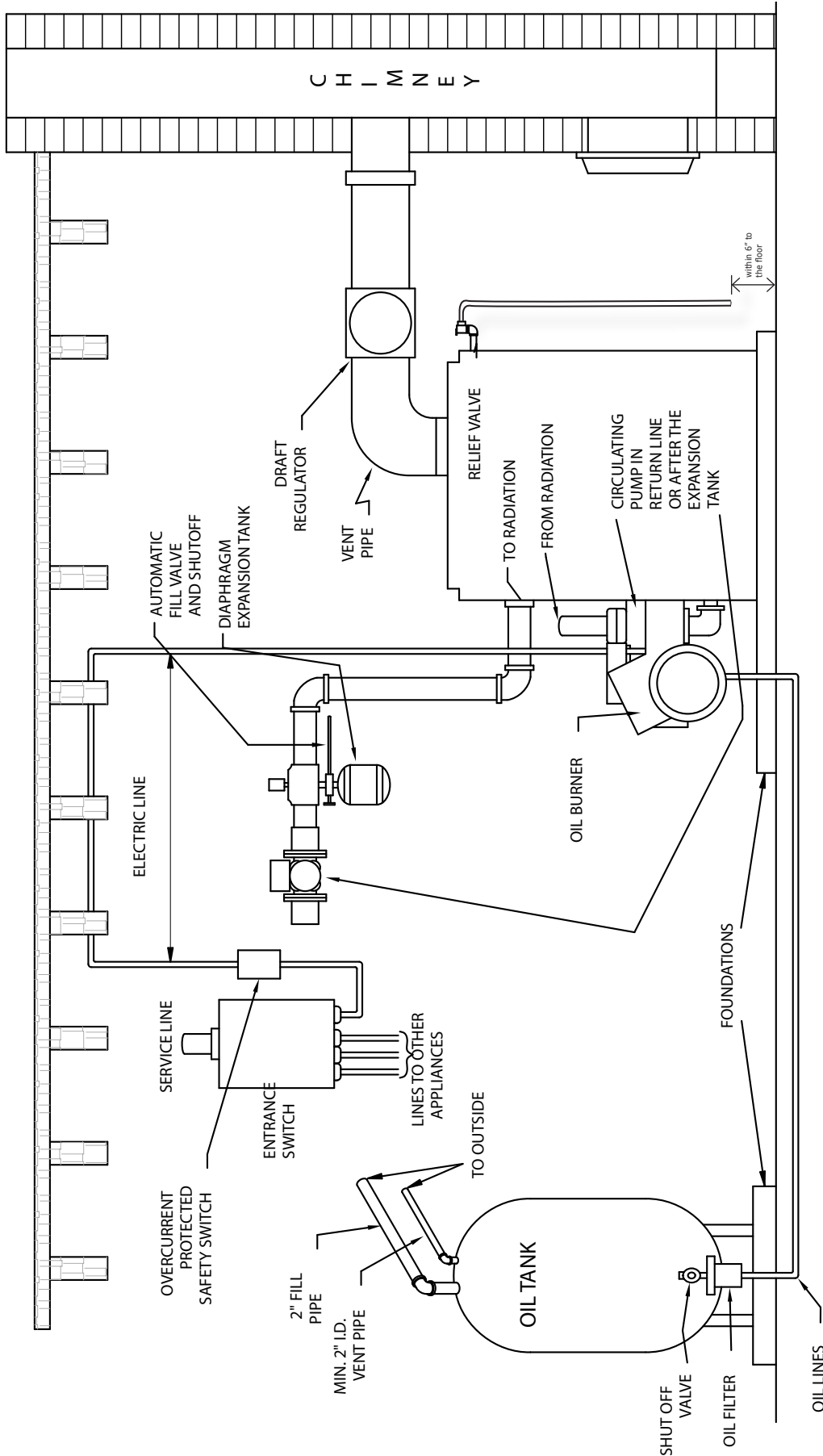
MINIMUM CLEARANCE DIMENSIONS

BOILER CLEARANCES			
Unit	Combustible Clearance	Accessibility, Cleaning, and Servicing	Flue to Combustible Clearance
Top	6"	24"	9"
Right Side	24"	24"	
Left Side	6"	6"	
Base	Non-combustible	Non-combustible	
Front	24"	24"	
Back	6"	6"	

All distances measured from the cabinet of the boiler.

INSTALLATION REQUIREMENTS

Figure 3 - Boiler With Piping System



GENERAL PRINCIPAL REQUIREMENTS FOR A TYPICAL INSTALLATION

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



⚠ 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.

Installation shall comply with NFPA-31 *Standard for the Installation of Oil Burning Equipment* (latest edition), and applicable provisions of local building codes to provide combustion and ventilation 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.

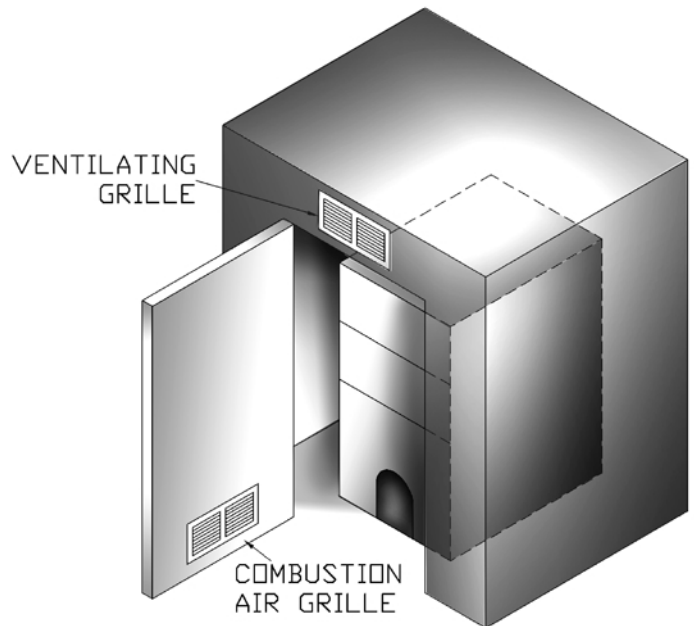
Unconfined space is defined as space whose volume is not less than 50 cubic feet per 1,000 Btu per hour of total input rating of all appliances installed in that space.

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)



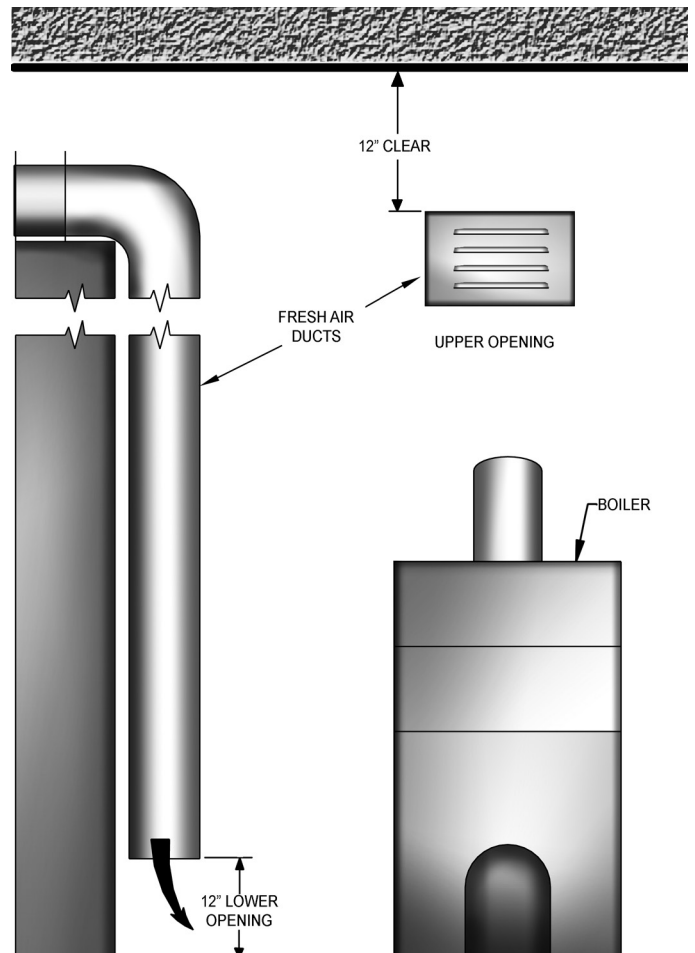
FRESH AIR FOR COMBUSTION

- 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.
5. **Install Safety Relief valve** in rear section using ¾" nipple and street elbow provided with boiler. See figures 6a and 6b.
 - 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.

Figure 6a - Safety Relief Valve Installation

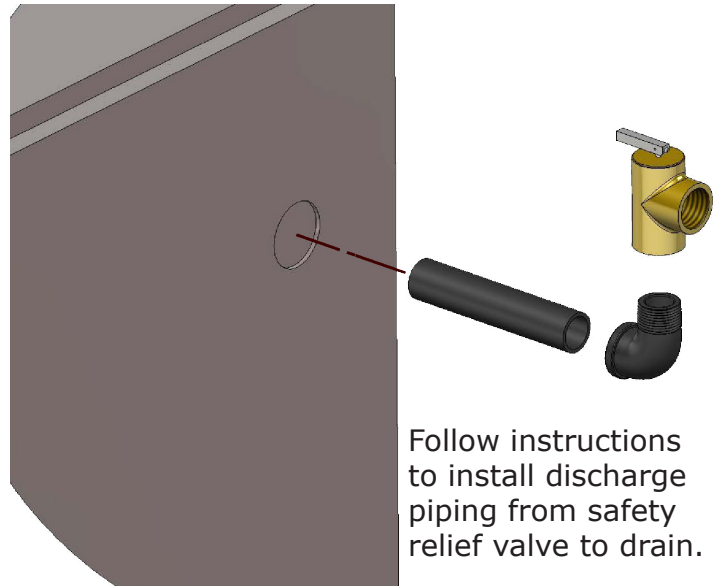
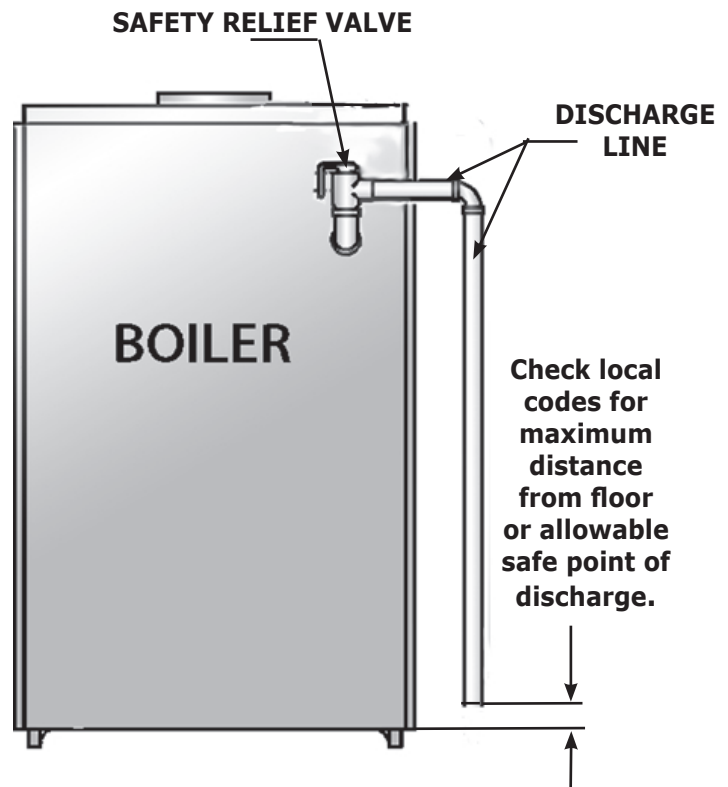


Figure 6b - Discharge Piping From Safety Relief Valve



SYSTEM PIPING

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**

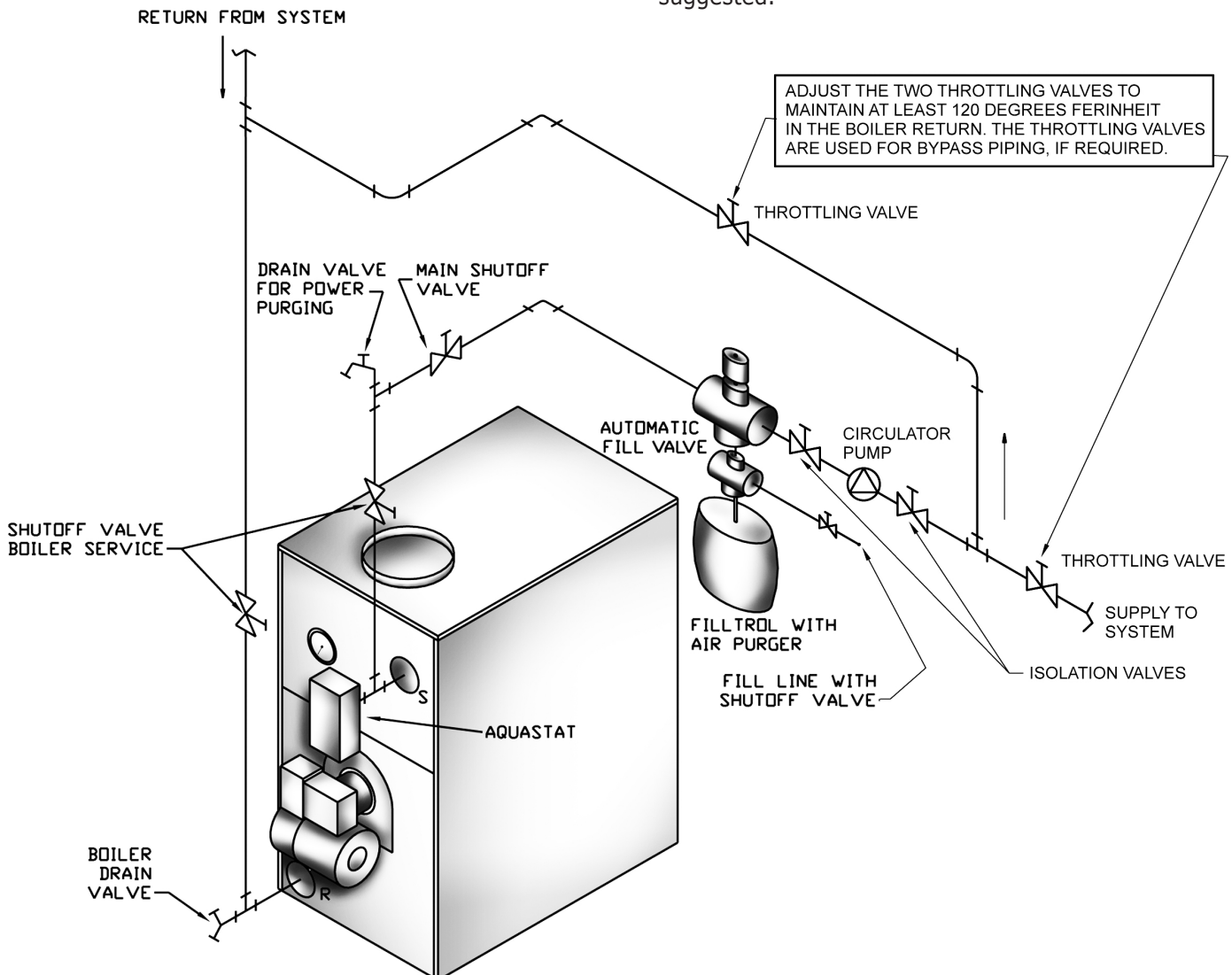
Low Design Water Temperature Systems (Below 140° F) And Large Water Content Systems

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 as shown in Figure 7) 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.



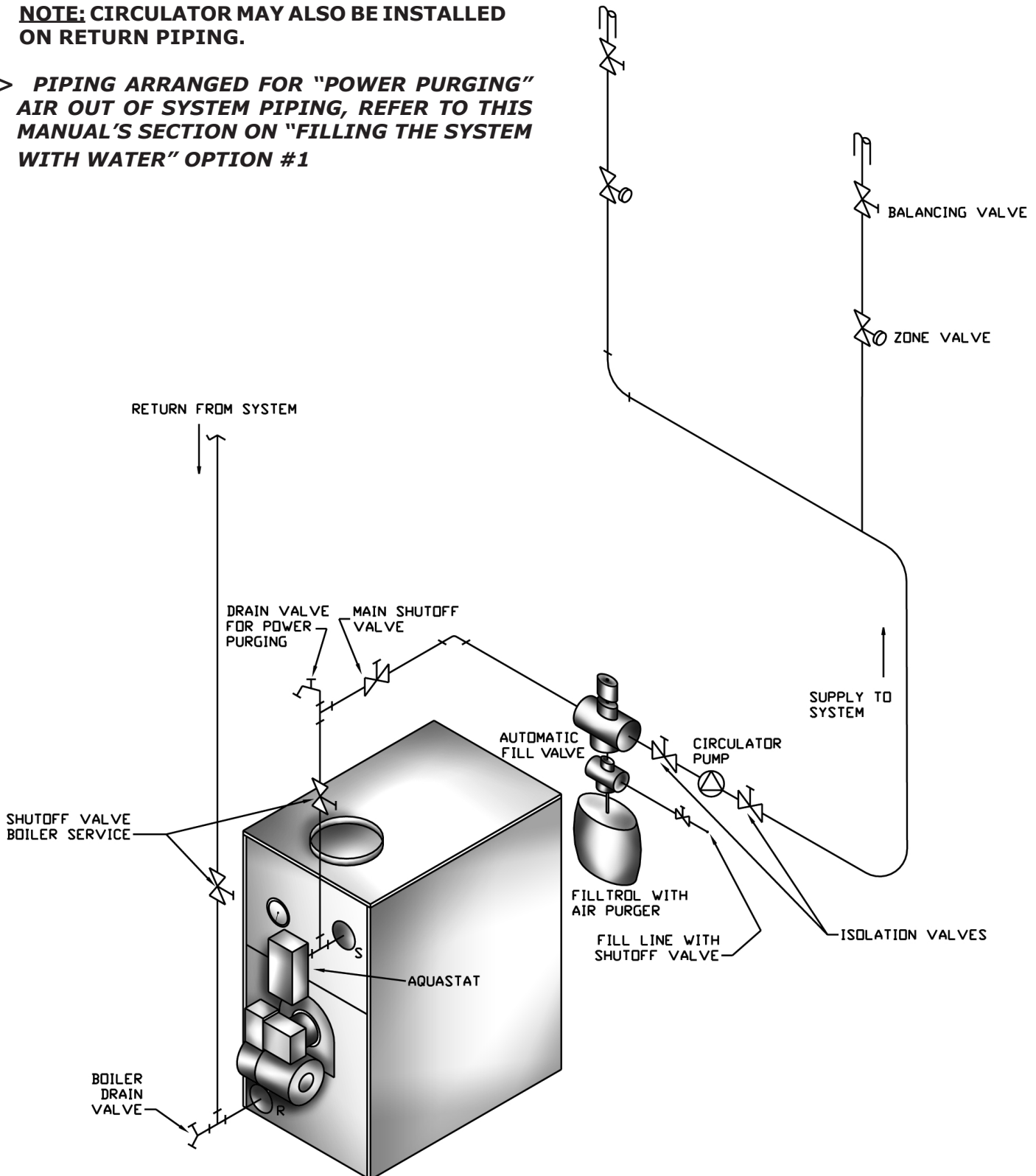
SYSTEM PIPING

Figure 8 - System Piping Arrangement Zoning With Zone Valves

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

NOTE: CIRCULATOR MAY 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**



SYSTEM PIPING

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

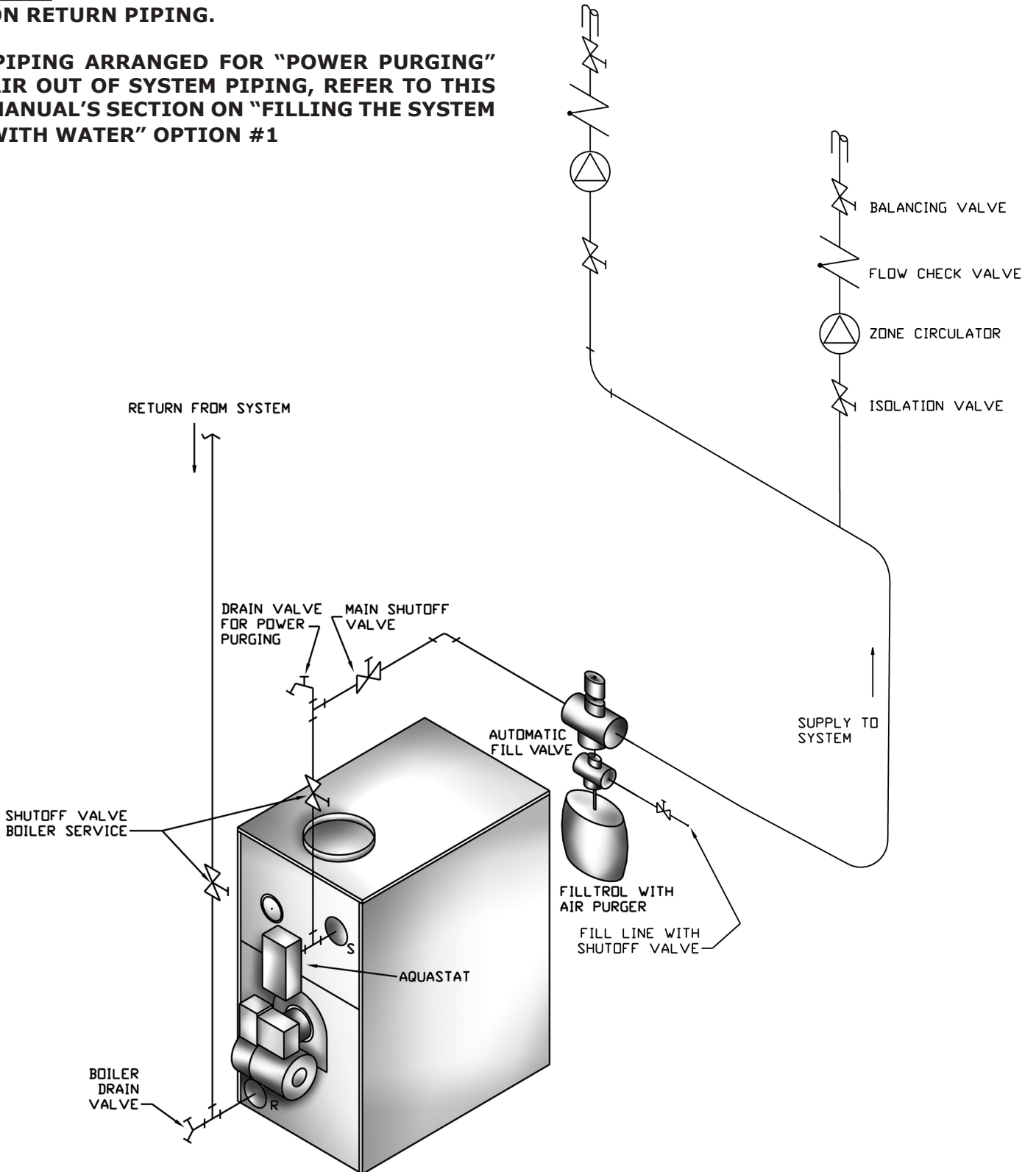
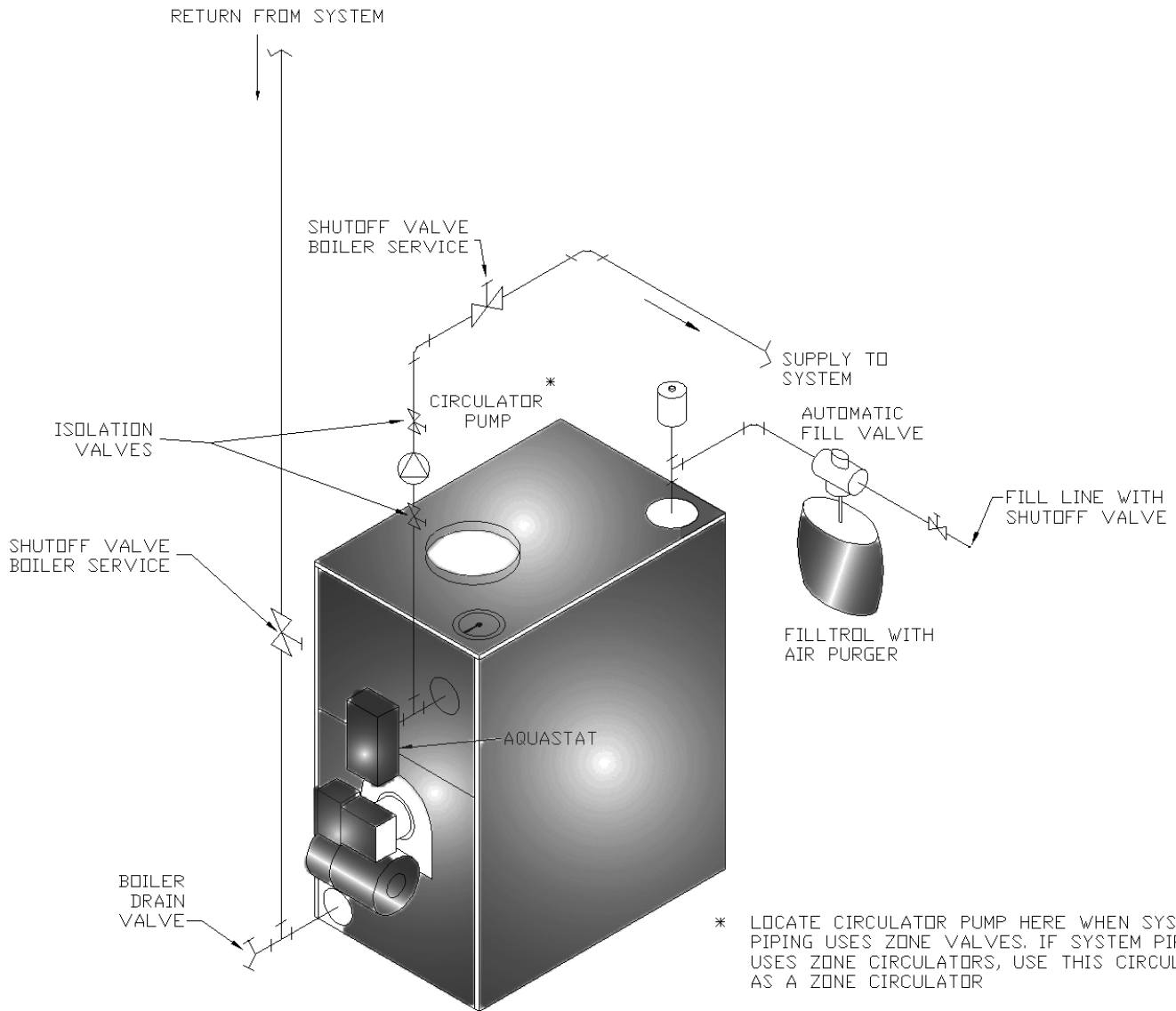


Figure 10 - System Piping Arrangement Alternate Near Boiler Piping

- > **DIAPHRAGM EXPANSION TANK MOUNTED OFF THE BOILER**

> **CIRCULATOR ON SUPPLY PIPING PUMPS AWAY FROM EXPANSION TANK**
- > **PER THIS MANUAL, USE OPTION #2 IN "FILLING THE SYSTEM WITH WATER"**

> **THIS PIPING ARRANGEMENT CAN BE USED WITH ZONE VALVES OR ZONE CIRCULATORS**



SYSTEM PIPING

Tankless Coil Piping Arrangement

⚠ DANGER

Scald, Burn Hazard! Temperatures exceeding 120°F will cause severe burns or death. Use of water tempering device or mixing valve may be required by Authority having jurisdiction, follow all codes as required before leaving installation.

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.

Factory Packaged with Tankless Heater Coil

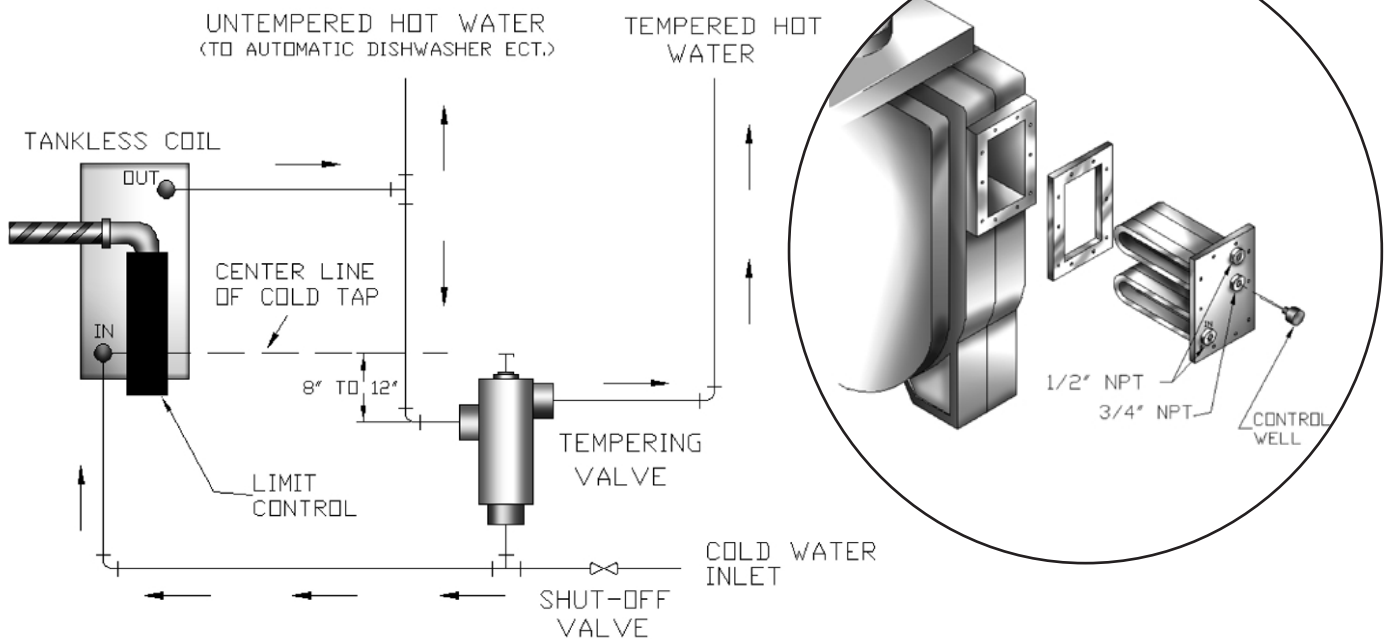
- Hydrolevel Control
Combination high limit / low limit control is located on tankless coil cover plate.

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).

Boiler Model	Burner Firing Rate (gph)	Input (MBH)	Tank less Rating (gpm)‡
3KWC0.80(T)	0.80	112	3.05
4KWC1.00(T)	1.00	140	3.25
4KWC1.25(T)	1.25	175	3.50
5KWC1.35(T)	1.35	189	3.60
5KWC1.55(T)	1.55	217	3.80

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

Figure 11 -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 *NFPA-31 Standard for the installation of Oil-Burning Equipment* (latest edition) and applicable provisions of local building codes.

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*.

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.

Check your chimney to make certain that it is right size, properly constructed and in good condition.

See Table "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"

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

Sidewall Venting With Listed Power Venter

- This boiler is not approved for direct sidewall horizontal venting.
- In the U.S. : Per section E.11 of *NFPA 31-2020 Standard for the Installation of Oil Burning Equipment*, a listed power venter providing mechanical draft may be used when approved by the Authority having jurisdiction. Select the listed power venter to match the BTU per hour input of the boiler being vented. Follow all manufacturer's installation and operating instructions for venting and termination included with the power venter.



CHIMNEY AND CHIMNEY CONNECTIONS

WARNING

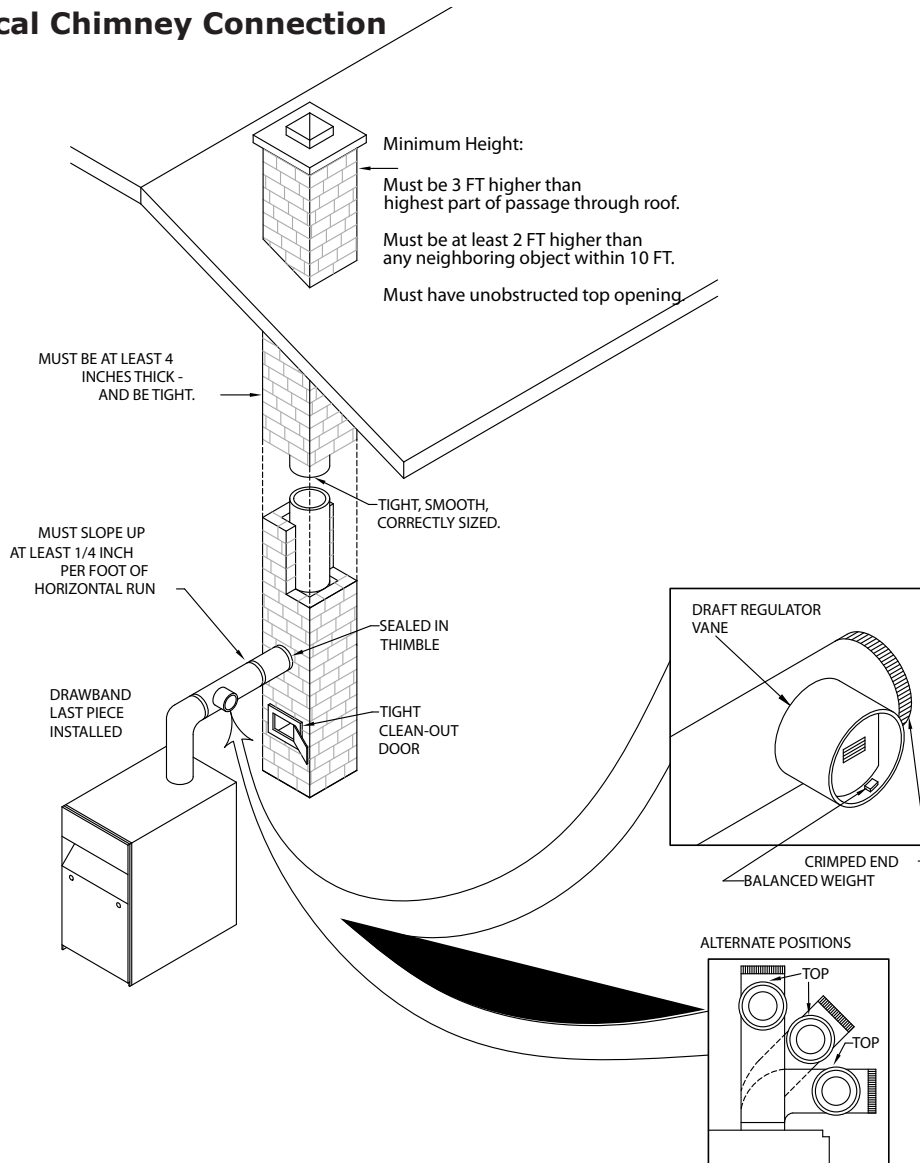
Fire Hazard. Maintain minimum vent pipe clearance of 9" from surface of vent to wood and other combustible materials. Failure to comply may result in death or serious injury.

Chimney Connector And Draft Regulator

- Venting the boiler requires 6" diameter chimney connector pipe and use of manufacturer provided draft regulator.
- Regulator, when properly installed, automatically controls the draft.
- Install in horizontal section of pipe, may also be installed in angled or vertical section of pipe.
- Verify "top" of regulator is at the top and short pipe section which holds the vane is horizontal.

- Even though locating draft regulator close to chimney reduces noise, **install draft regulator as close as practicable to the boiler.**
- Install chimney connector, start at boiler with vertical pipe, elbow, then install draft regulator horizontally.
- When regulator is in place, start at chimney and work back to the regulator.
- Join the two sections with draw-band.
- Horizontal pipe must slope up toward the 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 a stovepipe wire.

Figure 12 -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 120 volt electrical supply to L1 and L2 terminals and two thermostat wires to T and T terminals on Hydrolevel limit control

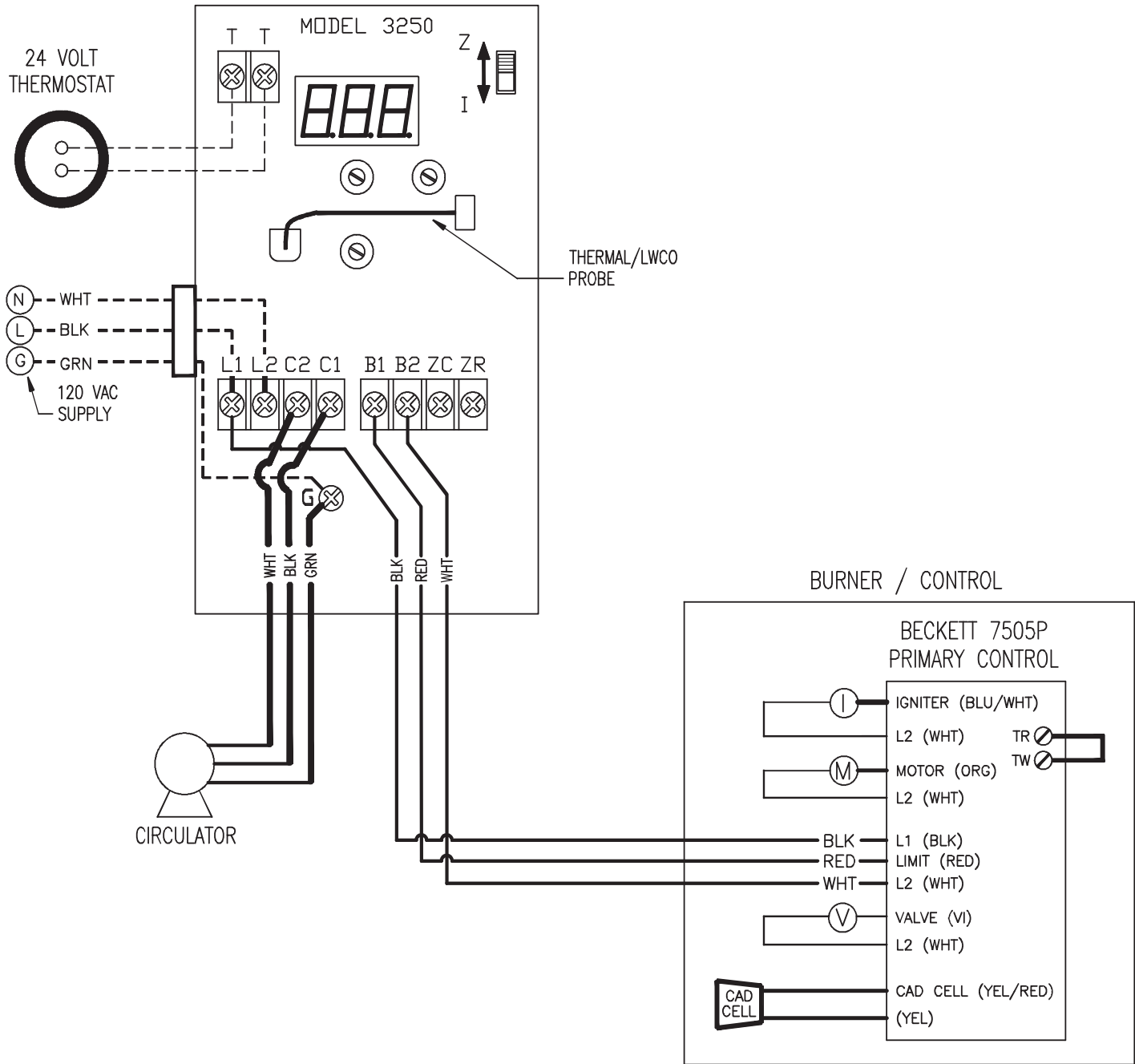
Run separate circuit from separate over current protection device in your electrical service entrance panel. Minimum 15 ampere circuit. Locate shutoff switch at boiler. Turn off during any maintenance. Solder and tape or securely fasten connections with wire nuts.

OIL BURNER WIRING

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

ELECTRICAL WIRING

Figure 13 - Boiler With Hydrolevel 3250 Control



How A Hot Water System Operates

Entire heating system (boiler, piping, and radiation units) is filled with water. As water in the 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 the boiler. This arrangement provides positive and rapid response to the thermostat.

Filling The System With Water

OPTION #1 This method utilizes boiler piping as shown in figures 7, 8 and 9.

- 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 will fill piping and push 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 it 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 until finishing with highest radiation unit.
- If heating system has automatic vents, this manual venting is unnecessary but it will speed up proper filling of the system.

If system is a 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, which 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 then 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.

OPERATING THE BOILER

Start: Fill entire system with water. Vent all air from system following section for Filling The Boiler.

Fuel Units And Oil Lines:

- Install oil line(s) to oil burner.
- Recommend using heavy wall copper tubing and flared fittings, not compression fittings.
- All connections and joints must be absolutely airtight. Use an appropriate non-hardening thread sealing compound on the threaded connections, not Teflon tape.
- See fuel unit data sheet furnished with the burner for sizing, lift, and length of tubing recommendations.

Oil burner is equipped with single stage fuel unit for single pipe installation. This is satisfactory where fuel supply is on same level as or above burner permitting gravity flow of oil. *Per NFPA 31 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. Refer to fuel unit instructions furnished with burner for specific instructions on two pipe installations. Do not exceed fuel unit manufacturer's recommendations for running vacuum.

NOTICE

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 a 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 a 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 to the section "**Fresh Air For Combustion**" for additional sizing guidelines.

Draft Regulators: Barometric draft regulator is required for controlling draft through boiler. Mount barometric draft regulator 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:

- A. Combustion chamber over fire draft shall be $-0.01''$ WC to $-0.02''$ WC.
- B. Stack draft will be approximately $-0.02''$ WC. to $-0.04''$ WC.
- C. Larger installation, greater draft will be required in stack to obtain desired over fire draft.

Nozzles And Electrodes: Use proper size, spray angle, and spray pattern nozzle.

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.

Depending on burner type, electrode tip spacing may need to be set prior to reassembling nozzle line electrode assembly.

Refer to following pages for setting electrode tip spacing.

Final Burner Adjustments: Final burner adjustments must be made using combustion test instruments. Refer to preliminary burner settings charts for initial startup. 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 requires 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 CO_2 and as insurance margin increase air to sufficiently reduce CO_2 by $\frac{1}{2}\%$ to 1%.

If clean fire cannot be obtained, it is 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, start and stop burner several times to assure good operation with no fluttering or rumbling. Verify there are no oil leaks. Record nozzle size, oil pressure, combustion readings, and air settings on tag or label attached to burner or, boiler.

PRELIMINARY BURNER SETTINGS

BECKETT AFG

BOILER MODEL	BURNER MODEL	INPUT RATE [gph]	INSERTION DEPTH	DELAVAN OIL NOZZLE	PUMP PRESSURE [psi]	LOW FIRE BAFFLE	BURNER HEAD	HEAD SETTING	AIR SHUTTER/BAND	STATIC PLATE
3KWC0.80(T)	AFG50MBAS	0.80	2-1/4"	0.65-70°W	150	YES	L1	N/A	10/1	3-3/8"
4KWC1.00(T)	AFG50MDASN	1.00	2-1/2"	0.85-60°A	140	NO	V1	0	6/1	2-3/4"
4KWC1.25(T)	AFG50MDASN	1.25	2-1/2"	1.00-60°W	155	NO	V1	0	10/1	2-3/4"
5KWC1.35(T)	AFG50MDASN	1.35	2-1/2"	1.10-60°B	150	NO	V1	0	7/1	2-3/4"
5KWC1.55(T)	AFG50MDASN	1.55	2-1/2"	1.25-60°B	155	NO	V1	2	10/2	2-3/4"

Note: All burners fire at an overfire draft of -0.02 inches w.c. The burner settings provided are for initial startup only. Final adjustment must be made using combustion test instruments.

Figure 14 - Beckett AFG Burner Electrode Adjustments (V1, L1) Heads

Boiler Model	Dimension "N" (electrode to nozzle)	Dimension "X" (above nozzle Center)	Dimension "Z" (end of air tube to head)
3 Section	1/16"	5/16"	1-3/4" +/- 1/32"
4/5 Section	1/8"	1/4"	1-3/4" +/- 1/32"

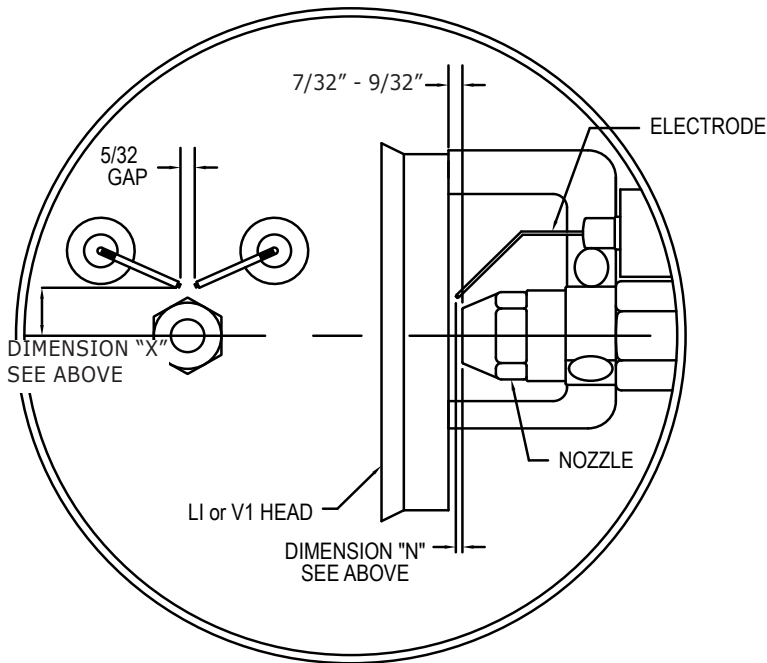
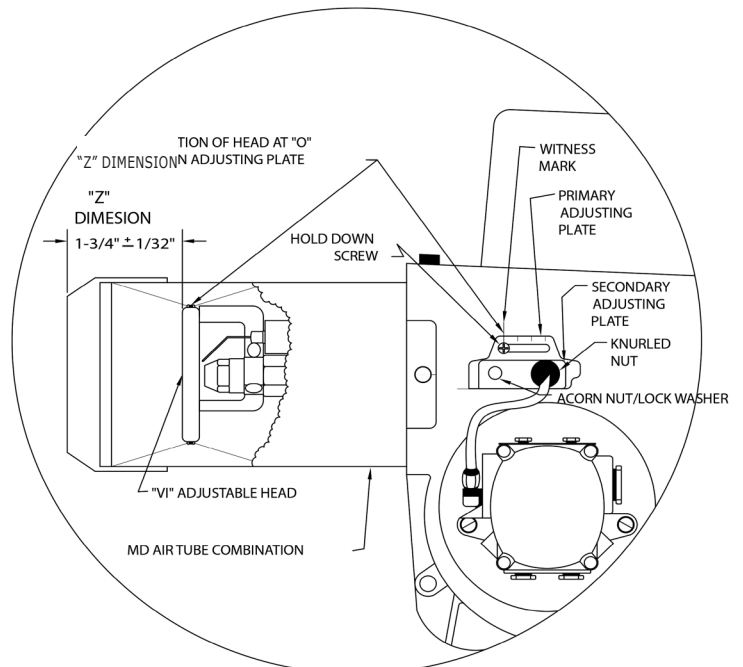


Figure 15 - Beckett AFG Variable (V1) Head Adjustments and Settings



CHECKING AND ADJUSTING CONTROLS

WARNING

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

NOTICE

Installer shall follow these instructions carefully.

This boiler is equipped with the Hydrolevel 3250-Plus temperature limit and operating control.

Consult Hydrolevel literature provided with boiler for detailed information on various features of control and instructions for setting up the control.

High limit is factory set to 190°F.

Low limit is factory set to OFF. This setting is applicable to models without tankless coil so they operate as a cold start boiler.

Low limit is used to maintain temperature in boilers equipped with tankless coils. For models with tankless coil, turn the low limit dial clockwise until the desired temperature is displayed.

Limit settings may be varied to meet the requirements of the installation. Low limit set point must be at least 10°F less than high limit set point.

Economy feature is factory set to 1 for single zone system. Adjust per Hydrolevel instructions.

Low water cut off feature is factory set for automatic mode. Refer to the Hydrolevel instructions to activate manual reset mode or to disable low water cut off feature.

Adjust Thermostat Heat Anticipator or Thermostat Cycle Rate According to Instructions Included With The Thermostat

Check Thermostat Operation:

Follow instructions included with your thermostat.

Locate thermostat five feet above the floor on inside wall. Locate thermostat to sense average room temperature, avoid the following:

THERMOSTAT LOCATIONS TO AVOID

DEAD SPOTS	HOT SPOTS	COLD SPOTS
Behind doors	Concealed pipes	Concealed pipes or ducts
	Fireplace	
	TV sets	Stairwells drafts
Corners & alcoves	Radios	Doors drafts
	Lamps	Unheated room on other side of wall
	Direct sunlight	
	Kitchens	

When temperature on thermostat is set above indicated thermostat temperature, boiler's burner should start. Verify that when room temperature reaches selected temperature setting, thermostat should turn boiler's burner off, and once room temperature falls few degrees boiler starts operating again.

Do not start burner unless all cleanout doors are secured in place.

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.

WARNING

Burn and scald hazard. Do not attempt to start the burner when excess oil has accumulated, when the unit is full of vapor, or when the combustion chamber is very hot. Failure to follow these instructions could result in death or serious injury.

Annually: Recommend flue passages, combustion chamber area (target wall, fire door insulation, durablanket), burner adjustment, control operation, and boiler seals (fire door gasket or silicone seal, cast iron sectional seals, flue collector) be checked once each year by trained 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 Service Technician to replace the valve and inspect heating system to determine cause, may indicate equipment malfunction. Safety relief valve should be tested monthly during heating season. Prior to testing, make certain discharge pipe is properly connected to valve outlet and arranged so as to contain and safely dispose of boiler discharge. Hold trip lever fully open for at least five seconds in order to flush free any sediment that may lodge on valve seat. Permit valve to snap shut. Refer to valve manufacturer's instructions packaged for more details.

Conventional Expansion Tank: Tank may become water logged or may receive excess 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 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: 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, drain it completely (water left in system may freeze and will crack pipes and/or boiler).

Tankless Coil (Or Cover Plate) Gasket: Check gasket at least twice year for leakage, replace if necessary. If gasket is replaced, make sure when coil plate (or cover plate) is reattached, ten nuts are torqued in alternating pattern to insure equal force is applied to entire gasket creating good seal. Nuts should be torqued so gasket does not squeeze out from behind the plate.

Control Well: Remove control well every five years and clean any scale or sediment deposits from all parts exposed to boiler water. After cleaning, reinstall well using pipe sealing compound. Teflon tape is not recommended.

Oil Burner Maintenance

Perform following preventative maintenance annually, prior to heating season is preferred.

1. **Do not oil-** Oil burner motors are permanently lubricated.
2. **Fuel Filter-** Replace to prevent contaminated fuel from reaching nozzle. Partially blocked fuel filter can cause premature failure of fuel pump.
3. **Fuel Pump Unit-** Replace pump screen and clean pump unit to maintain fuel delivery to nozzle.
4. **Ignition Electrodes** - Clean and adjust per manufacturer's recommendations, to maintain reliable ignition of oil.
5. **Nozzle-** Replace to maintain safe and reliable combustion efficiency. Replace with nozzle as required in charts located in this manual.
6. **Fan and Blower Housing-** Must be kept clean, free of dirt, lint and oil to maintain proper amount of air fuel requires to burn.
7. **Check Final Burner Adjustments.**

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

OIL BOILER CLEANING INSTRUCTIONS

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 16.
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:

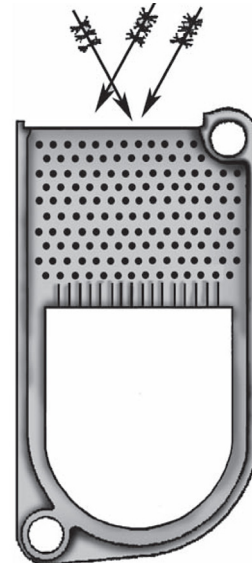
- Keep boiler and area around it clean
- Never burn refuse or any material other than specified fuel in your boiler
- Have your boiler checked each year by qualified technician

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.

Figure 16 - Brush Diagonally Through Flue Passages

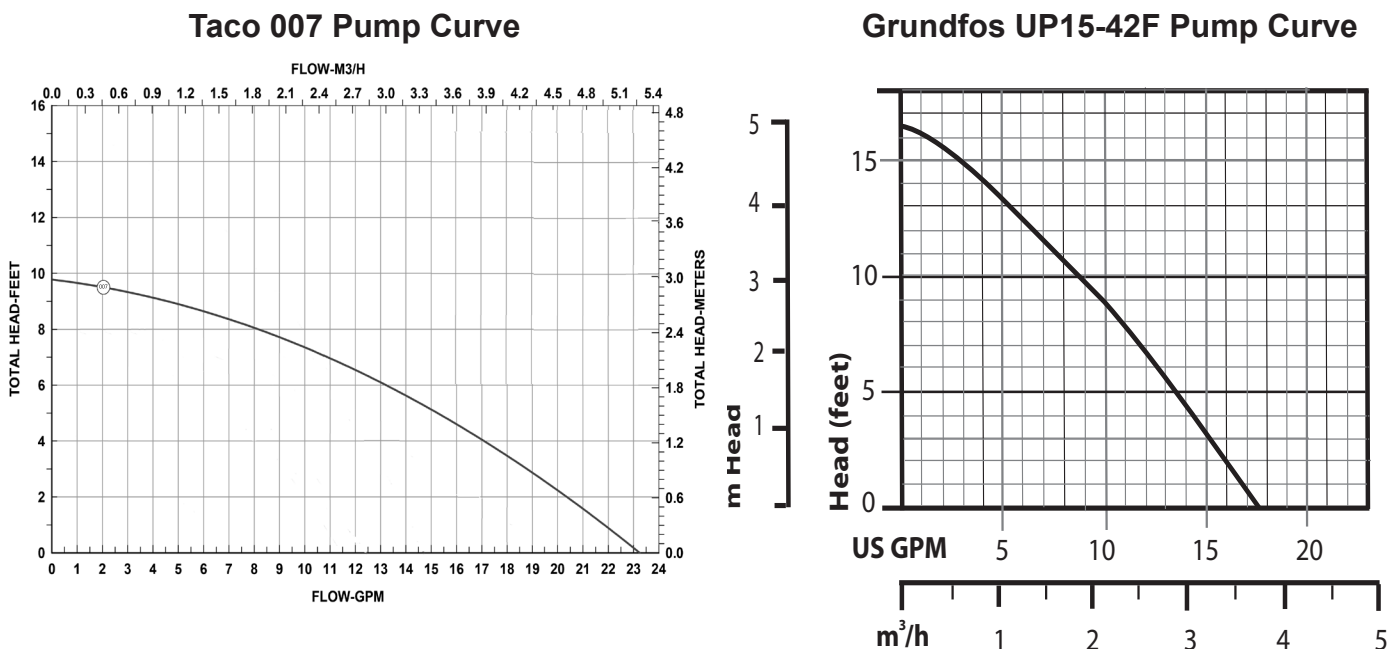


SERVICE HINTS

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. 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 17 - Pump Curves



IMPORTANT

In accordance with Section 325 (f) (3) of the Energy Policy and Conservation Act, this boiler is equipped with a feature that saves energy by reducing the boiler water temperature as the heating load decreases.

This feature is equipped with an override which is provided primarily to permit the use of an external energy management system that serves the same function.

THIS OVERRIDE MUST NOT BE USED UNLESS AT LEAST ONE OF THE FOLLOWING CONDITIONS IS TRUE:

- An external energy management system is installed that reduces the boiler water temperature as the heating load decreases.
- This boiler is not used for any space heating
- This boiler is part of a modular or multiple boiler system having a total input of 300,000 BTU/hr or greater.
- This boiler is equipped with a tankless coil.



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All specifications subject to change without notice.

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