

INSTALLATION AND SERVICE MANUAL



HYDRONIC HEATING BOILERS and DOMESTIC WATER HEATERS 399,999 - 2,070,000 Btu/hr MODELS



⚠ WARNING: Do not use this appliance if any part has been under water. The possible damage to a flooded appliance can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

⚠ WARNING: Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury, exposure to hazardous materials or loss of life. Refer to this manual. Installation and service must be performed by a qualified installer, service agency or the gas supplier. This unit contains materials that have been identified as carcinogenic, or possibly carcinogenic, to humans.

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

– Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
 - Do not touch any electric switch; do not use any phone in your building.
 - Immediately call your gas supplier from a neighbors phone. Follow the gas supplier's instructions.
 - If you cannot reach your gas supplier, call the fire department.
- Installation and service must be performed by a qualified installer, service agency or the gas supplier.

Save this manual for future reference.

Hydronic Heating Boilers and Domestic Water Heaters

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Installation and Service Manual

GENERAL PRODUCT INFORMATION

Special Instructions

This manual supplies information for the installation, operation and servicing of the appliance. Read and understand this manual completely before installing unit.

Installation and service must be performed by a qualified service installer, service agency, or the gas supplier.

Unpacking

Upon receiving equipment, check for signs of shipping damage. Pay particular attention to parts accompanying the boiler which may show signs of being hit or otherwise being mishandled. Verify total number of pieces shown on packing slip with those actually received. In case there is damage or a shortage, immediately notify the carrier.

Codes

The equipment shall be installed in accordance with those installation regulations in force in the local area where the installation is to be made. These shall be carefully followed in all cases. Authorities having jurisdiction shall be consulted before installations are made. In the absence of such requirements, the installation shall conform to the latest edition of the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CGA-B149 Installation Code. Where required by the authority having jurisdiction, the installation must conform to American Society of Mechanical Engineers Safety Code for Controls and Safety Devices for Automatically Fired Boilers, ASME CSD-1. All boilers conform to the latest edition of the ASME Boiler and Pressure Vessel Code, Section IV.

Note: The ceramic fiber material used in this appliance is an irritant; when handling or replacing the ceramic materials it is advisable that the installer follow these safety guides.

REMOVAL OF COMBUSTION CHAMBER LINING OR BASE PANELS:

- Avoid breathing dust and contact with skin and eyes.
- Use NIOSH certified dust respirator (N95) (<http://www.cdc.gov/niosh/hompage.html>).
- Lightly mist with water (only those areas being handled) the combustion chamber lining or base insulation to prevent airborne fibers.
- Remove combustion chamber lining or base insulation from the boiler and place it in a plastic bag for disposal.

- Wash potentially contaminated clothes separately from other clothing. Rinse clothes thoroughly.
- NIOSH stated First Aid:
 - Eye:** Irrigate immediately.
 - Breathing:** Fresh air.

⚠ WARNING: The combustion chamber lining in this appliance contains ceramic fiber materials. Ceramic fibers can transform into cristobalite (crystalline silica) when exposed to temperatures above 2192°F (1200°C) dependent upon the length of exposure time.*

The International Agency for Research on Cancer (I.A.R.C.) has concluded, "Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans."**

Testing has confirmed that the ceramic fibers in this application do not reach 2192°F (1200°C).

*Reference Dyson, D., Butler, M., Hughes, R., Fisher, R., and Hicks, G. The Devitrification of Alumino-silicate Ceramic Fiber Materials - The Kinetics of the Formation of Different Crystalline Phases, *Ann. Occup. Hyg.* Vol. 41, No. 55, 1997.
**Reference I.A.R.C. Monograph 68, June 1997.

Warranty

Factory warranty (shipped with unit) does not apply to units installed or operated improperly.

Improper installation or system design causes most operating problems.

1. Excessive water hardness causing a lime build up in the copper tube is not the fault of the equipment and is not covered under the appliance manufacturer's warranty (see *Water Treatment*, page 40 and *Water Chemistry*, page 52.)
2. Excessive pitting and erosion on the inside of the copper tube may be caused by too much water velocity through the tubes and is not covered by the appliance manufacturer's warranty (see *System Temperature Rise Chart* on page 37 for flow requirements).

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SAFETY INFORMATION

The information contained in this manual is intended for use by qualified professional installers, service technicians or gas suppliers. Consult your local expert for proper installation or service procedures.

IMPORTANT: Read this owner's manual carefully and completely before trying to install, operate, or service this unit. Improper use of this unit can cause serious injury or death from burns, fire, explosion, electrical shock, and carbon monoxide poisoning.

⚠ DANGER: Carbon Monoxide poisoning may lead to death!

IMPORTANT: Consult and follow local building and fire regulations and other safety codes that apply to this installation. Consult your local gas utility company to authorize and inspect all gas and flue connections.

⚠ WARNING: Should overheating occur or the gas supply fail to shut off, do not turn off or disconnect the electrical supply to the pump. Instead, shut off the gas supply at a location external to the unit.

⚠ WARNING: To minimize the possibility of serious personal injury, fire or damage to your unit, never violate the following safety rules.

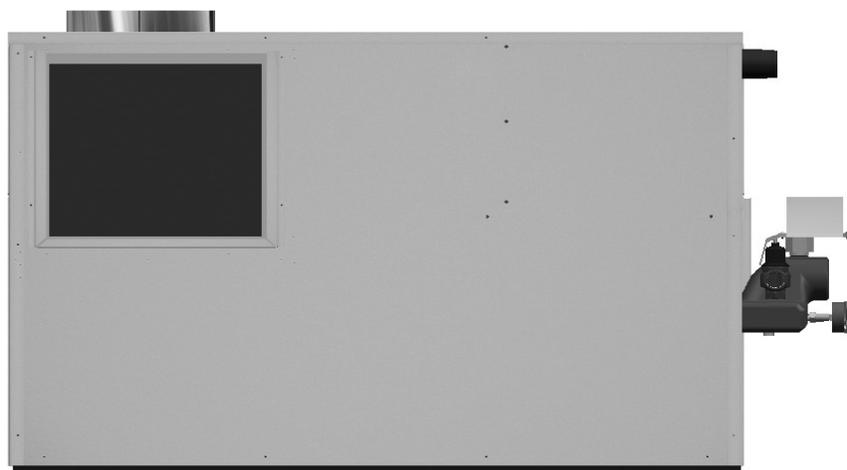
1. This unit is only for use with the type of gas indicated on the rating plate.
2. If you smell gas
 - shut off gas supply
 - do not try to light any appliance
 - do not touch any electrical switch; do not use any phone in your building
 - immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions
 - if you cannot reach your gas supplier, call the fire department
3. Boilers and water heaters are heat producing appliances. To avoid damage or injury, do not store materials against the appliance or the vent-air intake system. Use proper care to avoid unnecessary contact (especially children) with the appliance and vent-air intake components.
4. Never cover your unit, lean anything against it, store trash or debris near it, stand on it or in any way block the flow of fresh air to your unit.
5. **UNDER NO CIRCUMSTANCES MUST FLAMMABLE MATERIALS SUCH AS GASOLINE OR PAINT THINNER BE USED OR STORED IN THE VICINITY OF THIS APPLIANCE, VENT-AIR INTAKE SYSTEM OR ANY LOCATION FROM WHICH FUMES COULD REACH THE APPLIANCE OR VENT-AIR INTAKE SYSTEM.**
6. Appliance surfaces become hot during operation. Be careful not to touch hot surfaces. Keep all adults, children, and animals away from operation of the hot unit. Severe burns can occur.
7. You must take adequate care to prevent scald injury when storing water at elevated temperatures for domestic use.
8. This unit must have an adequate supply of fresh air during operation for proper gas combustion and venting.
9. Make sure all exhaust venting is properly installed and maintained. Improper venting of this unit could lead to increased levels of carbon monoxide.
10. Do not use this boiler if any part has been under water. Immediately call a qualified service technician to replace the boiler. The possible damage to a flooded boiler can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.
11. Do not alter this unit in any way. Any change to this unit or its controls can be dangerous.

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PRODUCT IDENTIFICATION



Front View



Rear View

FIG. 1 Front and Rear View

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION

This unit meets the safe lighting performance criteria with the gas manifold and control assembly provided, as specified in the ANSI standards for gas-fired units, ANSI Z21.13/CSA 4.9 and ANSI Z21.10.3/CSA 4.3.

LOCATING UNIT

1. Maintain all clearances from combustible construction when locating unit. See *Clearances from Combustible Construction*, this page.
2. Locate the unit so that if water connections should leak, water damage will not occur. When such locations cannot be avoided, install a suitable drain pan that is well-drained under the unit. The pan must not restrict combustion air flow. The appliance manufacturer is not responsible for water damage in connection with this unit, or any of its components.
3. Install indoor units so that the ignition system components are protected from any water while operating or during service.
4. Appliances located in a residential garage and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit must be installed so that all burners and burner ignition devices have a minimum clearance of not less than 18" (46 cm) above the floor. The appliance must be located or protected so that it is not subject to physical damage by a moving vehicle.
5. DO NOT install this appliance in any location where gasoline or flammable vapors are likely to be present.
6. You must install unit on a level, non-combustible floor.
7. Do not install unit directly on carpet or other combustible material. A concrete-over-wood floor is not considered non-combustible. Maintain required clearances from combustible surfaces.
If installing unit in an area with a combustible floor, you must use a special combustible floor base. See *Base for Combustible Floors*, on page 7.
8. For outdoor models, you must install an optional vent cap. Instructions for mounting the vent cap are included in the venting section. Do not install outdoor models directly on the ground. You must install the outdoor unit on a concrete, brick, block, or other non-combustible pad. Outdoor models have additional special location and clearance requirements. See *Outdoor Installation Venting*, page 26. A wind proof cabinet protects the unit from weather.

Clearances from Combustible Construction

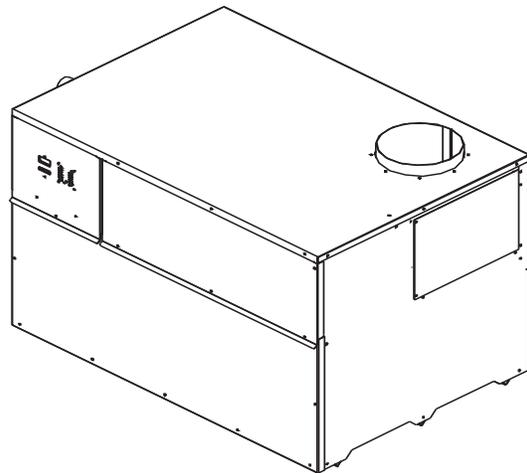
Maintain minimum specified clearances for adequate operation. Allow sufficient space for servicing pipe connections, pump and other auxiliary equipment, as well as the unit. See rating plate for specific service clearance requirements.

Right Side	3" (7.5 cm)
Rear	3" (7.5 cm) (3" min. from any surface)
Left Side	6" (15cm) (24" (0.61m) suggested for service)
Front	Alcove* (30" (0.76m) suggested for service)
Top	3" (7.5cm)
Flue	1" (25.4mm)
Hot Water Pipes	1" (25.4mm)

*An Alcove is a closet without a door.

Note: No additional clearance is needed on the right side of the unit for the observation port. An observation port is located on both the right and left side of the unit.

No additional clearances for combustibles are needed for use of the Direct Vent (DV) air inlet assembly.



3 INCH MINIMUM FROM UNIT TO WALL

FIG. 2 Clearances from Combustible Construction

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Base for Combustible Floors

There are no manufactured combustible floor base kits available for 990,000 - 2,070,000 Btu models. See Table-A below for floor base kits that are available.

You must construct a base for combustible floor installation. Install unit over a base of hollow clay tiles or concrete blocks from 8" to 12" thick and extending at least 24" beyond the unit sides. Place tiles or blocks so that the holes line up horizontally to provide a clear passage through the tiles or blocks. Place a 1/2" fireproof millboard over the top of the tile or block base. Place a 20-gauge sheet metal cover over the fireproof millboard. Center the unit on the base. Also follow this procedure if electrical conduit runs through the floor beneath the unit. This base must meet all local fire and safety codes.

TABLE - A COMBUSTIBLE FLOOR KITS	
Input Btu/hr	Kit Number
399,999	CFK3301
500,000	CFK3302
650,000	CFK3303
750,000	CFK3304

FREEZE PROTECTION

Although these units are CSA International design certified for outdoor installations, such installations are not recommended in areas where the danger of freezing exists. You must provide proper freeze protection for outdoor installations, units installed in unheated mechanical rooms or where temperatures may drop to the freezing point or lower. If freeze protection is not provided for the system, a low ambient temperature alarm is recommended for the mechanical room. Damage to the unit by freezing is non-warrantable.

Anytime the temperature measured at any of the sensors (except the outside air temperature sensor) drops below 35°F (2°C), the control turns on the pump contact and the alarm relay. The screen displays an error message (EO2).

Pump Operation

This unit is equipped with a pump delay feature as standard. The delay is selectable through the temperature controller. As shipped from the factory, the ΔT_{MIN} is set to "OFF", which creates a 30 second pump delay at the end of a Call for Heat.

The value of ΔT_{MIN} can be changed to a value between 1°F and 20°F. This will cause the unit to continue pump operation until the ΔT is less than the value selected (30 second minimum).

A value of "ON" is selectable through the control for ΔT_{MIN} . This will operate the pump continuously. Alternatively, the pump can be powered by a separate circuit for continuous operation.

Note: Pump relay is rated for 1 HP maximum.

Location

Locate indoor boilers and hot water supply boilers in a room having a temperature safely above freezing [32°F (0°C)].

CAUTION: A mechanical room operating under a negative pressure may experience a down draft in the flue of a boiler which is not firing. The cold outside air pulled down the flue may freeze a heat exchanger. This condition must be corrected to provide adequate freeze protection.

Hydronic System Antifreeze

Freeze protection for a heating boiler or hot water supply boiler using an indirect coil can be provided by using hydronic system antifreeze. Follow the appliance manufacturers instructions. Do not use undiluted or automotive type antifreeze.

WARNING: Do not use antifreeze in domestic water heater applications.

Outdoor Boiler Installation

Adequate hydronic system antifreeze must be used. A snow screen should be installed to prevent snow and ice accumulation around the unit or its venting system.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

Shut-Down and Draining

If for any reason, the unit is to be shut off, the following precautionary measures must be taken:

1. Shut off gas supply.
2. Shut off water supply.
3. Shut off electrical supply.
4. Drain the unit completely. Remove one threaded plug or bulbwell from the inlet side of the front header and one from the outlet side of the front header on the heat exchanger. Blow all water out of the heat exchanger (see FIG. 3).
5. Drain pump and piping.

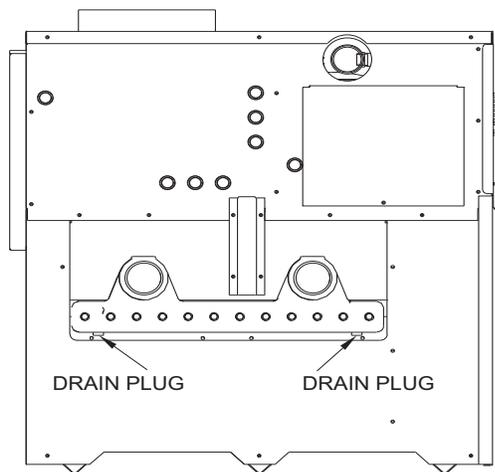


FIG. 3 Draining Unit

Freeze Protection for a Heating Boiler System (if required)

1. Use only properly diluted inhibited glycol antifreeze designed for hydronic systems. Inhibited propylene glycol is recommended for systems where incidental contact with drinking water is possible.

⚠ WARNING: Do not use undiluted or automotive type antifreeze.

2. A solution of 50% antifreeze will provide maximum protection of approximately -30°F (-34°C).
3. Follow the instructions from the antifreeze manufacturer. Quantity of antifreeze required based on total system volume including expansion tank volume.

4. Glycol is denser than water and changes the viscosity of the system. The addition of glycol will decrease heat transfer and increase frictional loss in the boiler and related piping. A larger pump with more capacity (15% to 25% more) may be required to maintain desired flow rates and prevent a noise problem in a glycol system.
5. Local codes may require a back flow preventer or actual disconnect from city water supply when antifreeze is added to the system.

COMBUSTION AND VENTILATION AIR

Provisions for combustion and ventilation air must be in accordance with Section 5.3, Air for Combustion and Ventilation, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of the local building codes.

Provide properly-sized openings to the equipment room to assure adequate combustion air and proper ventilation when the unit is installed with conventional venting or sidewall venting.

Combustion Air Filter

This unit has a standard air filter located at the combustion air inlet. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The filter size on the 399,999 - 750,000 units is 12" x 12" x 1" (30.5cm x 30.5cm x 2.5cm) and 16" x 16" x 1" (40.6cm x 40.6cm x 2.5 cm) on the 990,000 - 2,070,000 units. You can find these commercially available filters at any home center or HVAC supply store.

For convenience and flexibility, you can direct the combustion air inlet from either the back or right side of the unit. To arrange the combustion air inlet for side entry, follow the steps below:

1. Remove the metal panel from the unit's side wall (see FIG. 4).
2. Remove screws from the air filter/bracket assembly.
3. Move the filter/bracket assembly from the rear of unit to the side opening (see FIG. 5).
4. Attach filter/bracket assembly to the unit's side using the pre-drilled screw holes.
5. Attach the metal panel to the rear combustion air opening to seal it off.

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Combustion Air Options

⚠ CAUTION: Under no circumstances should the mechanical room ever be under a negative pressure. Particular care should be taken where exhaust fans, attic fans, clothes dryers, compressors, air handling units, etc., may take away air from the unit.

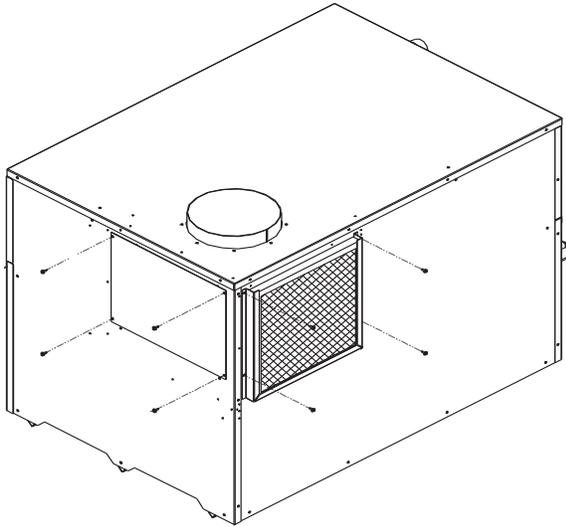


FIG. 4 Metal Panel Covering Side Combustion Air Inlet

This unit has four combustion air options.

1. Outside Combustion Air, No Ducts

You can direct outside combustion air to this unit using either one or two permanent openings.

One Opening

The opening must have a minimum free area of one square inch per 3000 Btu input (7cm^2 per kW). You must locate this opening within 12" (30cm) of the top of the enclosure.

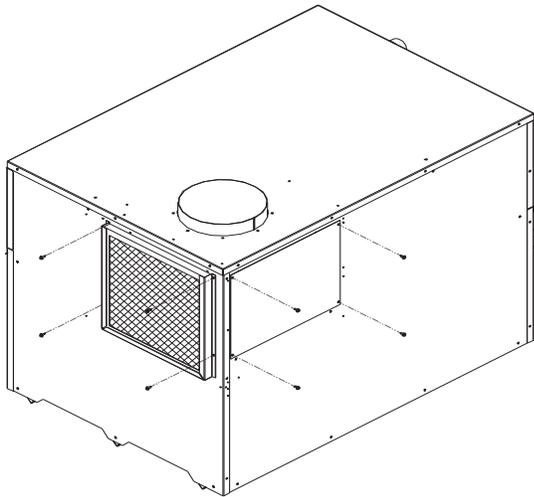


FIG. 5 Moving Air Filter/Bracket Assembly from Rear of Unit to Side

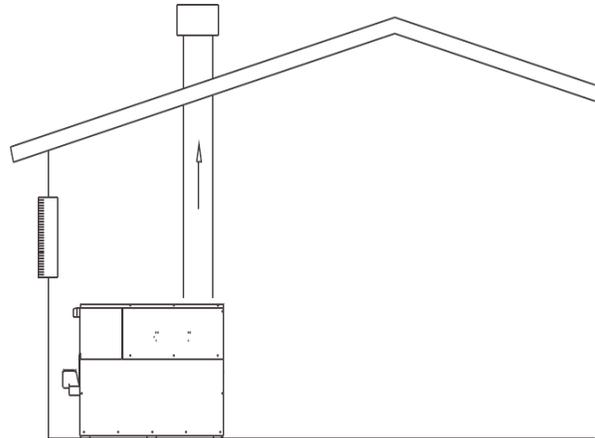


FIG. 6 Outside Combustion Air - Single Opening

Two Openings

The combustion air opening must have a minimum free area of one square inch per 4000 Btu/hr input (5.5cm^2 per kW). You must locate this opening within 12" (30cm) of the bottom of the enclosure.

The ventilation air opening must have a minimum free area of one square inch per 4000 Btu/hr input (5.5cm^2 per kW). You must locate this opening within 12" (30cm) of the top of the enclosure.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

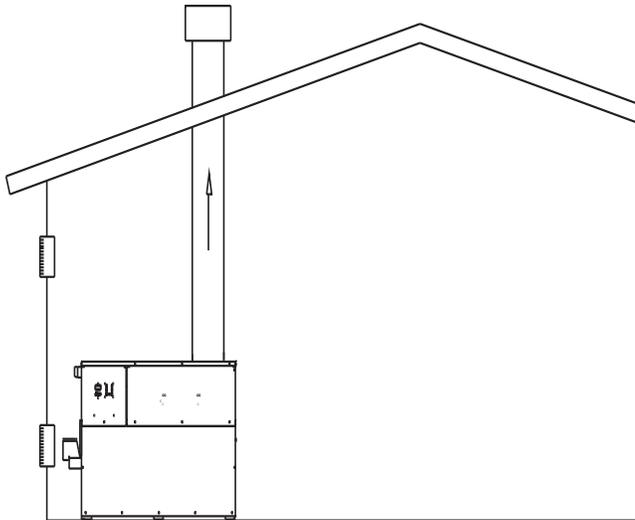


FIG. 7 Outside Combustion Air - Two Openings

2. Outside Combustion Air, Using Ducts

You can direct outside combustion air to this unit using two air ducts to deliver the air to the boiler room.

Each of the two openings must have a minimum free area of one square inch per 2000 Btu input (11cm^2 per kW).

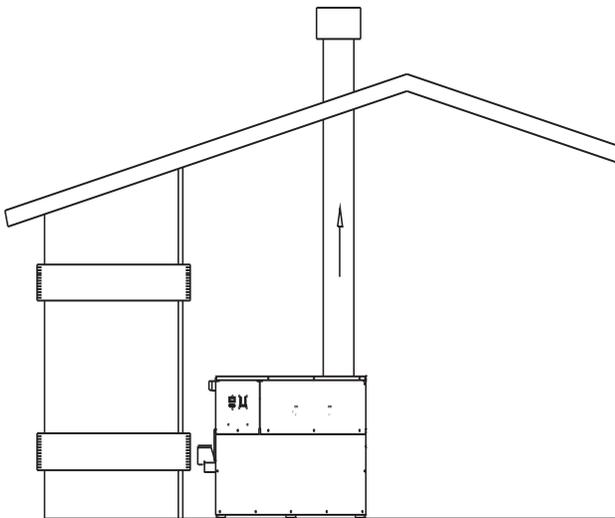


FIG. 8 Outside Combustion Air Through Ducts

3. Outside Combustion Air - Using Direct Venting

With this option, you can connect combustion air vent piping directly to the unit. See the information under *Direct Venting*

starting on page 22 for specific information regarding this option.

4. Combustion Air from Interior Space

You can direct combustion air to this unit using air from an adjoining interior space. You must provide two openings from the boiler room to the adjoining room.

Each of the two openings must have a net free area of one square inch per 1000 Btu input (22cm^2 per kW), but not less than 100 square inches (645cm^2).

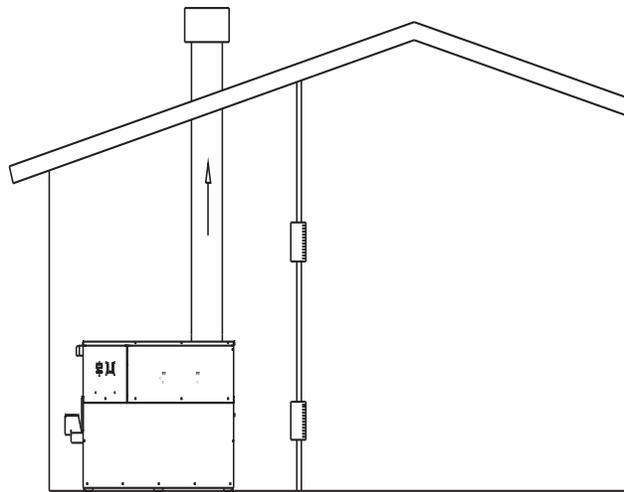


FIG. 9 Combustion Air from Interior Space

All dimensions are based on net free area in square inches. Metal louvers or screens reduce the free area of a combustion air opening a minimum of approximately 25%. Check with louver manufacturers for exact net free area of louvers. Where two openings are provided, one must be within 12" (30 cm) of the ceiling and one must be within 12" (30 cm) of the floor of the mechanical room. Each opening must have a minimum net free area as specified in TABLE-C, page 14. Single openings shall be installed within 12" (30 cm) of the ceiling.

The combustion air supply must be completely free of any flammable vapors that may ignite or chemical fumes which may be corrosive to the unit. Common corrosive chemical fumes which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as Freon, trichloroethylene, perchloroethylene, chlorine, etc. These chemicals, when burned form acids which quickly attack the heat exchanger finned tubes, headers, flue collectors, and the vent system. The result is improper combustion and a non-warrantable, premature unit failure.

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Exhaust Fans

Any fan or equipment which exhausts air from the boiler room may deplete the combustion air supply and/or cause a down draft in the venting system. Spillage of flue products from the venting system into an occupied living space can cause a very hazardous condition that must be immediately corrected. If a fan is used to supply combustion air to the boiler room, the installer must make sure that it does not cause drafts which could lead to nuisance operational problems with the boiler.

Vertical DirectAire™ and Horizontal DirectAire™ venting systems have specific requirements for combustion air ducts from the outside which are directly connected to the unit. See the requirements for combustion air duct in the venting section.

VENTING

General Information

You must supply adequate combustion and ventilation air to this unit. You must provide minimum clearances for the vent terminal from adjacent buildings, windows that open, and building openings. Follow all requirements set forth in the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment or applicable local building codes. Vent installations for connection to gas vents or chimneys must be in accordance with Part 7, "Venting of Equipment" of the above-mentioned standards.

IMPORTANT: Examine the venting system at least once each year. Check all joints and vent pipe connections for tightness. Also check for corrosion or deterioration. If you find any problems, correct them at once.

Venting Support

Support horizontal portions of the venting system to prevent sagging. Provide an upward slope of at least 1/4 inch per foot (21mm/m) on all horizontal runs from the unit to the vertical flue run or to the vent terminal on sidewall venting installations.

Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney. The weight of the venting system must not rest on the unit. Provide adequate support of the venting system. Follow all local and applicable codes. Secure and seal all vent connections. Follow the installation instructions from the vent material manufacturer.

Vertical Vent Termination Clearances and Location

The vent terminal should be vertical and exhaust outside the building at least 2 feet (0.61m) above the highest point of the roof within a 10 foot (3.05m) radius of the termination.

The vertical termination must be a minimum of 3 feet (0.91m) above the point of exit.

A vertical termination less than 10 feet (3.05m) from a parapet wall must be a minimum of 2 feet (0.61m) higher than the parapet wall.

You must locate the air inlet termination elbow at least 12" (30cm) above the roof or above normal snow levels.

Keep the vent cap clear of snow, ice, leaves, and debris to avoid blocking the flue.

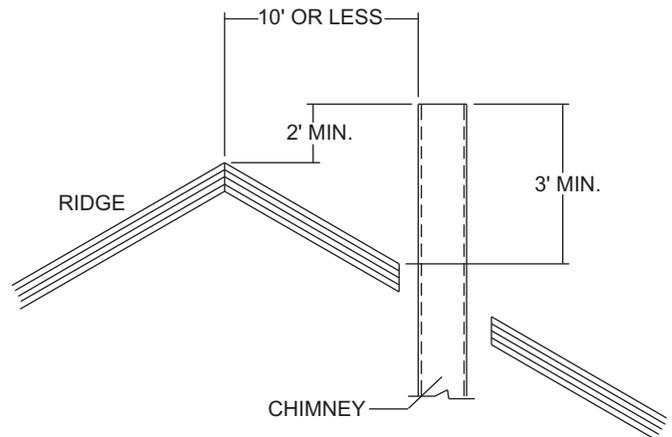


FIG. 10 Vent Termination from Peaked Roof - 10' or Less From Ridge

IMPORTANT: Vent terminations are not shown in Figures 10, 11, 12, and 13. Make sure all vertical vents are installed with vent terminations recommended by the vent manufacturer.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

Sidewall Vent Termination Clearances and Location

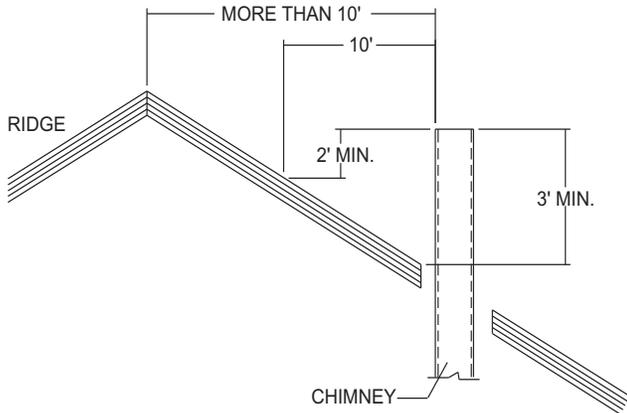


FIG. 11 Vent Termination from Peaked Roof More Than 10' From Ridge

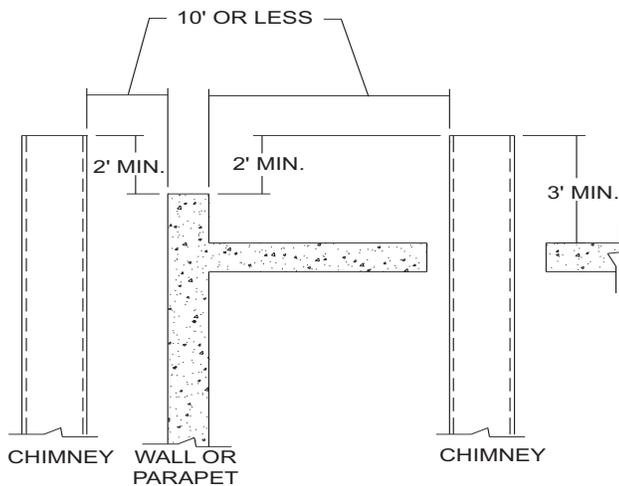


FIG. 12 Vent Termination from Flat Roof 10' or Less from Parapet Wall

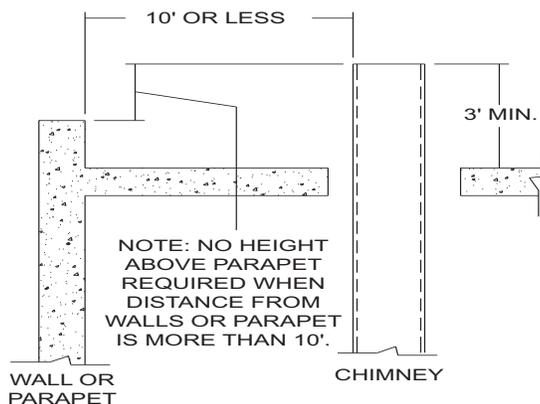


FIG. 13 Vent Termination from Flat Roof More Than 10' from Parapet Wall

Locate the bottom of the vent terminal at least 12 inches (30cm) above grade and above normal snow levels. Locate the bottom of the vent terminal at least 7 feet (2.13m) above grade when located adjacent to public walkways. Do not terminate directly above a public walkway.

Do not terminate the venting system in a window well, stairwell, alcove, courtyard, or other recessed area. Do not terminate the venting system below grade.

Locate vent termination at least 3 feet (0.91m) from an inside corner of an L-shaped structure.

Provide a minimum clearance of 4 feet (1.2m) horizontally from electric meters, gas meters, regulators, and relief equipment. Never locate vent cap above or below electric meters, gas meters, regulators, and relief equipment unless a 4 foot (1.2m) horizontal clearance is maintained.

Terminate the venting system at least 3 feet (0.9m) above any forced air inlet within 10 feet (3.05m).

Terminate the venting system at least 4 feet (1.2m) below, 4 feet (1.2m) beside, or 1 foot (30cm) above any door, window, or gravity air inlet into any building.

Locate vent termination at least 8 feet (2.4m) horizontally from any combustion air intake located above the sidewall termination cap.

⚠ CAUTION: Units which are shut down or will not operate may experience freezing due to convective air flow in flue pipe, through the air inlet, or from negative pressure in the mechanical room. In cold climates, operate pump continuously to help prevent freezing of boiler water. Provide proper freeze protection. See *Freeze Protection*, page 7.

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TABLE - B Flue and Air Inlet Pipe Sizes		
Input Btu/hr	Flue Size	Air Inlet Size*
399,999	6"	6"
500,000	6"	6"
650,000	8"	8"
750,000	8"	8"
990,000	10"	10"
1,260,000	12"	12"
1,440,000	12"	12"
1,800,000	14"	12"
2,070,000	14"	12"

* Minimum diameter for air inlet pipe. Installer may increase diameter one pipe size for ease of installation, if needed.

Combustion Air Inlet Piping

⚠ WARNING: Locate and install the combustion air inlet cap correctly. Failure to do so can allow the discharge of flue products to be drawn into the combustion process. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

The sidewall or vertical rooftop DirectAire™ combustion air supply system has specific vent material and installation requirements. The air inlet pipe connects directly to the unit to supply combustion air. In most installations, the combustion air inlet pipe will be a dedicated system with one air inlet pipe per unit. You can combine multiple air inlets if the guidelines in *Combined Air Inlet Points*, page 15 are followed. The air inlet pipe will be connected to a combustion air inlet cap as specified in this section.

For normal installations, this system uses a single-wall pipe to supply combustion air from outdoors directly to the unit.

In cold climates, use a Type-B double-wall vent pipe or an insulated single-wall pipe for combustion air. This will help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

Length of Air Inlet Pipe

The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Do not exceed the limits for the combustion air inlet piping lengths.

Sidewall Air Inlet

The sidewall air inlet cap is supplied in the Horizontal DirectAire™ Vent Kit. Order the kit from the appliance manufacturer. This sidewall cap supplies combustion air for a single unit only. See TABLE-D, page 19, for kit numbers.

Locate the unit as close as possible to the sidewall where you will install the combustion air supply system.

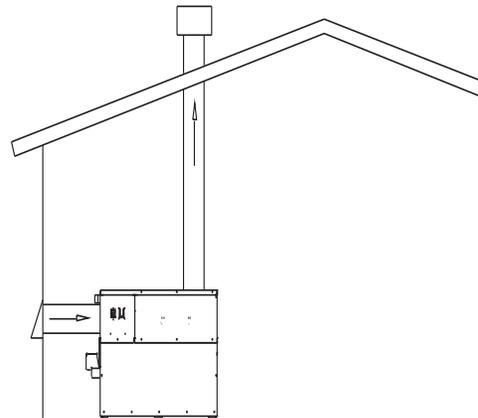


FIG. 14 Sidewall Combustion Air Inlet

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

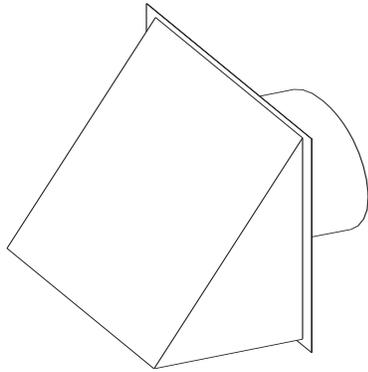


FIG. 15 Air Inlet Cap for Sidewall Termination

To prevent recirculation of flue products from an adjacent vent cap into the combustion air inlet, follow all applicable clearance requirements in the latest edition of the National Fuel Gas Code and/or CAN/CGA-B149 Installation Code and instructions in the Installation and Service Manual.

You must install the combustion air inlet cap at least one foot (0.30m) above ground level and above normal snow levels.

The point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (powered vent cap) if it is located within 10 feet (3.05m) of the flue outlet from the powered vent cap. Make sure to properly install the air inlet cap assembly on the air inlet pipe.

You must install the combustion air inlet cap and the powered vent cap on the same wall and in the same pressure zone.

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Vertical Rooftop Air Inlet

Use the vertical air inlet terminations available from the appliance manufacturer, recommended and/or supplied by the vent manufacturer, or use two 90° elbows as described on page 24.

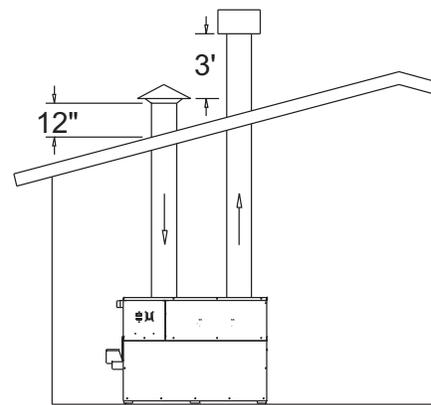


FIG. 16 Roof Top Combustion Air Inlet

Clearances

You must locate the air inlet termination elbow at least 12" (30cm) above the roof or above normal snow levels.

TABLE-C Minimum Recommended Combustion Air Supply To Boiler Room			
Boiler Input	Combustion Air Source		
	Outside Air*/2 Openings	Outside Air*/1 Opening	Inside Air/2 Openings
399,999	100 in ² (745 cm ²)	133 in ² (858 cm ²)	400 in ² (2581 cm ²)
500,000	125 in ² (806 cm ²)	167 in ² (1077 cm ²)	500 in ² (3226 cm ²)
650,000	163 in ² (1052 cm ²)	217 in ² (1400 cm ²)	650 in ² (4194 cm ²)
750,000	188 in ² (1213 cm ²)	250 in ² (1613 cm ²)	750 in ² (4839 cm ²)
990,000	248 in ² (1,600cm ²)	330 in ² (2,129 cm ²)	990 in ² (6,388 cm ²)
1,260,000	315 in ² (2,032cm ²)	420 in ² (2,710 cm ²)	1260 in ² (8,130 cm ²)
1,440,000	360 in ² (2,323cm ²)	480 in ² (3,097 cm ²)	1440 in ² (9,291 cm ²)
1,800,000	450 in ² (2,903cm ²)	600 in ² (3,871 cm ²)	1800 in ² (11,614 cm ²)
2,070,000	518 in ² (3,342cm ²)	690 in ² (4,452 cm ²)	2070 in ² (13,356 cm ²)

*Outside air openings shall directly communicate with the outdoors. When combustion air is drawn from the outside through a duct, the net free area of each of the two openings must have twice (2 times) the free area required for Outside Air/2 Openings. The above requirements are for the boiler only, additional gas fired units in the boiler room will require an increase in the net free area to supply adequate combustion air for all units. Combustion air requirements are based on the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada refer to CAN/CGA-B149 Installation Code. Check all local code requirements for combustion air.

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If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (vent cap).

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Combined Air Inlet Points

The air inlet pipes from multiple boilers can be combined to a single common connection if the common air inlet pipe has a cross sectional area equal to or larger than the total area of all air inlet pipes connected to the common air inlet pipe.

Example: Two 10" air inlet pipes (78.5 in² area each) have a total area of 157 in² and will require a 15" (176.7 in² area) common air inlet pipe.

The air inlet point for multiple boiler air inlets must be provided with an exterior opening which has a free area equal to or greater than the total area of all air inlet pipes connected to the common air inlet. This exterior opening for combustion air must connect directly to the outdoors. The total length of the combined air inlet pipe must not exceed a maximum of 50 (15.2m) equivalent feet. Subtract 5 feet (1.5m) for each 90° elbow in the air inlet pipe. You must deduct the restriction in area provided by any screens, grills or louvers installed in the common air inlet point. These are common on the sidewall air inlet openings. Screens, grills or louvers installed in the common air inlet can reduce the free area of the opening from 25% to 75% based on the materials used.

Vent System Options

This unit has six venting options.

1. Conventional Negative Draft Venting

This option uses a vertical rooftop flue termination. Combustion air is supplied from the mechanical room. See column 2 for detailed information.

2. Vertical DirectAire™ Venting

This option uses a vertical conventional vent for flue products. Combustion air is supplied by a pipe from the sidewall or rooftop. See page 17 for venting details.

3. Sidewall Venting

This option uses a powered vent assembly to exhaust the flue products out a sidewall vent termination. Combustion air is supplied from the mechanical room. See page 19 for venting details.

4. Horizontal DirectAire™ Venting

This option uses a powered vent assembly to exhaust the flue products out a sidewall. Combustion air is supplied by a pipe from the sidewall. See page 21 for venting details.

5. Direct Venting

This option uses a sealed AL29-4C flue and a separate combustion air pipe to the outdoors. This system terminates both the flue and combustion air inlet in the same pressure zone. The flue outlet and combustion air intake may terminate at either a sidewall (horizontal) or the rooftop (vertical). See page 22 for venting details.

6. Outdoor Installation Venting

This option uses the installation of a special air inlet/vent cap on top of the unit. See page 26 for venting details.

All units are shipped from the factory equipped for conventional negative draft venting. All other optional vent systems require the installation of specific vent kits and venting materials. The following is a detailed explanation of the installation requirements for each venting system, components used and part numbers of vent kits for each model.

Barometric Damper Location

Any venting system option that requires a barometric damper must adhere to the following directions for optimum performance.

The preferred location for the barometric damper is in a tee or collar installed in the vertical pipe rising from the unit's flue outlet. The barometric damper **MUST NOT** be installed in a bull head tee installed on the unit's flue outlet. The tee or collar containing the barometric damper should be approximately three feet vertically above the connection to the unit's flue outlet. This location ensures that any positive velocity pressure from the unit's internal combustion fan is dissipated and the flue products are rising due to buoyancy generated from the temperature of the flue products. Adjust the weights on the damper to ensure that draft is maintained within the specified range.

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INSTALLATION Continued

1. Conventional Negative Draft Venting

IMPORTANT: Before installing a venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

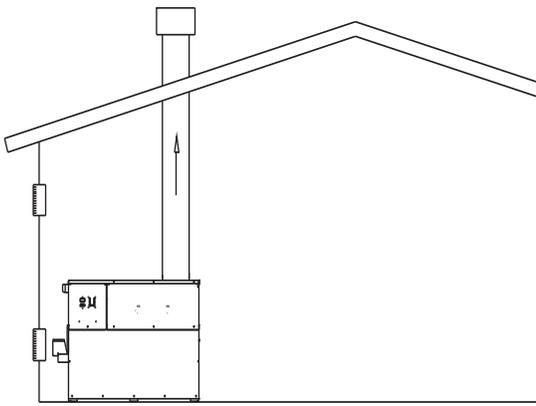


FIG. 17 Conventional Negative Draft Vertical Venting with Combustion Air Louvers

This option uses Type-B double-wall flue outlet piping. The blower brings in combustion air. The buoyancy of the heated flue products cause them to rise up through the flue pipe. The flue outlet terminates at the rooftop.

Negative Draft

The negative draft in a conventional vent installation must be within the range of 0.02 to 0.08 inches w.c. to ensure proper operation. Make all draft readings while the unit is in stable operation (approximately 2 to 5 minutes).

Connect the flue vent directly to the flue outlet opening on the top of the unit. No additional draft diverter or barometric damper is needed on single unit installations with a dedicated stack and a negative draft within the specified range of 0.02 to 0.08 inches w.c. If the draft in a dedicated stack for a single unit installation exceeds the maximum specified draft, you must install a barometric damper to control draft. Multiple unit installations with combined venting or common venting with other Category I negative draft appliances require each boiler to have a barometric damper installed to regulate draft within the proper range.

Do not connect vent connectors serving appliances vented by natural draft (negative draft) to any portion of a mechanical draft

system operating under positive pressure. Connecting to a positive pressure stack may cause flue products to be discharged into the living space causing serious health injury.

Flue Outlet Piping

With this venting option, you must use Type-B double-wall (or equivalent) vent materials. Vent materials must be listed by a nationally-recognized test agency for use as vent materials. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Use the National Fuel Gas Code venting tables for double-wall vent to properly size all vent connectors and stacks. Follow the vent manufacturer's instructions when installing Type-B vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors. Locate the unit as close as possible to a chimney or gas vent.

Avoid long horizontal runs of the vent pipe, 90° elbows, reductions and restrictions.

No additional draft diverter or barometric damper is required on single unit installations with a dedicated stack and a negative draft maintained between 0.02 to 0.08 inches w.c.

Common Venting Systems

You can combine the flue with the vent from any other negative draft, Category I appliance. Using common venting for multiple negative draft appliances requires you to install a barometric damper with each unit. This will regulate draft within the proper range. You must size the common vent and connectors from multiple units per the venting tables for Type-B double-wall vents in the latest edition of the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CGA-B149 Installation Code.

Common venting systems may be too large when an existing unit is removed.

At the time of removal of an existing appliance, the following steps shall be followed with each appliance remaining connected to the common venting system placed in operation, while other appliances remaining connected to the common venting system are not in operation.

1. Seal any unused opening in the common venting system.
2. Visually inspect the venting system for proper size and horizontal pitch. Make sure there is no blockage or restriction, leakage, corrosion and other unsafe conditions.

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3. If possible, close all building doors and windows. Close all doors between the space in which the appliances remaining connected to the common venting system are located and other building spaces.
4. Turn on clothes dryers and any other appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan.
5. Close fireplace dampers.
6. Place in operation the unit being inspected. Follow the lighting instructions. Adjust thermostat so unit will operate continuously.
7. Test for spillage at the draft hood/relief opening after 5 minutes of main burner operation. Use the flame of a match or candle, or smoke from a cigarette, cigar or pipe.
8. After making sure that each appliance remaining connected to the common venting system properly vents when tested as above, return doors, windows, exhaust fans, fireplace dampers and other gas burning appliances to their previous conditions of use.
9. Correct any improper operation of the common venting system so that the installation conforms to the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment. When resizing any portion of the common venting system, resize to approach the minimum size as determined using the appropriate tables of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA-B149 Installation Code for Gas Burning Appliances and Equipment.

Masonry Chimney Installations

A masonry chimney must be properly sized for the installation of a high efficiency gas-fired appliance. Venting of a high efficiency appliance into a cold or oversized masonry chimney can result in operational and safety problems. Exterior masonry chimneys, with one or more sides exposed to cold outdoor temperatures, are more likely to have venting problems. The temperature of the flue products from a high efficiency appliance may not be able to sufficiently heat the masonry structure of the chimney to generate proper draft. This will result in condensing of flue products, damage to the masonry flue/tile, insufficient draft and possible spillage of flue products into an occupied living space. Carefully inspect all chimney systems before installation.

⚠ WARNING: Do not vent this unit into a masonry chimney without a sealed stainless steel liner system. Any breaks, leaks, or damage to the masonry flue/tile will allow the positive-pressure flue products to leak from the chimney and into occupied living spaces. This could cause serious injury or death due to carbon monoxide poisoning and other harmful flue products.

IMPORTANT: Check with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion-resistant liner system.

Inspection of a Masonry Chimney

A masonry chimney must be carefully inspected to determine its suitability for the venting of flue products. A clay-tile-lined chimney must be structurally sound, straight and free of misaligned tile, gaps between liner sections, missing sections of liner or any signs of condensate drainage at the breaching or clean out. If there is any doubt about the condition of a masonry chimney, it must be relined with a properly-sized and approved chimney liner system. An unlined masonry chimney must not be used to vent flue products from this high-efficiency unit. **An unlined chimney must be relined with an approved chimney liner system when a new appliance is being attached to it.** Metallic liner systems (Type-B double-wall or flexible or rigid metallic liners) are recommended. Consult with local code officials to determine code requirements or the advisability of using or relining a masonry chimney.

Vertical Vent Termination Clearances and Location

Follow all vertical venting termination information for clearances and location under *Vertical Vent Termination Clearances and Location*, page 11.

2. Vertical DirectAire™ Venting

IMPORTANT: Before installing the venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

The Vertical DirectAire™ vent system is the same as the Conventional Negative Draft vent system, except it pulls combustion air from the outdoors through a vertical air inlet. Follow all requirements in 1. *Conventional Negative Draft Venting*, page 16.

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INSTALLATION Continued

Vent Kits

The Vertical DirectAire™ vent system requires you to install two vent pipes directly to the unit; one vertical pipe with a rooftop termination for the flue products and one pipe for combustion air. For this venting option, you must purchase the DV box adapter from the appliance manufacturer. The DV box attaches to the air inlet of the unit. The pipe for combustion air attaches to the DV box.

You can terminate the combustion air pipe either horizontally with a sidewall air inlet or vertically with a rooftop air inlet. The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m).

⚠ WARNING: Only use a sidewall air inlet cap supplied by the appliance manufacturer or a rooftop air inlet cap supplied by the vent manufacturer. Using any other air inlet cap for single unit installations or using a common air inlet cap for multiple units with insufficient free area and/or protections from wind and weather may result in operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

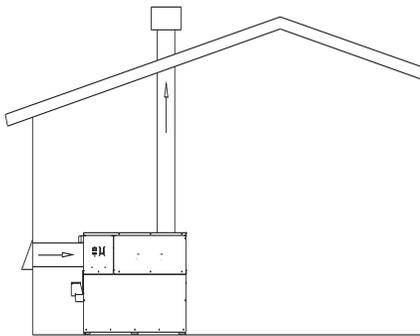


FIG. 18 Vertical DirectAire Installation with Sidewall Combustion Air Inlet

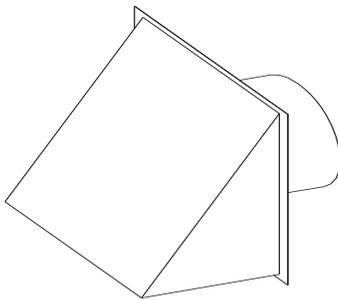


FIG. 19 Air Inlet Cap for Sidewall Termination

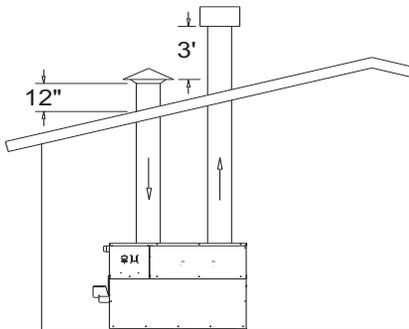


FIG. 20 Vertical DirectAire Installation with Roof Top Combustion Air Inlet

For single unit installations with sidewall air inlet, (see FIG. 18) you must order the sidewall air inlet kit from the appliance manufacturer. The part number for each SVK kit is listed by unit size in TABLE-D.

For single unit installations with rooftop air inlet (see FIG. 20), you must order the rooftop air inlet kit from the appliance manufacturer. The part number for each VDK kit is listed by unit size in TABLE-D. Purchase the flue pipe, rooftop flue termination, and air inlet pipe locally.

There is no vent kit for combined air supply systems for multiple units. Make sure the air inlet cap is properly sized. You must purchase this cap locally.

Venting of Flue Products

For venting flue products vertically to the outdoors, follow all requirements in the installation instructions for conventional venting in this manual.

Follow all clearance requirements in *Vertical Vent Termination Clearances and Location*, page 11.

A barometric damper is not required in the flue on Vertical DirectAire™ installations if the draft is within the negative 0.02 to 0.08 inches w.c. required for proper operation. If the draft exceeds this range, install a barometric damper.

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TABLE-D
DirectAire™ Kits

Input Btu/hr	Horizontal Kit*	Vertical Kit*
399,999	SVK3047	VDK3026
500,000	SVK3047	VDK3026
650,000	SVK3048	VDK3027
750,000	SVK3048	VDK3027
990,000	SVK3040	VDK3023
1,260,000	SVK3041	VDK3024
1,440,000	SVK3041	VDK3024
1,800,000	SVK3041	VDK3024
2,070,000	SVK3041	VDK3024

*The SVK kits include a DV box adapter and sidewall air inlet cap. The VDK kits include a DV box adapter and a rooftop air inlet cap.

3. Sidewall Venting

IMPORTANT: Before installing venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

This option uses a powered vent assembly which pulls the flue products out of the stack. This fan generates a negative draft at the unit. Combustion air is drawn from the mechanical room (see *Combustion and Ventilation Air*, page 8).

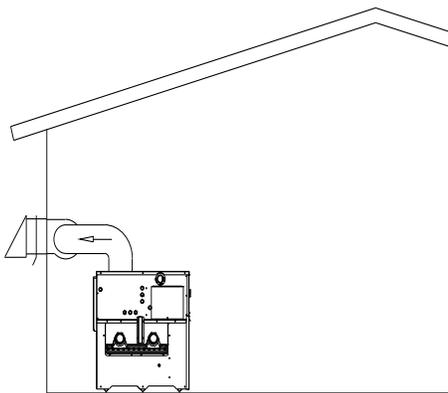


FIG. 21 Sidewall Venting Installation with an Induced Draft Fan and Sidewall Vent Cap

Sidewall Fan

The sidewall fan can be mounted on the inside/outside (depending upon model) with a sidewall vent hood installed on the exterior wall. The sidewall fan and accessories are included

in a venting kit provided by the appliance manufacturer. See TABLE-E for kit numbers.

The venting kit includes the sidewall fan, vent hood, tapered vent adapter, barometric damper, proving switch and all necessary relays to interlock with the heaters control system. The tapered vent adapter reduces the vent size at the inlet to the fan. There should be no reduction in vent diameter from the unit's flue outlet to the sidewall fan. The barometric damper must be installed on the flue and adjusted to supply a negative draft within the range of 0.04 to 0.08 inches w.c. while unit is operating.

Flue Outlet Piping

With this venting option, you must use Type-B double-wall (or equivalent) vent materials. Vent materials must be listed by a nationally-recognized test agency for use as vent materials. Make the connections from the unit vent to the sidewall fan/cap as direct as possible with no reduction in diameter. Use the National Fuel Gas Code venting tables for double-wall vent to properly size all vent connectors and stacks. Follow the vent manufacturer's instructions when installing Type-B vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls.

The maximum installed length of sidewall vent pipe with an induced draft fan must not exceed 100 feet (30.5m). Subtract 5 feet (1.5m) for each 90° elbow. Subtract 2.5 feet (0.7m) for each 45° elbow.

Sidewall Venting Termination

The sidewall vent cap must be installed on an exterior sidewall. The sidewall fan/power sidewall vent cap and accessories are included in a venting kit which is furnished by the appliance manufacturer in accordance with CSA International requirements. This venting kit includes the powered sidewall fan/cap, proving switch and all necessary relays to interlock with the heaters control system.

The sidewall fan/power sidewall vent cap must be interlocked with the units control system to start the fan on a call for heat and prove fan operation before the boiler fires. Plug-in and terminal strip connections are provided on the unit for easy connection of the factory supplied vent kit and control package for the sidewall vent fan. See the installation instructions provided with the vent kit.

Sidewall Venting Without Fan

For 399,999 - 750,000 Btu/hr models approved for sidewall venting without an external power vent fan, you must install specific vent kits and venting materials.

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INSTALLATION Continued

The following is a detailed explanation of *Sidewall Venting Without an External Power Vent Fan* installation requirements.

Flue Outlet Piping

Venting Guidelines

If using this venting option, a sealed AL29-4C venting system for flue products is required on all models of this appliance. This venting system operates with a positive pressure in the vent. The internal combustion air blowers generate this positive pressure which operates the combustion process and also exhausts the flue products from the building.

This vent system has specific vent material and installation requirements. Only use listed sealed AL29-4C vent system materials. Follow all installation requirements. See TABLE-B, page 13 for proper pipe size for your unit. A list of sealed AL29-4C flue pipe manufacturers is located on page 24.

Seal all vent joints and seams gas-tight.

Drain Tee Installation

A drain tee must be installed in the vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee must be installed as the first fitting after the horizontal ell on the top of the unit. Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (7.6cm) diameter circular trap loop in the drain tubing. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon wire ties. Use caution not to collapse or restrict the condensate drain line with the nylon wire ties. The condensate drain must be routed to a suitable drain for disposal of condensate that may occur in the direct vent system. Refer to the condensate drain installation instructions as supplied by the manufacturer of the vent material.

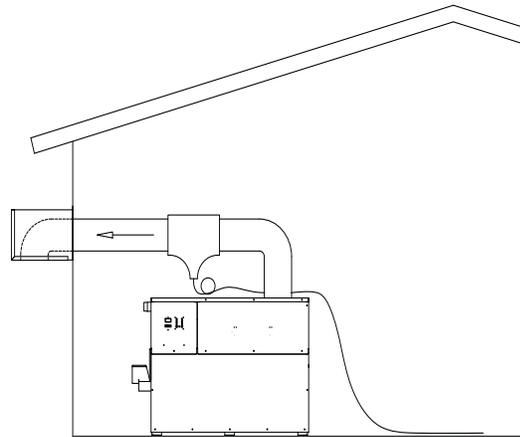


FIG. 22 Sidewall Vent

⚠ WARNING: Do not combine the flue from this unit with the vent from any other appliance. Do not combine flues from multiple appliances into a common vent. The flue from this unit must be a dedicated stack.

Connect the flue vent directly to the flue outlet opening on the top of unit. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Provide adequate clearance to combustibles for the vent connector and firestop. Follow the vent manufacturer's instructions when installing sealed AL29-4C vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors.

Locate the unit as close as possible to chimney or gas vent. When a vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

The installed length of flue from the unit to the outside point of termination must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

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Masonry Chimney Installation

A masonry chimney must be properly sized for the installation of a high efficiency gas-fired appliance. Venting of a high efficiency appliance into a cold or oversized masonry chimney can result in operational and safety problems. Exterior masonry chimneys, with one or more sides exposed to cold outdoor temperatures, are more likely to have venting problems. The temperature of the flue products from a high efficiency appliance may not be able to sufficiently heat the masonry structure of the chimney to generate proper draft. This will result in condensing of flue products, damage to the masonry flue/tile, insufficient draft and possible spillage of flue products into an occupied living space. Carefully inspect all chimney systems before installation.

⚠ WARNING: Do not vent this unit into a masonry chimney without a sealed stainless steel liner system. Any breaks, leaks, or damage to the masonry flue/tile will allow the positive-pressure flue products to leak from the chimney and into occupied living spaces. This could cause serious injury or death due to carbon monoxide poisoning and other harmful flue products.

IMPORTANT: Check with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion-resistant liner system.

Sidewall Vent Termination Clearances and Location

Follow all sidewall venting termination information for clearances and location under *Sidewall Vent Termination Clearances and Location*, page 12.

TABLE-E
Sidewall Vent Kits

Input Btu/hr	Kit* (w/Power Fan Assy.)	Max. Vent Length	Vent Termination Only (399,999 - 750,000 Btu/hr)	Max. Vent Length
399,999	SVK3006	100 ft.	SVK3043	50 ft.
500,000	SVK3006	100 ft.	SVK3043	50 ft.
650,000	SVK3008	100 ft.	SVK3044	50 ft.
750,000	SVK3008	100 ft.	SVK3044	50 ft.
990,000	SVK3009	100 ft.	N/A	N/A
1,260,000	SVK3010	100 ft.	N/A	N/A
1,440,000	SVK3010	100 ft.	N/A	N/A
1,800,000	SVK3012	100 ft.	N/A	N/A
2,070,000	SVK3012	100 ft.	N/A	N/A

*These kits include a sidewall venter assembly, vent termination, and barometric damper.

4. Horizontal DirectAire™ Venting

IMPORTANT: Before installing a venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

The Horizontal DirectAire™ vent system is the same as the Sidewall Venting system, except it pulls combustion air from the outdoors through a sidewall air inlet. Follow all requirements in *Sidewall Venting*, page 19.

The Horizontal DirectAire™ vent system requires you to install two vent pipes directly to the unit; one pipe for flue products and one for combustion air. Install both vent pipes horizontally with a sidewall termination point. For this venting option, you must purchase the DV box accessory from the appliance manufacturer. The DV box attaches to the air inlet of the unit. The pipe for combustion air attaches to the DV box.

Make vent connection directly to the top of the unit. No additional draft diverter or barometric damper is required on single unit installations with a dedicated stack and a negative draft maintained between 0.04 to 0.08 inches w.c.

The Horizontal DirectAire™ combustion air supply system has specific vent material and installation requirements. The air inlet pipe connects directly to the boiler to supply combustion air. The combustion air inlet pipe is a dedicated system with one air inlet pipe per boiler. You must connect the air inlet pipe to a combustion air inlet cap as specified in this section.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

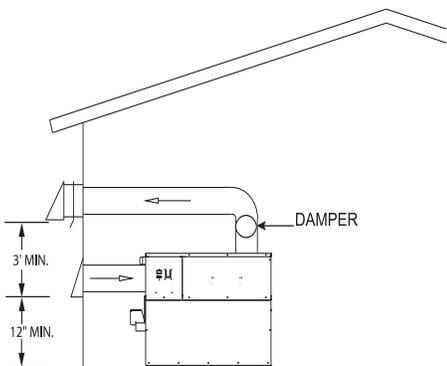


FIG. 23A Horizontal DirectAire Installation (Illustration with Sidewall Venter and Sidewall Combustion Air)

Combustion air supplied from outdoors must be free of contaminants (see *Combustion and Ventilation Air*, page 8).

Vent Kits

You must order the Horizontal DirectAire™ Vent Kit for sidewall installation from the appliance manufacturer. See TABLE-F for kit numbers. Each kit includes a sidewall powered vent cap fan, proving switch, controls, combustion air inlet cap to supply air to a single unit, the transition adapter to attach the field supplied single wall air inlet pipe to the unit and installation instructions. Purchase flue pipe and air inlet pipe locally.

The sidewall air inlet cap supplied in the Horizontal DirectAire™ Vent Kit is used to supply combustion air to a single boiler. Combustion air supply pipes from multiple units can not be combined into a single air inlet pipe and inlet point.

⚠ WARNING: Only use the sidewall air inlet cap recommended by the appliance manufacturer. Using another sidewall air inlet cap may result in operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

Venting of Flue Products

For venting flue products horizontally, follow all requirements in the installation instructions for sidewall venting.

Termination point for the flue products must follow the clearance requirements in *Sidewall Venting Termination*, page 19.

For proper operation, a barometric damper is provided for Horizontal DirectAire™ installations. The damper will help to ensure a draft between negative 0.04 to 0.08 inches w.c.

TABLE-F Horizontal DirectAire™ Kits	
Input Btu/hr	Kit*
399,999	HDK3031
500,000	HDK3031
650,000	HDK3032
750,000	HDK3032
990,000	HDK3026
1,260,000	HDK3027
1,440,000	HDK3027
1,800,000	HDK3028
2,070,000	HDK3028

*These kits include a sidewall venter assembly, vent termination, DV box adapter, sidewall air inlet cap, and a barometric damper.

5. Direct Venting

IMPORTANT: Before installing venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

This option uses sealed AL29-4C vent materials for the flue outlet piping and separate combustion air inlet piping. This system terminates both the flue and combustion air inlet in the same pressure zone. The flue outlet and combustion air intake may terminate at either a sidewall or the rooftop.

To use the optional *Direct Vent* system, you must install specific vent kits and venting materials. The following is a detailed explanation of *Direct Vent* installation requirements, including the components used and vent kit part numbers.

Flue Outlet Piping

Venting Guidelines

If using this venting option, a sealed AL29-4C venting system for flue products is required on all models of this appliance. This venting system operates with a positive pressure in the vent. The internal combustion air blowers generate this positive pressure which operates the combustion process and also exhausts the flue products from the building.

This vent system has specific vent material and installation requirements. Only use listed sealed AL29-4C vent system materials. Follow all installation requirements. See TABLE-B, page 13 for proper pipe size for your unit. A list of sealed AL29-4C flue pipe manufacturers is located on page 24.

Seal all vent joints and seams gas-tight.

Installation and Service Manual

Drain Tee Installation

A drain tee must be installed in the vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee must be installed as the first fitting after the horizontal ell on the top of the unit (see FIG. 23B). Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (7.6cm) diameter circular trap loop in the drain tubing. Prime the trap loop by pouring a small quantity of water into the drain hose before assembly to the vent. Secure the trap loop in position with nylon wire ties. Use caution not to collapse or restrict the condensate drain line with the nylon wire ties. The condensate drain must be routed to a suitable drain for disposal of condensate that may occur in the direct vent system. Refer to the condensate drain installation instructions as supplied by the manufacturer of the vent material.

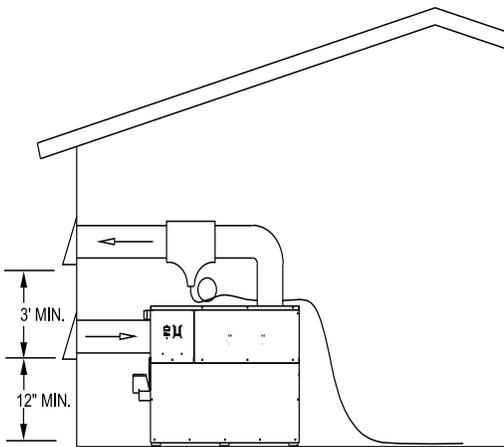


FIG. 23B Aire-Lock Direct Vent (Illustration with Sidewall Vent and Sidewall Combustion Air)

⚠ WARNING: Do not combine the flue from this unit with the vent from any other appliance. Do not combine flues from multiple appliances into a common vent. The flue from this unit must be a dedicated stack.

Connect the flue vent directly to the flue outlet opening on the top of unit. Make the connections from the unit vent to the outside stack as direct as possible with no reduction in diameter. Provide adequate clearance to combustibles for the vent connector and firestop. Follow the vent manufacturer's instructions when installing sealed AL29-4C vents and accessories, such as firestop spacers, vent connectors, thimbles, caps, etc.

Provide adequate clearance to combustibles for the vent connector and firestop.

When planning the venting system, avoid possible contact with plumbing or electrical wiring inside walls, ceilings, and floors. Locate the unit as close as possible to chimney or gas vent.

When a vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturer's instructions.

The installed length of flue from the unit to the outside point of termination must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Vertical DV Venting Termination

You must use the vent termination recommended by the vent manufacturer for vertical direct vent terminations. Follow all vertical venting termination information for clearances and location under *Vertical Vent Termination Clearances and Location*, page 11.

Masonry Chimney Installation

Do not use a standard masonry chimney to directly vent the combustion products from this unit.

To use a masonry chimney, the chimney must use a sealed, corrosion-resistant liner system. Sealed, corrosion-resistant liner systems (single-wall, double-wall, flexible, or rigid) must be rated for use with a high efficiency, positive pressure vent system.

Corrosion-resistant chimney liner systems are typically made from a high grade stainless steel such as AL29-4C. The liner must be properly sized and fully sealed throughout the entire length. Both the top and bottom of the masonry chimney must be capped and sealed to provide a dead air space around the liner.

⚠ WARNING: Do not vent this unit into a masonry chimney without a sealed stainless steel liner system. Any breaks, leaks, or damage to the masonry flue/tile will allow the positive-pressure flue products to leak from the chimney and into occupied living spaces. This could cause serious injury or death due to carbon monoxide poisoning and other harmful flue products.

IMPORTANT: Check with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion-resistant liner system.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

Horizontal DV Venting Termination

Horizontal venting uses the unit's internal combustion air blowers to force the flue products out of the horizontally-terminated flue.

You must purchase a horizontal direct vent kit from the appliance manufacturer to ensure proper operation. See TABLE-G, page 24 to determine which horizontal direct vent kit you need. When installing the vent cap, the wall opening must provide an air space clearance of 2 inches (5.1cm) around the flue pipe. The diameter of the opening for installation of the sidewall cap will be 4 inches (10.2cm) larger (minimum) than the nominal diameter of the installed vent pipe to the horizontal vent cap.

Install the horizontal vent cap from the outside. Mount the vent cap to the wall using four screws or wall anchors. Seal under the screw heads with caulking. Install the Category IV vent pipe from the unit to the vent cap. See detailed instructions packed with the horizontal direct vent kit.

Horizontal Vent Termination Clearances and Location

Follow all sidewall venting termination information for clearances and location under *Sidewall Vent Termination Clearances and Location*, page 12.

TABLE-G Direct Vent Kits		
Input Btu/hr	Horizontal Kit*	Vertical Kit*
399,999	DVK3004	VDK3026
500,000	DVK3004	VDK3026
650,000	DVK3005	VDK3027
750,000	DVK3005	VDK3027
990,000	DVK3000	VDK3023
1,260,000	DVK3001	VDK3024
1,440,000	DVK3001	VDK3024
1,800,000	DVK3002	VDK3024
2,070,000	DVK3002	VDK3024

* The DVK kits include a DV box adapter, air inlet cap, and a sidewall vent termination. The VDK kits include a DV box adapter and an air inlet cap.

Flue Pipe Materials

The following manufacturers supply flue materials suitable for these models. All materials are made with AL29-4C stainless steel. Call the following numbers for the nearest distributor.

Heat-Fab, Inc. Saf-T CI Vent. 1-800-772-0739.

Protech Systems, Inc. Fas-N-Seal Vent. 1-800-766-3473.

Metal-Fab, Inc. Corr/Guard Vent. 1-800-835-2830.

Combustion Air Inlet Piping

The Direct Vent system requires the installation of a pipe to supply combustion air from the outdoors directly to the unit. Make sure the combustion air inlet is in the same pressure zone as the vent terminal.

In cold climates, use a Type-B double-wall vent pipe or an insulated single wall pipe for combustion air. This will help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

⚠ CAUTION: Units that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe.

Length of Air Inlet Pipe

The installed length of air inlet pipe from the unit to the outside air inlet cap must not exceed 50 equivalent feet (15.2m). Subtract 5 feet (1.5m) of equivalent length for each 90° elbow. Subtract 2.5 feet (0.7m) of equivalent length for each 45° elbow.

Do not exceed the limits for the combustion air inlet piping lengths.

Connecting the Air Inlet Pipe to the Unit

Connect the air inlet piping directly to the unit by attaching it to the DV box adapter. The DV box adapter is included in the direct vent kits for horizontal direct vent. The combustion air inlet area of the unit is located at the right rear corner of the unit. This unit uses a simple air filter to ensure clean air is used for the combustion process. Attach the DV box adapter over the air filter (see FIG. 24). Align screw holes on the DV box adapter with the screw holes surrounding the air filter hanger. Insert sheet metal screws and tighten firmly.

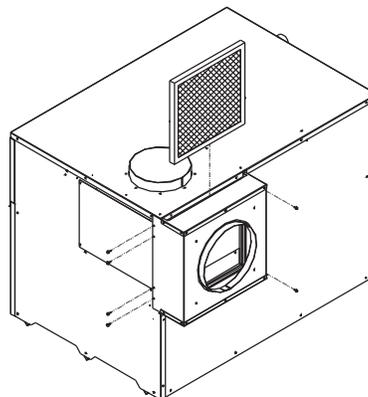


FIG. 24 Attaching DV Box Adapter to Unit

Installation and Service Manual

For venting versatility, you can move the air filter assembly and DV box adapter to the right side of the unit. Remove the metal panel on the unit's right side (see FIG. 25). Remove the filter/bracket assembly from the rear of the unit. Attach the filter/bracket assembly and DV box adapter to the right side opening using the pre-drilled screw holes. Make sure you attach the metal panel to the rear combustion air opening of the unit.

The DV box adapter has an air inlet pipe mounting ring. Connect combustion air inlet piping to the direct vent box mounting ring.

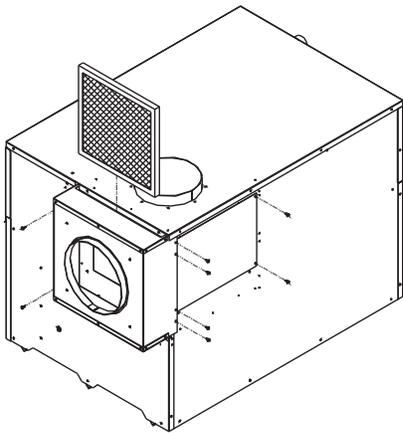


FIG. 25 Moving Air Filter Assembly and DV Box Adapter

Air Inlet Piping Materials

The air inlet pipe(s) must be sealed. Select air inlet pipe material from the following specified materials.

- PVC, CPVC, or ABS*
- Dryer vent or sealed flexible duct (not recommended for roof top air inlet)
- Galvanized steel vent pipe with joints and seams sealed as specified below
- Type-B double-wall vent with joints and seams sealed as specified below.

* Plastic pipe may require an adapter (not provided) to transition between the air inlet connection on the unit and the plastic air inlet pipe.

⚠ WARNING: Use only vent or air intake materials specified in this manual. Follow vent pipe manufacturer's instructions. Failure to do so can result in property damage, personal injury, or death. Mixing of venting materials will void the warranty and certification of this unit.

Sealing Type-B Double-Wall Vent Pipe or Galvanized Vent Pipe

Follow the steps below to properly seal Type-B double-wall vent pipe or galvanized vent pipe.

1. Seal all joints and seams of the air inlet pipe using either aluminum foil duct tape meeting UL Standard 723 or 181 A-P or a high quality UL Listed silicon sealant such as those manufactured by Dow Corning or General Electric.
2. On horizontal runs, do not install vent pipe with seams pointing down. Position vent pipe so that the seams are on the top side of the vent pipe.
3. Secure all joints with a minimum of three sheet metal screws or pop rivets. Apply aluminum foil duct tape or silicone sealant to all screws or rivets installed in the vent pipe.
4. Ensure that the air inlet pipes are properly supported.

Sealing PVC, CPVC, ABS, Dryer Vent, and Flex Duct Vent Pipe

1. Clean the PVC, CPVC, or ABS air inlet pipe using the pipe manufacturer's recommended solvents. Seal the pipe joints using standard commercial pipe cement.
2. For PVC, CPVC, ABS, dryer vent, or flex duct air inlet piping, use a silicone sealant to ensure a proper seal at the unit inlet and the air inlet cap.
3. For Dryer vent or flex duct, also use a screw-type clamp to attach the inlet vent material to the unit inlet and the air inlet cap.

Properly sealing the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

⚠ WARNING: Properly seal all joints and seams in the inlet vent piping system. Failure to do so may result in flue gas recirculation, spillage of flue products, and carbon monoxide emissions. Carbon monoxide poisoning can cause severe personal injury or death.

Vertical and Sidewall Combustion Air Inlet

IMPORTANT: To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

⚠ WARNING: Locate and install the combustion air inlet termination correctly. Failure to do so can allow the discharge of flue products to be drawn into the combustion process. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems and the spillage of flue products. Spillage of flue products can cause personal injury or death due to carbon monoxide poisoning.

You must locate the combustion air cap and the flue gas outlet on the same roof top surface (vertical direct vent system) or sidewall surface (horizontal direct vent system) and in the same pressure zone as the vent termination. Follow all clearance requirements listed on this page.

Purchase and assemble the combustion air inlet cap to protect the air inlet from wind and weather.

Alternatively, assemble the combustion air inlet cap for vertical rooftop air inlet from items purchased locally. The air inlet cap consists of two 90° elbows installed to the air inlet pipe (see FIG. 26). Install the first 90° elbow on the rooftop at the highest vertical point of the air inlet pipe. Install the second 90° elbow on the horizontal outlet of the first elbow. The outlet of the second 90° elbow will be pointing down. You may use a 90° elbow and a 90° straight elbow to make this assembly. If you use a straight piece of pipe between the two 90° elbows, it should not exceed 6" (51mm) in length.

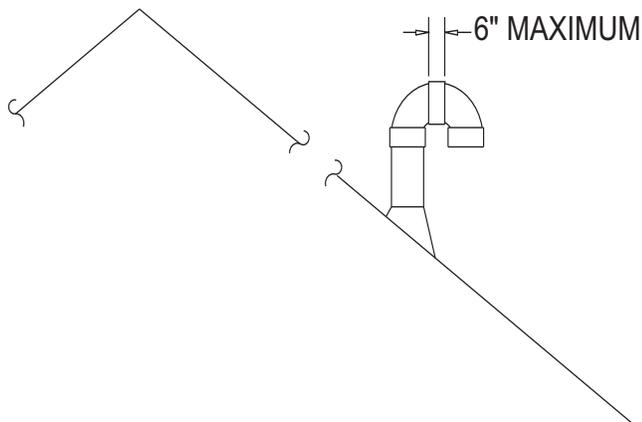


FIG. 26 Vertical Rooftop Air Inlet

For horizontal direct vent termination of combustion air, you must use the termination cap from the appliance manufacturer. The sidewall air inlet cap is available as part of a direct vent kit. See TABLE-G, page 24 for Horizontal Direct Vent Kits.

Vertical Combustion Air Inlet Clearances

You must locate the air inlet termination elbow at least 12" (30cm) above the roof or above normal snow levels.

If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) below the point of flue gas termination (vent cap).

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Horizontal Combustion Air Inlet Clearances

You must locate the horizontal air inlet termination point at least 12" (30cm) above grade and above normal snow levels.

If the air inlet cap is within a 10-foot (3.05m) radius of the flue outlet, the point of termination for the combustion air inlet cap must be at least 3 feet (0.91m) horizontally and 12 inches (30cm) below the point of flue gas termination (vent cap). Do not install the horizontal combustion air inlet cap above the flue outlet.

Do not install the combustion air inlet cap closer than 10 feet (3.05m) from an inside corner of an L-shaped structure.

Multiple Sidewall Direct Vent Installations

The combustion air inlet caps for multiple appliance installations must maintain the same minimum clearance from the closest flue vent cap as specified in single appliance installations. You may install multiple flue outlet caps side-by-side and multiple combustion air inlet caps side-by-side, but the air inlet must always be at least 3 feet (0.91m) horizontally and 12 inches (30cm) below the closest flue outlet. Do not install combustion air inlet caps above the flue outlets.

Maintain all clearances and installation requirements for multiple appliance installations.

6. Outdoor Installation Venting

IMPORTANT: Before installing a venting system, follow all venting clearances and requirements found in the *Venting, General Information* section, page 11.

Units are self-venting and can be used outdoors when installed with the optional outdoor cap. This cap mounts directly to the top of the unit and covers the flue outlet and combustion air inlet openings. No additional vent piping is required.

Installation and Service Manual

⚠ WARNING: Only install outdoor models outdoors and only use the vent cap supplied by the appliance manufacturer. Personal injury or product damage may result if any other cap is used or if an outdoor model is used indoors. Properly install all covers, doors and jacket panels to ensure proper operation and prevent a hazardous condition.

Combustion air supply must be free of contaminants (see *Combustion and Ventilation Air*, page 8). To prevent recirculation of the flue products into the combustion air inlet, follow all instructions in this section.

Outdoor Vent/Air Inlet Location

Keep venting areas free of obstructions. Keep area clean and free of combustible and flammable materials. Maintain a minimum clearance of 3" (76mm) to combustible surfaces and a minimum of 3" (76mm) clearance to the air inlet. To avoid a blocked air inlet or blocked flue condition, keep the outdoor cap air inlet, flue outlet and drain slot clear of snow, ice, leaves, debris, etc.

Do not install outdoor models directly on the ground. You must install the outdoor unit on a concrete, brick, block, or other non-combustible pad.

Do not locate unit so that high winds can deflect off of adjacent walls, buildings or shrubbery causing recirculation. Recirculation of flue products may cause operational problems, bad combustion or damage to controls. Locate unit at least 3 feet (0.91m) from any wall or vertical surface to prevent wind conditions from affecting performance.

Multiple unit outdoor installations require 48" (1.22m) clearance between each vent cap. Locate outdoor cap at least 48" (1.22m) below and 48" (1.22m) horizontally from any window, door, walkway or gravity air intake.

Locate unit at least 10 feet (3.05m) away from any forced air inlet.

Locate unit at least 3 feet (0.91m) outside any overhang.

Clearances around outdoor installations can change with time. Do not allow the growth of trees, shrubs or other plants to obstruct the proper operation of the outdoor vent system.

Do not install in locations where rain from building runoff drains will spill onto the unit.

TABLE-H Outdoor Vent Cap Kits		
Input Btu/hr	Kit* without Pump Cover	Kit* with Pump Cover
399,999	ODK3748	ODK3052
500,000	ODK3748	ODK3052
650,000	ODK3749	ODK3053
750,000	ODK3749	ODK3053
990,000	ODK3036	ODK3049
1,260,000	ODK3064	ODK3065
1,440,000	ODK3037	ODK3050
1,800,000	ODK3038	ODK3051
2,070,000	ODK3038	ODK3051

* These kits include an outdoor vent cap and gasket.

Flue gas condensate can freeze on exterior walls or on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition. Some discoloration to exterior building or unit surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The Outdoor Vent Cap Kit

The optional outdoor vent cap kit is available from the appliance manufacturer. The outdoor cap part numbers are listed by unit size. See TABLE-H for kit numbers.

Install the outdoor vent cap on the rear of the unit (see FIG. 27). Complete installation instructions are included with the outdoor vent cap kit.

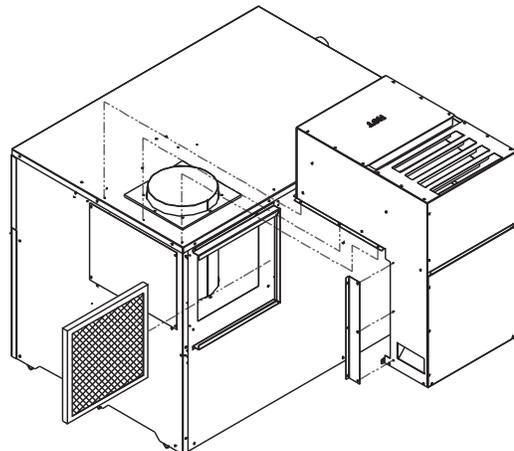


FIG. 27 Outdoor Vent Cap Installed on Rear of Unit

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

CONNECTING TO GAS SUPPLY

Only supply gas type specified on the unit's rating plate. This unit is orificed for operation up to 2000 feet altitude. If installing above 2000 feet elevation, consult the appliance manufacturer.

INLET PRESSURE: Measure inlet pressure at the inlet pressure tap located upstream of the combination gas valve(s).

See TABLE-I for maximum and minimum inlet pressures. Do not exceed the maximum. Minimum inlet pressure is for the purpose of input adjustment.

TABLE-I Inlet Pressure		
	Max.	Min.
Nat. Gas	10.5" w.c.	4.5" w.c.
LP Gas	13" w.c.	8" w.c.

MANIFOLD PRESSURE: Measure manifold pressure at the pressure tap on the downstream side of the combination gas valves. The gas regulator on the unit's combination gas valve is adjustable to supply proper manifold pressure for normal operation. See TABLE-M, page 32 for net manifold pressure settings.

If you must adjust regulator pressure, follow the instructions under *Gas Manifold Pressure Adjustment*, page 31. Do not increase regulator pressure beyond specified pressure setting.

Gas Pressure Test

1. Disconnect unit from the gas supply piping system during any piping system pressure testing greater than 1/2 PSIG (3.5kPa).
2. Isolate the unit from the gas supply piping system by closing a manual shutoff valve during any piping system pressure testing that is equal to or less than 1/2 PSIG (3.5kPa).
3. Test all gas connections for gas leaks before placing unit in operation.

Gas Piping

To safely operate this unit, you must properly size the gas supply piping. See TABLES-J, K, & L for piping and fitting requirements. Gas pipe size may be larger than heater connection.

For ease of service, install a union.

Install a manual main gas shutoff valve, outside of the unit gas connection within six feet of the unit in accordance with the requirements of the National Fuel Gas Code, ANSI Z223.1.

You must provide a sediment trap (drip leg) in the inlet of the gas connection to the unit.

NOTE: It is the installer's responsibility to supply the sediment trap (drip leg).

IMPORTANT: Do not block access to the electrical cover plate when installing the sediment trap. The sediment trap must be a minimum of 12 inches from the appliance.

The combination gas valves have an integral vent limiting device and do not require venting to atmosphere, outside the building. The unit will not operate properly if the reference hose is removed or a vent to atmosphere is installed.

Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.

Connecting Gas Piping to Unit

All gas connections must be made with pipe joint compound resistant to the action of liquefied petroleum (L.P.) and natural gases. All piping must comply with local codes and ordinances. Piping installations must comply with approved standards and practices.

1. Make sure gas line is a separate line direct from the meter unless the existing gas line is of sufficient capacity. Verify pipe size with your gas supplier.

Installation and Service Manual

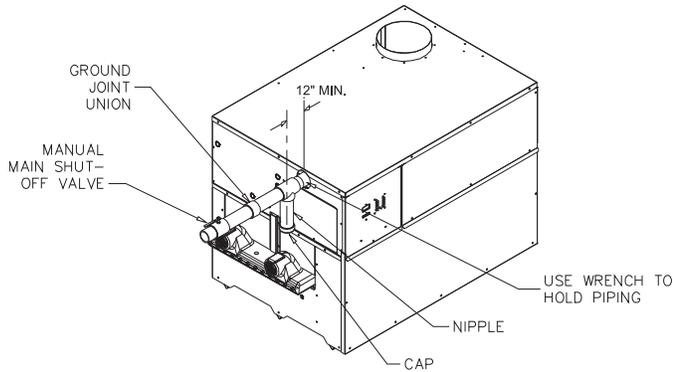


FIG. 28 Gas Line Connection

2. Use new, properly threaded black iron pipe free from chips. If you use tubing, make sure the ends are cut square, deburred and clean. Make all tubing bends smooth and without deformation. Avoid flexible gas connections. Internal diameter of flexible lines may not provide unit with proper volume of gas.
3. Install a manual main gas shutoff valve at the unit's gas inlet, outside of the unit.
4. Run pipe or tubing to the unit's gas inlet. If you use tubing, obtain a tube to pipe coupling to connect the tubing to the unit's gas inlet.
5. Install a sediment trap in the supply line to the unit's gas inlet (see FIG. 28).
6. Apply a moderate amount of good quality pipe compound (do not use Teflon tape) to pipe only, leaving two end threads bare.
7. Remove seal over gas inlet to unit.
8. Connect gas pipe to inlet of unit. Use wrench to support gas manifold on the unit.
9. For L.P. gas, consult your L.P. gas supplier for expert installation.
10. Ensure that all air is completely bled from the gas line before starting the ignition sequence. Start up without properly bleeding air from the gas line may require multiple reset functions of the ignition control module to achieve proper ignition.

⚠ WARNING: Do not have any open flame in proximity to the gas line when bleeding air from the gas line. Gas may be present.

Gas Train and Controls

Note: The gas train and controls assembly provided on this unit have been tested under the applicable American National Standard to meet minimum safety and performance criteria such as safe lighting, combustion and safety shutdown operation.

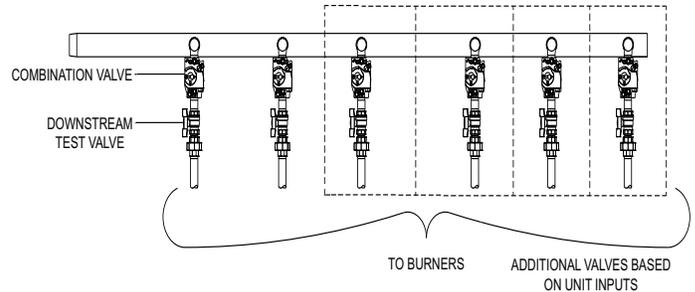


FIG. 29 Typical Boiler Gas Train Drawing

TABLE-J Suggested Gas Pipe Size for Single Unit Installations					
Btu/hr Input	Distance From Meter (in feet)				
	0-50	51-100	101-200	201-300	301-500
399,999	1 1/4"	1 1/4"	1 1/2"	2"	2"
500,000	1 1/4"	1 1/2"	2"	2"	2 1/2"
650,000	1 1/2"	2"	2"	2 1/2"	2 1/2"
750,000	1 1/2"	2"	2"	2 1/2"	3"
990,000	2"	2"	2 1/2"	2 1/2"	3"
1,260,000	2"	2 1/2"	2 1/2"	3"	3"
1,440,000	2 1/2"	2 1/2"	3"	3"	3 1/2"
1,800,000	2 1/2"	3"	3"	3 1/2"	3 1/2"
2,070,000	2 1/2"	3"	3"	3 1/2"	4"

For each elbow or tee, add equivalent straight pipe to total length from table below.

Figure 29 on this page shows a typical boiler gas train.

TABLE-K Fittings to Equivalent Straight Pipe							
Diameter Pipe (inches)							
3/4	1	1 1/4	1 1/2	2	3	4	5
Equivalent Length of Straight Pipe (feet)							
2	2	3	4	5	10	14	20

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

Water heater models do not have downstream test valves, but the rest of the gas train is represented by Figure 29.

Combination Gas Valves

These units fire in multiple stages of burner input. Each stage of burner operation has a combination gas valve(s) to cycle the gas supply on and off and regulate gas to the burners. Each combination valve consists of a gas regulator and two valve seats to meet the requirements for redundant gas valves. The valve has a gas control knob that must remain in the open position at all times when the unit is in service. The gas control valve has pressure taps located on the inlet and discharge sides of the valve. Manifold pressure is adjusted using the regulator located on the valve. A manifold gas pressure tap for each burner stick is located on the discharge side of the valve.

The manifold pressure is preset at the factory and adjustment is not usually required. If you must adjust regulator pressure, follow the instructions under *Gas Manifold Pressure Adjustment*, page 31.

Venting of Combination Gas Valves

The combination gas valve/regulator used on all units is equipped with an integral vent limiting orifice per ANSI Z21.78. The vent limiter ensures that the volume of gas emitted from the valve in the event of a failed gas diaphragm does not exceed the maximum safe leakage rate allowed by agency requirements. Combination gas valve/regulators equipped with integral vent limiters are not required to have vent or relief lines piped to the outdoors. The termination of the vent limited opening on the combination gas valve/regulator complies with the safety code requirements of CSD-1, CF-190(a) as shipped from the appliance manufacturer without the installation of additional vent lines.

Checking Gas Supply Pressure

Use the following procedure to check gas supply pressure.

1. Turn the main power switch to the “OFF” position.
2. Turn gas valve knobs to the “OFF” position.
3. Shut off gas supply at the field-installed manual gas cock in the gas piping to the unit. If fuel supply is L.P. gas, shut off gas supply at the tank.
4. Remove the 1/8" hex plug, located on the “inlet” side of the gas valve. You may also use a tapping on the field-

installed main manual gas cock or gas piping. Install a fitting in the inlet pressure tapping suitable to connect to a manometer or magnehelic gauge. Range of scale should be 14" w.c. or greater to check inlet pressure.

5. Turn on gas supply at the manual gas cock, turn on L.P. gas at the tank if required.
6. Turn the power switch to the “ON” position.
7. Turn the gas valve knobs to the “ON” position. Set the electronic temperature control or thermostat to call for heat.
8. Observe the gas supply pressure as all burners are firing. Ensure that inlet pressure is within the specified range. See *Connecting To Gas Supply*, page 28 for minimum and maximum gas supply pressures.
9. If gas pressure is out of range, contact gas utility, gas supplier, qualified installer or service agency to determine necessary steps to provide proper gas pressure to the control.
10. If gas supply pressure is within normal range, turn the power switch to the “OFF” position.
11. Turn gas valve knobs to the “OFF” position.
12. Shut off gas supply at the manual gas cock in the gas piping to the unit. If fuel supply is L.P. gas, shut off gas supply at the tank.
13. Remove the manometer and related fitting from the “inlet” side of the gas valve, replace 1/8" hex plug in gas valve and tighten.
14. Turn on gas supply at the manual valve, turn on L.P. gas at the tank if required.
15. Turn the power switch to the “ON” position.
16. Turn the gas valve knob to the “ON” position.
17. Set the electronic temperature control or thermostat to call for heat.

⚠ WARNING: After completing any testing on the gas system, leak test all gas connections. Apply a soap/water solution to all gas connections while main burners are operating. Bubbles forming indicate a leak. Repair all leaks at once. Do not operate this unit with a leak in the gas train, valves or related piping.

Installation and Service Manual

Check burner performance by cycling the system while you observe burner response. Burners should ignite promptly. Flame pattern should be stable, see *Burner Flames*, page 56. Turn system off and allow burners to cool, then cycle burners again to ensure proper ignition and flame characteristics.

Gas Manifold Pressure Adjustment

IMPORTANT: The gas valves are referenced to the fan pressurized chamber by a hose connected from the vent of the gas valve regulator to the chamber pressure tap located on the front inside portion of the jacket. Reference the drawings in this section for component and connection points for pressure measurement. The procedure for connecting a manometer or magnehelic must be followed to obtain actual net manifold pressure for normal operation. A manometer or magnehelic gauge legible in 0.1" increments up to 10 inches w.c. is required to check and adjust the manifold pressure. The regulator cover screw on the gas valve must be in place and tight at all times for the unit to operate properly.

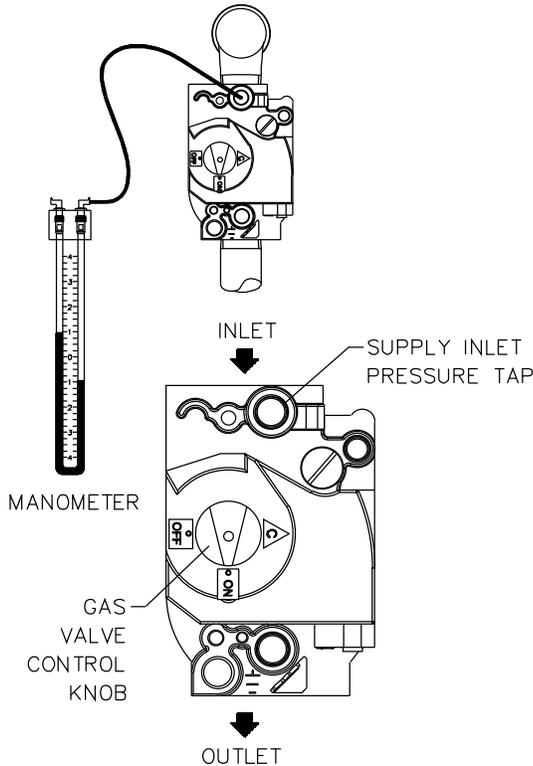


FIG. 30 Measuring Gas Supply Pressure at Combination Gas Valve

1. Loosen knurled knob that fastens the control panel access door and pull out control panel.
2. Turn the power switch located in the lower left corner behind the control panel access door to the "O" or "OFF" position.
3. Remove the top front jacket access panels to access the gas valves.

TABLE - L														
Multiple Unit Installations Gas Supply Pipe Sizing														
Nominal Iron Pipe Size, (Inches)	Length of Pipe In Straight Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/4"	369	256	205	174	155	141	128	121	113	106	95	86	79	74
1"	697	477	384	328	292	267	246	256	210	200	179	164	149	138
1 1/4"	1,400	974	789	677	595	543	502	472	441	410	369	333	308	287
1 1/2"	2,150	1,500	1,210	1,020	923	830	769	707	666	636	564	513	472	441
2"	4,100	2,820	2,260	1,950	1,720	1,560	1,440	1,330	1,250	1,180	1,100	974	871	820
2-1/2"	6,460	4,460	3,610	3,100	2,720	2,460	2,310	2,100	2,000	1,900	1,700	1,540	1,400	1,300
3"	11,200	7,900	6,400	5,400	4,870	4,410	4,000	3,800	3,540	3,300	3,000	2,720	2,500	2,340
4"	23,500	16,100	13,100	11,100	10,000	9,000	8,300	7,690	7,380	6,870	6,150	5,640	5,130	4,720

Maximum capacity of pipe in thousands of BTU's per hour for gas pressures of 14 Inches Water Column (0.5 PSIG) or less and a total system pressure drop of 0.5 Inch Water Column (Based on NAT GAS, 1025 BTU's per Cubic Foot of Gas and 0.60 Specific Gravity).

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

4. Locate the reference hose on the second gas valve which goes from the vent fitting on the gas valve to a barbed fitting on the deck of the unit (see FIG. 31).
5. Remove the flexible cap from the barbed fitting on the “tee” located in this line and hook one side of the manometer, or (-) side of a magnehelic gauge, to this “tee”. **Retain this cap for future use.**
6. Remove the 1/8" hex plug from the manifold pressure tap on the gas valve (see FIG. 31). **Retain plug for future use.**
7. Install a fitting in this tap that is suitable for connection of a hose to a manometer, or (+) side of a magnehelic gauge (see FIG. 31).
8. Turn the power switch to the “I” or “ON” position.
9. Push the reset button(s) for the ignition control(s), if necessary.
10. Set the electronic temperature control to call for heat (see Programming Temperature Control).
11. Once the unit is firing the manometer/magnehelic will reflect the Manifold Gas Pressure. Compare this reading to the respective value in TABLE-M for Natural Gas or Propane Gas.
12. If adjustment is necessary, remove the regulator cover screw on the gas valve. **NOTE: If the gas valve under adjustment is located on a manifold assembly monitored by an igniter, the unit may shut down and recycle when the regulator cover screw is removed. This is normal.**
13. Turn the regulator adjustment screw “clockwise” to raise the regulator gas pressure. Turn the regulator adjustment screw “counterclockwise” to lower the regulator gas pressure.
14. Replace the regulator cover screw and make sure it is tight for proper operation.
15. Read the value on the manometer/magnehelic and compare it to the values in TABLE-M.
16. Repeat this adjustment procedure for each gas valve as necessary to adjust to the proper manifold gas pressure.
17. Remove hoses, replace and tighten plugs and caps when complete.

18. Replace top front upper jacket access panels and control panel door in reverse order.

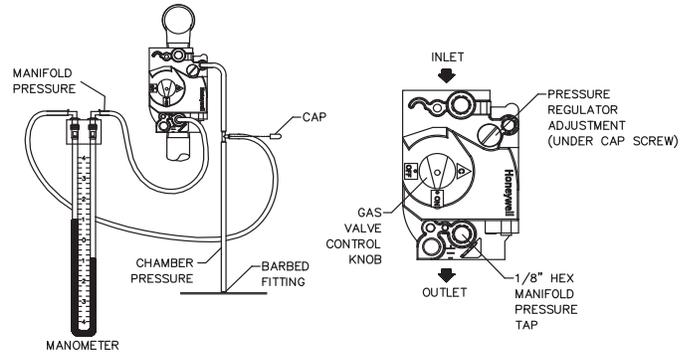


FIG. 31 Measuring Manifold Gas Pressure

19. If proper ignition and burner operation is not achieved after checking gas supply pressure, see *Cleaning and Maintenance*, page 57 for *Combustion Air Fan Adjustment*. Follow the procedure to adjust the combustion air fans as necessary.

TABLE-M Net Manifold Pressure	
399,999 - 750,000	
Nat. Gas	1.8" w.c.
LP Gas	4.6" w.c.
990,000 - 2,070,000	
Nat. Gas	1.2" w.c.
LP Gas	4.6" w.c.

CONNECTING TO WATER SUPPLY

Inlet and Outlet Connections

For ease of service, install unions on the water inlet and water outlet of the unit. The connection to the unit marked “Inlet” on the header should be used for return from the system. The connection on the header marked “Outlet” is to be connected to the supply side of the system.

Installation and Service Manual

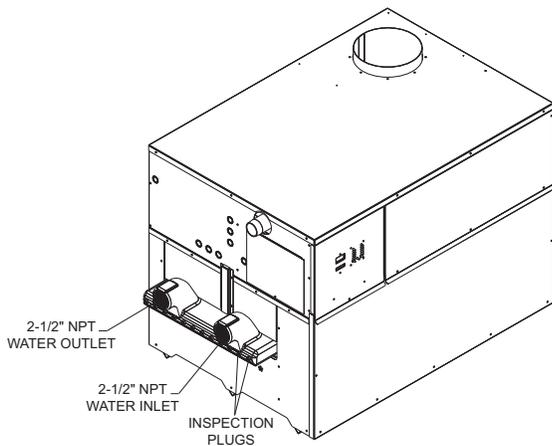


FIG. 32 Water Connections

Relief Valve

This unit is supplied with a relief valve(s) sized in accordance with ASME Boiler and Pressure Vessel Code, Section IV (“Heating Boilers”). The relief valve(s) is installed in the vertical position and mounted in the hot water outlet. Place no other valve between the relief valve and the unit. To prevent water damage, pipe the discharge from the relief valve to a suitable floor drain for disposal when relief occurs. Do not install any reducing couplings or other restrictions in the discharge line. The discharge line will allow complete drainage of the valve and line. Manually operate the relief valves at least once a year.

CAUTION: Avoid contact with hot discharge water.

Water Flow Switch

A water flow switch is factory installed. The flow switch is wired in series with the 24 VAC safety control circuit at the

units terminal strip. This wiring connection installs the flow switch in the 24 VAC safety circuit to prove water flow before main burner ignition. The factory supplied flow switch is installed in the outlet side of the front header. The 399,999 - 750,000 units require a minimum flow of 15 - 18 GPM whereas the 990,000 - 2,070,000 units require a minimum flow of 26 GPM to make the flow switch and start burner operation. Ensure that the pump installed on the unit will supply adequate flow to make the flow switch contacts and operate the unit. A water flow switch meets most code requirements for a low-water cut off device on appliances requiring forced circulation for operation.

Low Water Cutoff (If Equipped)

If installing this unit above radiation level, you must install a low water cut-off device at the time of appliance installation. Electronic or float type low water cutoff controls are available as a factory supplied option on all units. Inspect the low water cutoff every six months, including flushing of float types. The low water cutoff control is located on the control panel directly behind the control panel cover.

The reset and test buttons (if equipped) are located on the control panel cover.

CONNECTING TO ELECTRICAL SUPPLY

This unit is wired for 120 VAC service. The unit, when installed, must be electrically grounded in accordance with the requirements of the authority having jurisdiction or in the absence of such requirements, with the latest edition of the National Electrical Code ANSI/NFPA No. 70. When the unit is installed in Canada, it must conform to the CAE C22.1, Canadian Electrical Code, Part 1 and/or local Electrical Codes.

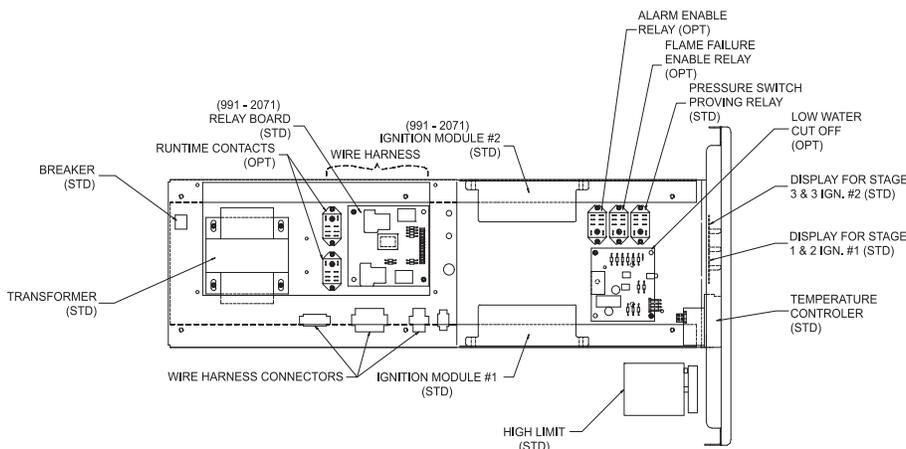


FIG. 33 Control Panel Component Location Drawing

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

1. Use only Type-T wire [63°F (35°C) rise] on all wiring between the unit and field-installed devices.
2. Enclose line voltage wire exterior to the unit in approved conduit or approved metal-clad cable.
3. The pump must run continuously when unit is being fired (hot water heating boilers must use the optional pump delay if the pump is to be cycled. See *Freeze Protection*, page 7 when cycling the pump). Water heaters use the pump delay as standard in accordance with ASHRAE 90.1 requirements.
4. To avoid serious damage, do not energize the unit until the system is filled with water.
5. Provide the unit with proper overload protection.

IMPORTANT: Do not block access to the electrical cover plate when installing electrical conduit.

⚠ CAUTION: This boiler system should not be operated at less than 12 PSIG.

Provide suitable hangers or floor stands to support hot water piping. The boiler alone should not support hot water piping. Copper pipe systems are subject to considerable expansion and contraction. Rigid pipe hangers could allow the pipe to slide in the hanger resulting in noise transmitted into the system. Use padding on rigid hangers installed with a copper system. Pipe the boiler pressure relief valve to a suitable floor drain. See the relief valve section in this manual.

⚠ CAUTION: A leak in a boiler “system” will cause the “system” to intake fresh water constantly, which will cause the tubes to accumulate a lime/scale build up. This will cause a non-warrantable failure.

TABLE-N
AMP Draw Data

Btu/Hr Input	Controls	Fans	Approximate Total Amps
399,999	3.6	2.7	6.3
500,000	3.6	2.7	6.3
650,000	5.4	3.4	8.8
750,000	5.4	3.4	8.8
990,000	7.3	3.2	10.5
1,260,000	7.3	3.2	10.5
1,440,000	7.3	6.7	14.0
1,800,000	7.3	6.7	14.0
2,070,000	7.3	6.7	14.0

BOILER SYSTEM PIPING

The drawings in this section show typical boiler piping installations. Before beginning the installation, consult local codes for specific plumbing requirements. Be sure to provide unions and valves at the boiler inlet and outlet so it can be isolated for service. You must install an air separation device in the installation piping to eliminate trapped air in the system. Locate a system air vent at the highest point in the system. The system must also have a properly sized expansion tank installed. Typically, an air charged diaphragm-type compression tank is used. You must install the expansion tank close to the boiler and on the suction side of the system pump to ensure proper operation.

General Plumbing Rules

1. Check all local codes.
2. For serviceability of boilers, always install unions.
3. Always pipe the pressure relief valve to an open drain.
4. Locate system air vents at the highest point of the system.
5. Expansion tank must be installed near the boiler and on the suction side of the pump.
6. Support all water piping.

Water Connections: Heating Boilers Only

The 399,999 - 750,000 boilers have 2" NPT inlet and outlet connections whereas the 990,000 - 2,070,000 boilers have 2 1/2" NPT inlet and outlet connections. **Note:** Field-installed reducing bushings may decrease flow resulting in boiler noise or flashing to steam.

Circulator Pump Requirements

This is a low mass, high efficiency hot water boiler which must have adequate flow for quiet, efficient operation. Pump selection is critical to achieve proper operation. A pump should be selected to achieve proper system design water temperature rise. A heat exchanger head-loss chart (FIG.'s 34 and 35) is provided to assist in proper pump selection. Also provided is a System Temperature Rise Chart (TABLE-P, page 37). This table provides GPM and boiler head-loss at various temperature rises for each boiler based on Btu/hr input. Temperature rise is the difference in boiler inlet temperature and boiler outlet temperature while the boiler is firing.

Installation and Service Manual

Example: The boiler inlet temperature is 160°F (71°C) and the boiler outlet temperature is 180°F (82°C), this means that there is a 20°F (11°C) temperature rise across the boiler.

Heat Exchanger Pressure Drop Chart

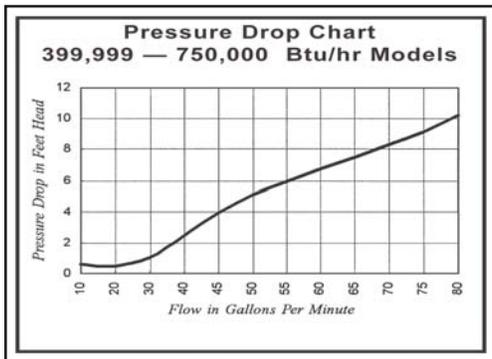


FIG. 34 Pressure Drop Chart 399,999 - 750,000

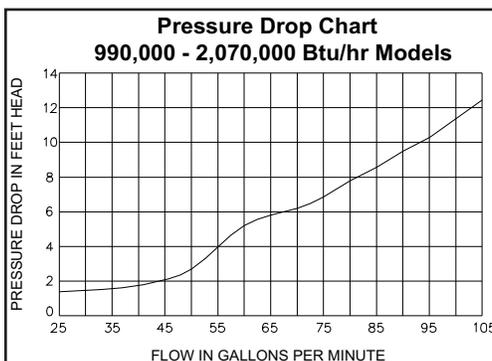


FIG. 35 Pressure Drop Chart 990,000 - 2,070,000

Circulator Pump Specifications

1. Maximum operating pressure for pump must exceed system operating pressure.
2. Maximum water temperature should not exceed nameplate rating.
3. Cast iron circulators may be used for closed loop systems.
4. A properly sized expansion tank must be installed near the boiler and on the suction side of the pump.

Circulator Pump Operation (Heating Boilers Only)

The boiler pump should run continuously unless the boiler is provided with the pump delay control system. External wire leads are furnished with this option to allow the power supply for the pump to be switched across the normally open contacts of the relay, allowing the control relay to cycle the pump on each call for heat. The field installed boiler pump using the

factory supplied pump control system must not exceed 10 AMPS at 120VAC. As shipped from the factory, the control system is set to cycle the boiler pump on at each call for heat before the burners fire and run the pump for a 30 second period after the thermostat is satisfied. This will remove any residual heat from the combustion chamber before turning the pump off. See *Wiring Diagram*, page 64.

Pump Installation and Maintenance

For installation and maintenance information on the circulator pump, refer to pump manufacturers instructions included in the instruction package.

Primary/Secondary Boiler Piping

Boiler installations with a primary/secondary piping system as shown in FIG. 36 are recommended. This type of system uses a dedicated pump to supply flow to the boiler only. This secondary pump is sized based on desired boiler flow rate, boiler head loss and head loss in the secondary system piping only. A properly-sized primary (system) pump provides adequate flow to carry the heated boiler water to radiation, air over coils, etc. The points of connection to the primary (system) loop should be a maximum of 12" (or 4 pipe diameters) apart to ensure connection at a point of zero pressure drop in the primary system. Multiple boilers may also be installed with a primary/secondary manifold system as shown in FIG. 37. The multiple boilers are connected to the manifold in reverse return to assist in balancing flow to multiple boilers.

⚠ CAUTION: DO NOT allow the flow in the primary (system) loop to drop lower than the flow in the secondary loop at any time during boiler operation. Improper operation of the boiler(s) and possible tripping of the high limits and relief valves may occur.

The installer must ensure that the boiler has adequate flow without excessive temperature rise. Low system flow can result in overheating of the boiler water which can cause short burner on cycles, system noise and in extreme cases, a knocking flash to steam. These conditions indicate the need to increase boiler flow by installation of a larger circulator pump or the installation of a system bypass. System noise may also indicate an oversized boiler.

⚠ CAUTION: At no time should the system pressure be less than 12 PSIG.

Hydronic Heating Boilers and Domestic Water Heaters

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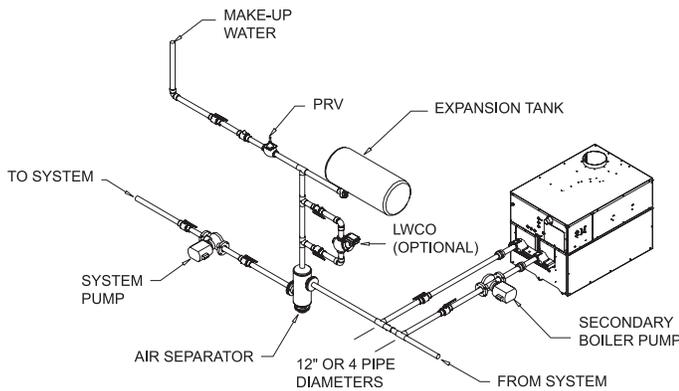


FIG. 36 Primary/Secondary Piping of a Single Boiler

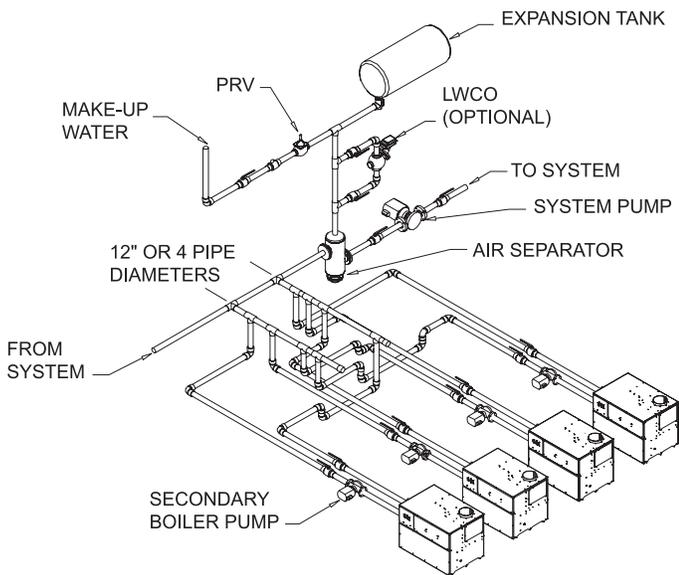


FIG. 37 Primary/Secondary Piping of Multiple Boilers

Low Temperature Return Water Systems

Any non-condensing boiler and venting system will develop operational problems when exposed to inlet water temperatures below 140°F. Lochinvar offers a low temperature protection valve (LTV) that is factory preset to maintain 140°F inlet water to the boiler regardless of the system return water temperature. See Table O for available valve kits.

Table - O LTV Valve Kits	
Input Btu/hr	LTV Valve Kit
399,999 - 750,000	VAL3048
990,000 - 2,070,000	VAL3047

Be sure to install the LTV valve per the piping diagrams included with the kits. Alternatively, a bypass as shown in FIG. 38 may be piped into the system. This piping is like a primary/secondary boiler installation with a bypass in the secondary boiler piping. Inlet water temperatures below 140°F (60°C) can excessively cool the products of combustion resulting in condensation on the heat exchanger and in the flue. Condensation can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the vent system and related components. The bypass allows part of the boiler discharge water to be mixed with the cooler boiler return water to increase the boiler inlet temperature above 140°F (60°C). This should prevent the products of combustion from condensing in most installations. The bypass should be fully sized with a balancing valve to allow for proper adjustment. A valve must also be provided on the boiler discharge, after the bypass. Closing this discharge valve forces water through the bypass. Start boiler adjustment with the bypass valve in the full open position and the boiler discharge valve half open. A small amount of the higher temperature boiler discharge water is mixed with the system water to maintain the desired lower system temperature. A remote low temperature range operator is recommended to control the boiler operation based on the lower system temperature. (See *Terminal Strip Connection Options* starting on page 40).

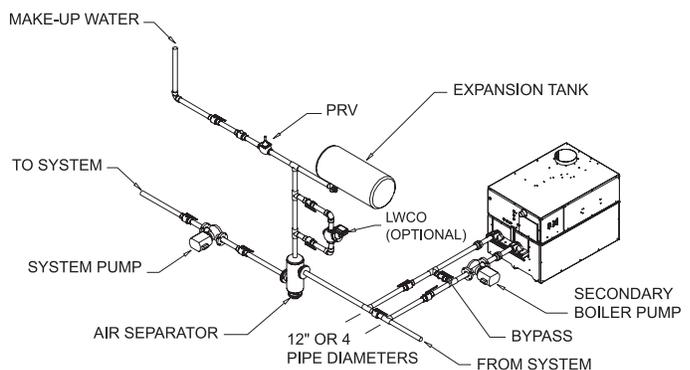


FIG. 38 Boiler with Low Temperature Bypass Piping

Installation and Service Manual

Radiant Floor and Snow Melt Heating Systems

This type of heating boiler application operates in a low temperature range which requires a boiler bypass as described under *Low Temperature Return Water Systems*. A non-metallic rubber or plastic tubing installed in a radiant (in floor) system must have an oxygen barrier to prevent oxygen from entering the system through the walls of the installed tubing. Excessive oxygen absorption into the system will result in an accelerated rate of corrosion causing a sludge buildup. This excessive corrosion will also damage the boiler and system components. Sludge formed as the result of excessive oxygen in the system can restrict water flow resulting in a premature boiler failure. Any boiler damage due to excessive oxygenation is non-warrantable.

TABLE-P
System Temperature Rise Chart Based on Btu/hr Input

Input	Output	ΔT 10°F		ΔT 20°F		ΔT 30°F		ΔT 40°F	
		GPM	FT. HD						
399,999	339,999	68	7.4	34	2.4	23	1.1	17	0.6
500,000	425,000	--	--	42	4.1	28	1.6	21	0.7
650,000	617,500	--	--	55	5.2	37	3.0	28	1.6
750,000	712,500	--	--	63*	7.2	42	4.1	32	2.3
990,000	841,500	--	--	83	5.4	55	2.6	42	1.5
1,260,000	1,071,000	--	--	107*	13	71	4.4	53	2.7
1,440,000	1,224,000	--	--	--	--	81	6.3	61	3.8
1,800,000	1,530,000	--	--	--	--	102*	11.8	76	6.6
2,070,000	1,759,500	--	--	--	--	--	--	87	9.0

*Requires Cupro-Nickel heat exchanger.

*** ⚠ CAUTION:** The maximum flow rate for models 399,999 - 750,000 Btu/hr is 55 GPM and 90 GPM on models 990,000 - 2,070,000 Btu/hr. Do not exceed the maximum flow rate of the heating boiler.

If higher flow rates are required through the boiler, an optional Cupro-Nickel heat exchanger is available. When using a Cupro-Nickel heat exchanger, GPM can be increased by 30 percent. Consult the factory for specific application requirements.

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Boiler Flow Rate

⚠ CAUTION: The maximum flow rate through the boiler with a copper heat exchanger **MUST NOT** exceed the following:

Input - Btu/hr	Maximum Flow Rate
399,999 - 750,000	55 GPM
990,000 - 2,070,000	90 GPM

If higher flow rates are required through the boiler, an optional Cupro-Nickel heat exchanger is available. Consult the factory for specific application requirements.

The heat exchanger is generally capable of operating within the design flow rates of the building heating system. Should the flow rate exceed the maximum allowable flow rate through the boiler an external bypass must be installed. The bypass should be fully sized with a balancing valve to allow for proper adjustment of flow. Flow rate can be determined by measuring the temperature rise through the boiler.

Boiler Bypass Requirements

The installer must ensure that the boiler is supplied with adequate flow without excessive temperature rise. It is recommended that this boiler be installed with a bypass in the piping if the maximum recommended flow rate is exceeded. The bypass will help to ensure that the boiler can be supplied with adequate water flow. Flow rates exceeding the maximum recommended flow will result in erosion of the boiler tubes. A typical bypass with a valve as shown in FIG. 40 will allow control of boiler flow.

Temperature/Pressure Gauge

This boiler is equipped with a dial type temperature/pressure gauge. This gauge is factory installed in the outlet side of the heat exchanger. The gauge has one scale to read system pressure and a separate scale to read water temperature in °F.

Placing the Boiler in Operation

Filling the System

All air must be purged from the system for proper operation. An air scoop and air vent must be located close to the boiler outlet and there should be a minimum distance between the cold water feed and the system purge valve.

1. Close all drain cocks and air vents.
2. Open the makeup water valve and slowly fill the system.
3. If a makeup water pump is employed, adjust the pressure to provide a minimum of 12 psi at the highest point in the system. If a pressure regulator is also installed in the line, it should be adjusted to the same pressure.
4. Close all valves. Purge one circuit at a time as follows:
 - A. Open one circuit drain valve and let the water drain for at least five minutes. Ensure that there are no air bubbles visible in the water stream before closing the drain valve.
 - B. Repeat this procedure for each circuit.

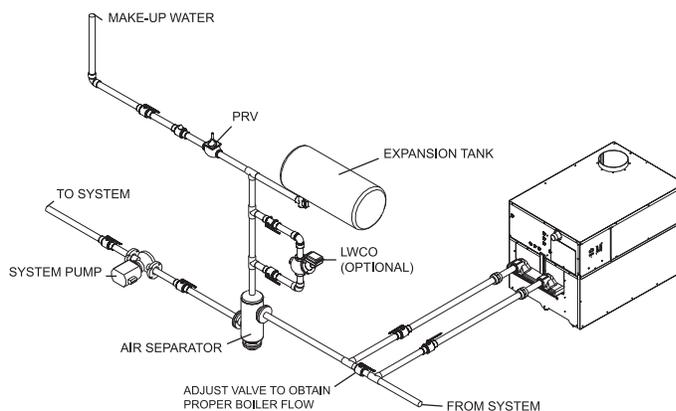


FIG. 40 Boiler Bypass Piping for High Flow Systems

5. Open all valves after all circuits have been purged. Make sure there are no system leaks.

⚠ CAUTION: Do not use petroleum based stop leak products. All system leaks must be repaired. The constant addition of make-up water can cause damage to the boiler heat exchanger due to scale accumulation. Scale reduces flow and heat transfer, causing overheating of the heat exchanger.

6. Run the system circulating pump for a minimum of 30 minutes with the boiler turned OFF.
7. Open all strainers in the system and check for debris.
8. Recheck all air vents as described in step 4.

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9. Inspect the liquid level in the expansion tank. The system must be full and under normal operating pressure to ensure proper water level in the expansion tank. Ensure that diaphragm type expansion tanks are properly charged and not water logged.
10. Start the boiler according to the operating instructions in this manual. Operate the system, including the pump, boiler and radiation units, for one hour.
11. Recheck the water level in the expansion tank. If it exceeds half the tank volume, open the tank to reduce the water level. Recheck pressure charge on diaphragm type tanks.
12. Shut down the entire system and vent all radiation units and high points in the system.
13. Close the water makeup valve and check the strainer and pressure reducing valve for sediment or debris. Reopen the water makeup valve.
14. Verify system pressure with the boiler pressure gauge before beginning regular operation.
15. Within three days of startup, recheck and bleed all air vents and the expansion tank using these instructions.

Installation with a Chilled Water System

Pipe refrigeration systems in parallel. Install duct coil downstream at cooling coil. Where the hot water heating boiler is connected to a heating coil located in the air handling units which may be exposed to refrigeration air circulation, the boiler piping system must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. The coil must be vented at the high point and hot water from the boiler must enter the coil at this point. Due to the fast heating capacity of the boiler, it is not necessary to provide a ductstat to delay circulator operation. Also, omit thermostat flow checks as the boiler is cold when heating thermostat is satisfied. This provides greater economy over maintaining standby heat (see FIG. 41).

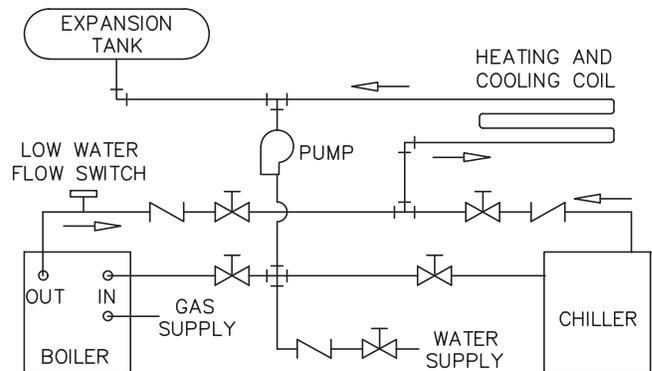


FIG. 41 Installation with a Chilled Water System

Boiler Operating Temperature Control

This unit can have up to four sensors. The four sensors are for inlet temperature, outlet temperature, system/tank temperature, or outdoor air temperature.

If the unit is ordered as a boiler without any options and you need remote sensing, you can relocate either the inlet or outlet sensors. For best performance, do not relocate the inlet or outlet sensors. Install an optional system sensor.

If the unit is ordered as a water heater, the tank sensor is included with the unit. Do not relocate the inlet or outlet sensors from their bulbwells.

The digital electronic operating temperature control for these units is located on the front control panel. The sensing elements for the temperature control are placed in the inlet and outlet bulbwells. See *Remote Mounting of Sensors (Outdoor Air Sensor)*, on page 48 of this manual. Carefully observe the discharge water temperature on the initial boiler "ON" cycles. The location of the temperature sensor will generally require a lower temperature set point on the operating control to achieve the desired discharge water temperature from the boiler. These sensing element locations allow a boiler operating with a low to moderate flow rate to sustain longer burner on cycles, preventing short boiler "ON" cycles based on high discharge water temperatures. For example, a boiler operating with a 180°F (82°C) discharge and a 20°F (11°C) temperature rise would require approximately a 160°F (71°C) to 165°F (74°C) set point with the temperature sensor installed on the inlet side of the heat exchanger. The exact temperature set point is based on your system's requirements.

Hydronic Heating Boilers and Domestic Water Heaters

INSTALLATION Continued

Set the control set point(s) to the desired operating water temperature. Observe the boiler discharge temperature after each set point adjustment to ensure proper operation.

See *Programming Temperature Control*, page 43 for complete programming information.

WATER TREATMENT

In hard water areas, water treatment should be used to reduce the introduction of minerals to the system. Minerals in the water can collect in the heat exchanger tubes and cause noise on operation. Excessive build up of minerals in the heat exchanger can cause a non-warrantable failure.

Terminal Strip Connection Options

The scenarios shown in FIG. 42 represent typical terminal strip connection requirements. The terminal strips are located on the left side of the unit under the electrical access panel. Other applications may be accommodated, but must be addressed individually.

FIG. 42-A shows the position of jumpers as shipped from the factory for stand-alone operation of boilers or water heaters (Modes 1 or 2). **NOTE: Boilers equipped with the Indoor/Outdoor Air Reset option should have the 3C-3NO jumper removed for proper operation.**

FIG. 42-B shows connections to the terminal strip for Remote ON/OFF control of the boiler or water heater (Modes 1 or 2). The 1C-1NO jumper must be removed when making these wiring connections. This remote ON/OFF control will provide an Enable/Disable signal to the unit and allow the unit to operate based on the stage set points, until the remote ON/OFF signal is cancelled. **NOTE: Remote ON/OFF control in Mode 3 requires the field addition of a jumper wire from 1NO to 3NO (the 3C-3NO jumper must also be removed).**

FIG. 42-C shows the connections on a boiler equipped with the I/O Air Reset option only (Mode 1) to accomplish a Domestic Hot Water (DHW) Priority Override **or** an Outdoor Air Lockout Override. This operation is not possible with Modes 2 or 3. The value of BOIL DSGN should be adjusted to a temperature setting that will satisfy the DHW requirements when the Priority Override or O.A. Lockout Override is activated. This figure also shows the optional Remote ON/OFF control which can be accomplished in addition to the DHW Priority Override or O.A. Lockout Override.

FIG. 42-D shows the connections necessary to operate the unit as a 2-Stage (High/Low Fire) boiler or water heater from an Energy Management System (EMS). The electronic control **MUST** be set to Mode 3 for this to properly operate. The value of BOIL MAX should be adjusted to a level that will function as a high temperature stop. The actual set point temperatures are controlled by the EMS.

FIG. 42-E shows the connections necessary to operate the unit as a 4-Stage boiler or water heater from an EMS. The electronic control **MUST** be set to Mode 3 for this to properly operate. The value of BOIL MAX should be adjusted to a level that will function as a high temperature stop. The actual set point temperatures are controlled by the EMS.

FIG. 42-F shows the Continuous and Intermittent terminals. External safety devices connected to these terminals will function to protect the unit. Devices connected to the Intermittent terminals (B1 and B2) are monitored only when there is an active Call for Heat. Devices connected to the Continuous terminals (A1 and A2) are monitored continuously and will activate an alarm (if the unit is equipped with the alarm option) **anytime** the safety device senses an abnormal condition. An additional wire may be field installed from these safety devices to terminals A3 or B3 (as appropriate) to activate an alarm (if the unit is equipped with the alarm option).

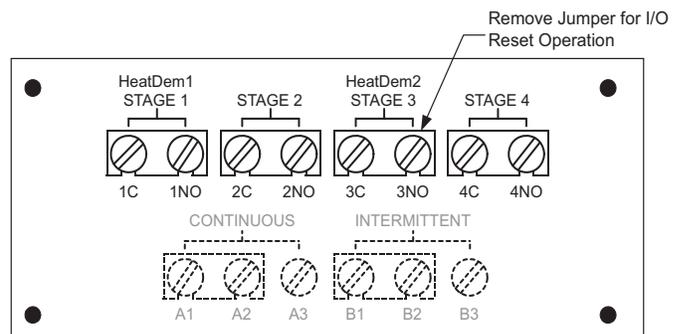


Figure 42A
STAND ALONE OPERATION

FIG. 42 Terminal Strip (A - F) Connection Options

Installation and Service Manual

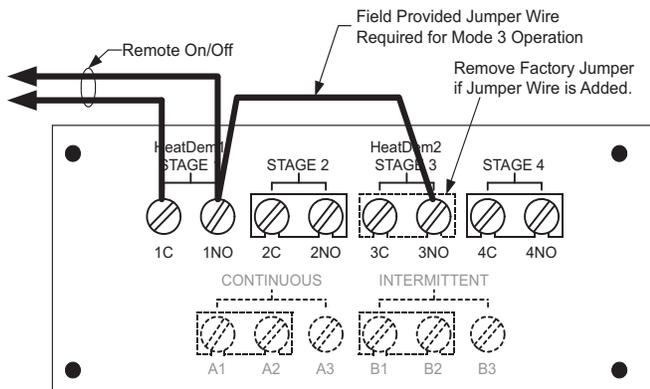


Figure 42B

REMOTE ON/OFF BOILER OR WATER HEATER

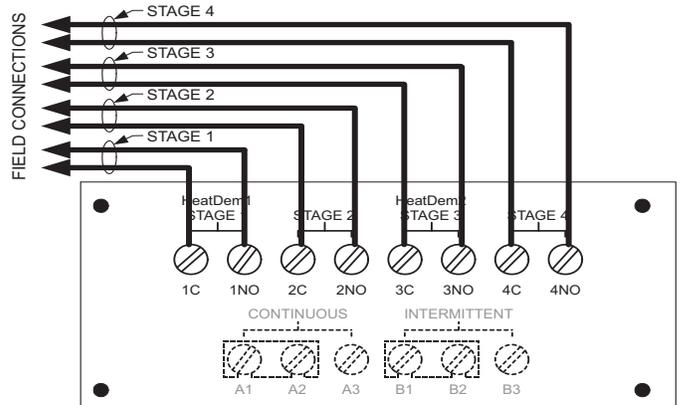


Figure 42E

4 STAGE (High/Low Fire) BOILER OR WATER HEATER

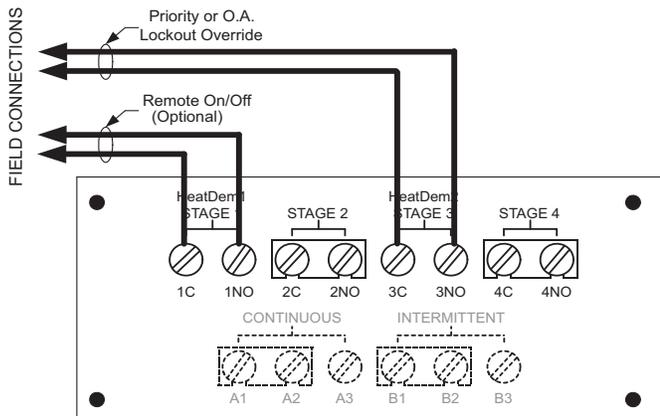
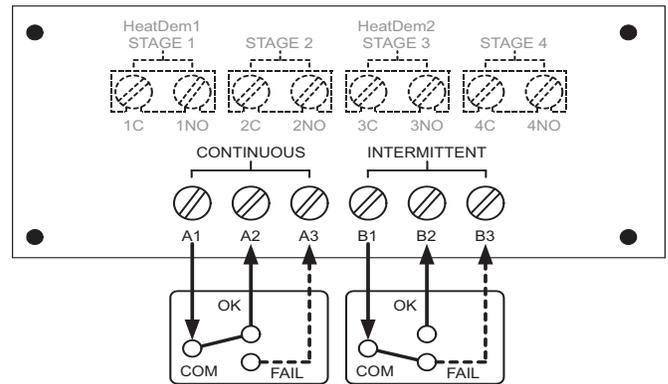


Figure 42C

BOILER WITH DOMESTIC HOT WATER PRIORITY OR I/O RESET OVERRIDE



CONTINUOUSLY MONITORED INTERMITTENTLY MONITORED

EXAMPLE DEVICES:
HIGH/LOW GAS, AUX. HI-LIMIT
AUX. LIMITS, EXT. FLOW SWITCH

Figure 42F

FIELD INSTALLED SAFETY DEVICES

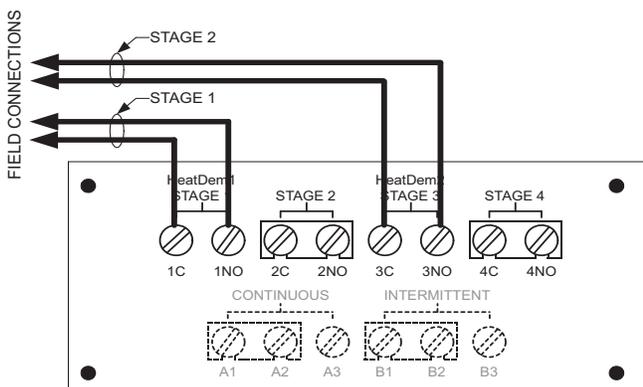


Figure 42D

2 STAGE (High/Low Fire) BOILER OR WATER HEATER

OPERATION

FOR YOUR SAFETY READ BEFORE OPERATING

- This appliance does not have a pilot. It is equipped with an ignition device which automatically lights the burner. Do not try to light the burner by hand.
- BEFORE OPERATING**, smell around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle to the floor.

Hydronic Heating Boilers and Domestic Water Heaters

OPERATION Continued

WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electric switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbors phone.
- Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

- C. Use only your hand to turn the gas control lever. Never use tools. If the lever will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.
- D. Do not use this boiler if any part has been under water. Immediately call a qualified service technician to replace the boiler. The possible damage to a flooded boiler can be extensive and present numerous safety hazards. Any appliance that has been under water must be replaced.

LIGHTING INSTRUCTIONS

1. STOP! Read the safety information.
2. Program the temperature control to the desired settings (see *Programming Temperature Control*, page 43).
3. Loosen knurled knob at bottom of control panel cover (see FIG. 43).
4. Grasp bottom of control panel cover and pull out.
5. Locate ON/OFF switch inside control area. Switch is located to the left of pull out control circuitry tray (see FIG. 44).
6. Turn power switch to "OFF" position.
7. This unit is equipped with ignition devices which automatically light the burners. Do not try to light the burners by hand.

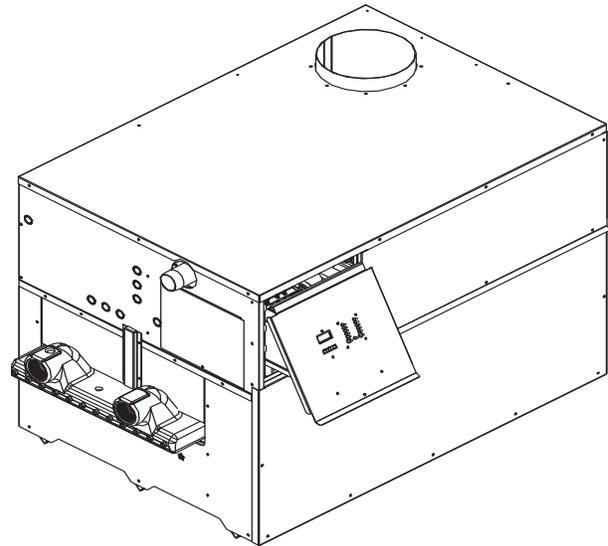


FIG. 43 Control Panel Cover

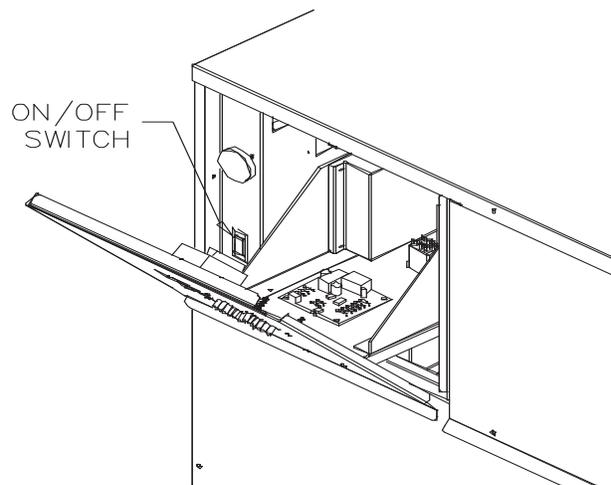


FIG. 44 ON/OFF Switch

8. Turn the manual gas cock clockwise to the "OFF" position.
9. Wait five (5) minutes to clear out any gas. If you smell gas, STOP! Follow "B" in the safety information. If you do not smell gas, go on to the next step.
10. Turn the manual gas cock counterclockwise to the "ON" position.
11. Turn power switch to "ON" position.
12. Slide control panel assembly back into unit. Tighten knurled knob at bottom of control panel cover.
13. If the unit will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

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To Turn Off Gas To Appliance

1. Open the front access panel to access control panel.
2. Turn power switch to “OFF” position.
3. Turn the manual gas cock clockwise to the “OFF” position.

⚠ WARNING: Should overheating occur or the gas fail to shut off, turn off the manual gas control valve to the unit.

⚠ WARNING: Return water temperatures must not be less than 140°F. If lower return water temperatures are required, follow the instructions for *Low Temperature Return Water Systems*, page 36.

The temperature control uses a Liquid Crystal Display (LCD) for interactive prompting during programming and display of sensed and assigned values. Programming is accomplished through the use of the three programming buttons.

Quick Programming Overview

Power Up

After turning the power switch to the “ON” position, the LCD screen will come on to the “View” menu. The screen will show the boiler outlet temperature setting (see FIG. 47, page 45).

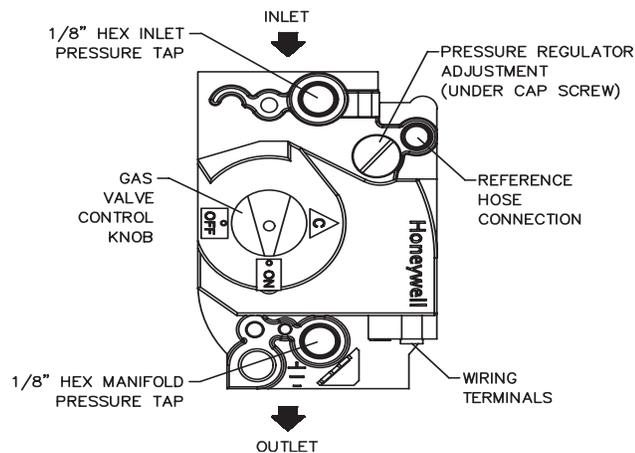


FIG. 45 Combination Gas Valve

PROGRAMMING TEMPERATURE CONTROL

Note: The temperature controller is pre-programmed at the factory with test settings. Stages per model may vary. These pre-programmed values are as follows:

Standard Btu/hr Models

399,999 - 500,000	2-Stage (Capable)
650,000 - 990,000	3-Stage (Capable)
1,260,000 - 2,070,000	4-Stage (Capable)

Stage	Set Point	Differential
1	125°F (52°C)	8°F (5°C)
2	120°F (49°C)	8°F (5°C)
3	115°F (46°C)	8°F (5°C)
4	110°F (43°C)	8°F (5°C)

Re-program the set points and differentials to meet your system requirements.

Hydronic Heating Boilers and Domestic Water Heaters

OPERATION Continued

TABLE-Q Adjust Menu Settings for Operating Modes			
Mode 1 (no outdoor sensor)	Mode 1 (outdoor sensor)	Mode 2	Mode 3
STG MODE (**Models 650 - 990)	STG MODE (**Models 650 - 990)	STG MODE (**Models 650 - 990)	STG MODE (**Models 650 - 990)
*BOIL MAX	OUTDR START	*BOIL MAX	*BOIL MAX
*SEn (no system sensor)	OUTDR DSGN	Set point TARGET 1	*ΔT MIN
Set point TARGET 1	BOIL START	DIFF 1	*ΔT MAX
DIFF 1	BOIL DSGN	Set point TARGET 2	units
Set point TARGET 2	WWSN	DIFF 2	
DIFF 2	*BOIL MAX	Set point TARGET 3	
Set point TARGET 3	*BOIL MIN	DIFF 3	
DIFF 3	*BOIL MASS	Set point TARGET 4 (** Models 1260 - 2070 only)	
Set point TARGET 4 (** Models 1260 - 2070 only)	BOIL DIFF	DIFF 4	
DIFF 4	Set point TARGET	*STG DLY	
*STG DLY	*ΔT MIN	*ΔT MIN	
*ΔT MIN	*ΔT MAX	*ΔT MAX	
*ΔT MAX	units	units	
units			

Note: * indicates the setting is only available in the advanced access level
 ** units listed in KBtu

TABLE-R View Menu Information	
Menu Description	
STG MODE	Stage Mode
OUTDR	Outdoor air temperature
BOIL TARGET	Boiler target temp during outdoor reset operation
BOIL SUP	Actual system sensor temp
BOIL OUT	Actual boiler supply water temp
BOIL IN	Actual boiler return water temp
BOIL ΔT	Temp difference between supply and return
TANK	Actual tank temp
BOIL ON	Accumulated runtime of boiler (up to 999 hours, then resets to 0)

Adjust Menu Setting Descriptions

BOIL MAX

Maximum boiler target supply temperature [either 200°F (93°C) or 250°F (121°C)].

SEn

Select whether staging is based on the boiler inlet or outlet sensor.

Set Point TARGET (1, 2, 3, or 4)

Temperature set point target for stages 1, 2, 3, or 4. Typically, users set the four different stages a few degrees apart. This allows segments of the heater to come on as the temperature drops.

DIFF (1, 2, 3, or 4)

Temperature differential for stages 1, 2, 3, or 4.

STG DLY

Stage delays can be set as follows:

Btu/hr Input	Stages
399,999 - 500,000	1 and 2
650,000 - 750,000	1,2 and 3
990,000	1,2 and 3 or 1,3 and 2
1,260,000 - 2,070,000	1,2 and 3,4 or 1,3 and 2,4

ΔT MIN

Set temperature at which purging stops.

ΔT MAX

Set temperature at which ΔT Max Error Code is generated.

UNITS

Set temperature reading at either °F or °C.

OUTDR START

Outdoor starting temperature.

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STG MODE

Used to distinguish between single and dual ignition module appliances. Applies ONLY on 650,000, 750,000, and 990,000 Btu/hr models.

OUTDR DSGN

Design outdoor air temperature used in the heat loss calculations.

BOIL START

Starting temperature of the boiler heating curve at outdoor starting temperature.

BOIL DSGN

Design heating supply water temperature.

WWSD

Set temperature for warm weather shut down.

BOIL MIN

Set minimum boiler target supply temperature.

BOIL MASS

Set boiler's thermal mass. The lower the value, the shorter the interstage delay.

BOIL DIFF

Set boiler differential during outdoor reset operation.

Set Point TARGET

Set point target whenever a reset override is present.

Ignition Systems and Stages

The 399,999 - 500,000 Btu/hr models have one ignition system and 2 stages of operation. The 650,000 - 750,000 Btu/hr models have one ignition system and 3 stages of operation. On the 990,000 Btu/hr model, there are two ignition systems and 3 stages of operation.

Note: For Stage Mode Delay on the 650,000 - 750,000 Btu/hr models set Stage Mode to 1. On the 990,000 Btu/hr model, set Stage Mode to 2.

The 1,260,000 - 2,070,000 Btu/hr models have two ignition systems and 4 stages of operation

On models with two ignition systems, ignition system 1 controls stages 1 and 2 and ignition system 2 controls stages 3 and 4. Stage 2 is tied to stage 1 and stage 4 is tied to stage 3. You can program the control to operate each ignition system independently. You can also program the ignition stage sequence as 1, 2, 3, and 4, or 3, 4, 1, and 2. This allows greater programming flexibility to meet your individual needs.

Note: One ignition system controls 1 - 3 stages on the 399,999 - 750,000 Btu/hr models.

Operating Modes

There are three operating modes on the temperature control:

Mode 1 - Boiler Operation

Mode 2 - Water Heater Operation

Mode 3 - Sequenced Operation

You can program the different values within each mode to control the operation, stages, differentials, water temperature, and pump operation.

Programming Buttons

Program and navigate the temperature control using the three programming buttons located under the LCD screen. The buttons are labeled "SELECT", "+", and "-" (see FIG. 46).

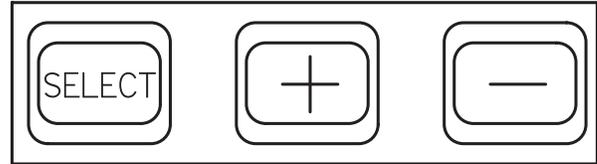


FIG. 46 Programming Buttons

View Menu

This is the default screen that appears after start up. The word "View" appears in the upper right part of the screen (FIG. 47). The View Menu provides current operational information.

To view the operational information, press the "Select" button to scroll through the different areas. TABLE-R, page 44 shows the various View Menu information areas.

To view the various settings without reprogramming the controller, press and hold the "Select" button for at least three seconds. The controller will display in one-second intervals each setting currently programmed into the controller.

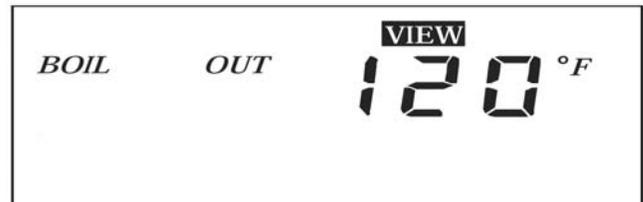


FIG. 47 View Menu

Adjust Menu

The Adjust Menu allows you to change settings or modes. The word "Adjust" appears in the upper right part of the screen. The unit will shut down while in the Adjust mode.

To activate the Adjust Menu, press in and hold all three programming buttons for three seconds. The LCD screen will change from the "View" menu to the "Adjust" menu. The operating mode will appear as either the number 1, 2, or 3, just under the word "Adjust" (see FIG. 48).

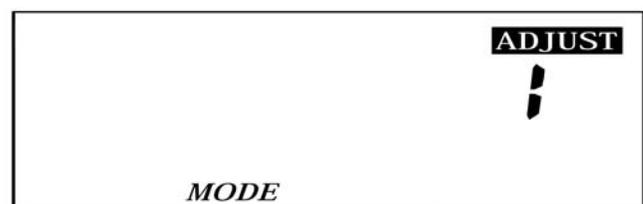


FIG. 48 Adjust Menu

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OPERATION Continued

Scroll through the different settings by pressing the “Select” button. Change settings by pressing either the “+” button or the “-” button.

If no buttons are pushed after a few seconds, the control will time-out and return to the “View” menu.

TABLE-Q, page 44 lists the Adjust Menu settings for the different operation modes.

Access Levels

There are two levels of programming access for this temperature control. These are the Advanced access level and the User access level. The control is set to the Advanced access level at the factory. You may wish to switch the control to the User level, limiting the operator to certain basic programming options. TABLE-Q shows the various menu settings for this control. The items marked with an asterisk (*) indicate adjustments only available in the Advanced access level.

To switch from the Advanced access level to the User access level, move the dip switch located on the back side of the temperature control (see FIG. 49).

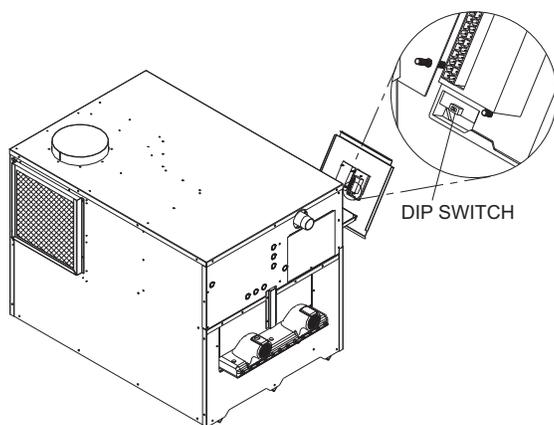


FIG. 49 User Access Level Dip Switch Location

Temperature Control

This is a four-stage temperature control that controls the burner ignition, pump, and alarm functions. This temperature controller can measure four different sensor inputs. They are as follows:

1. Outside Air Temperature Sensor
2. Inlet Water Temperature Sensor
3. Outlet Water Temperature Sensor
4. Multi-Purpose Temperature Sensor

Outside Air Temperature Sensor

Only use this sensor for boiler operations. This allows you to

tie boiler operation to the outside air temperature. As outside temperatures drop, the control will increase the temperature to the boiler. As outside temperatures rise, the control will decrease the temperature to the boiler. You can set the control to shut the boiler off when a desired outside air temperature level is reached.

Inlet Water Temperature Sensor

This sensor measures the inlet water temperature coming into the unit. This is the default controlling sensor as shipped from the factory.

Outlet Water Temperature Sensor

This sensor measures the outlet water temperature leaving the unit.

Multi-Purpose Temperature Sensor

Depending on what mode the control is in, this sensor is either a tank sensor or a system sensor.

Placement of Sensors

Outside Air Temperature Sensor

The outside air temperature sensor will only be used for boiler systems. The outside air sensor is optional. You can purchase the sensor from the appliance manufacturer. The sensor comes with a housing that helps protect the sensor from the elements. Mount the air sensor housing under the eave of the roof. Make sure the housing is out of direct sunlight. This will ensure that the sensor will accurately read the true outdoor temperature. For more information on mounting the sensor, see *Remote Mounting of Sensors*, page 48.

Inlet and Outlet Water Temperature Sensors

The inlet and outlet water temperature sensors are placed into the inlet or outlet bulbwells on the boiler. These sensors are installed by the factory in new units. If you have to reposition these sensors, use a thermal-conductive paste to coat the sensors. Insert the sensors in the appropriate bulbwell. Make sure to insert the sensors all the way into the bulbwell, leaving no air pocket between the front surface of the sensor and the back of the bulbwell. Air pockets are thermally non-conductive and will cause sensors to not read accurately.

Multi-Purpose Temperature Sensor

You can use the multi-purpose temperature sensor as a tank sensor or as a system sensor. Install a bulbwell (provided by the appliance manufacturer) in a water tank or a system loop. Place the multi-purpose temperature sensor in the bulbwell to monitor the water temperature.

Tank Sensor: This is used in water heating applications. Place sensor in water storage tank to measure water temperature. For more information on mounting the sensor, see *Remote Mounting of Sensors*, page 48.

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System Sensor: This is used for boiler applications. This sensor will control the water temperature within the building loop.

Staging Logic

There are two different types of staging logic used in the temperature control; Proportional (step) Staging Logic and PID Staging Logic. The staging logic used depends upon what mode the control is running under.

Proportional (Step) Staging Logic

The proportional method of staging is based on manually adjusted settings which determine when the next stage is required to fire. This method is used on Mode 1 for set point operation (with no outdoor sensor) and Mode 2 for water heating. The adjustable settings are:

Set Point TARGET 1, 2, 3, or 4: Staging set point target for each stage. Typically, users set the four different stages a few degrees apart to allow segments of the heater to come on as the temperature drops.

DIFF 1, 2, 3, or 4: Staging differential for each stage.

STG DLY: Interstage delay to turn on between stage 1 and 2 and between stage 3 and 4.

How It Works

A stage will turn on once the temperature drops to its Set point TARGET minus DIFF. The stage will turn off once the temperature rises to its Set point TARGET.

EXAMPLE:

Using stage one of the control as an example, the corresponding load would be energized and de-energized at the following temperatures based on the programmed settings.

Settings

Set Point: 160°F (71°C)

Differential: 8°F (5°C)

Output Energized

Stage One: Energized at 152°F (67°C)

Output De-energized

Stage One: De-energized at 160°F (71°C)

There is a time delay (STG DLY) that applies in the staging on sequence between stage 1 and 2 and between stage 3 and 4. For example, in order for stage 2 to turn on, the temperature must drop to Set point TARGET 2 minus DIFF 2, and the STG DLY must elapse. The STG DLY begins once stage 1 turns on. This operation applies between stage 3 and 4 as well.

Stage 1 and 2 are independent of stage 3 and 4. Stage 2 cannot fire before stage 1 and stage 4 cannot fire before stage 3.

PID Staging Logic (Outdoor Air Mode 1 Only)

This method is used on Mode 1 for outdoor reset with reset override operation (using the outside air temperature sensor). The PID method of staging allows the control to decide the most effective way to operate the stages to maintain an accurate temperature and minimize short cycling.

The control continuously monitors the actual supply temperature and compares it to the target temperature. The amount of error (proportional), the time the error has been present (integral), and the rate of change (derivative), determine if an additional stage is required to turn on or off.

The control automatically calculates the inter-stage differential as well as the delays between stages turning on or off.

OUTDR START, OUTDR DSGN, BOIL START and BOIL DSGN need to be field set based on installation design criteria to establish the reset curve. Verify that the WWSD is set to the desired value. Adjust BOIL MAX and BOIL MIN to appropriate values for the application.

Note: BOIL MIN should not be less than a setting which will ensure the return water temperature to the unit being 140°F minimum.

BOIL MASS should only need adjustment if changes in the interstage delay are necessary.

Graphic Symbols

The screen will display two graphic symbols. One is a circle with a triangle inside and the other is a graphic representation of a blower (see FIG. 50). The circle with a triangle inside represents the pump. When this symbol is present, the pump is operating. When the blower symbol is present, the controller is calling for heat.



FIG. 50 Graphic Symbols

Programming For Mode 1, Boiler Operation

Mode 1 is for boiler operation. Under Mode 1, there are two sublevels of operation.

1. Operate off of set point.
2. Operate off of outdoor air reset curve.

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OPERATION Continued

To program settings for Mode 1 operation, press in and hold the three programming buttons for 3 seconds. The screen will change from the View Menu to the Adjust Menu. “Adjust” will appear in the upper right corner of the screen. Just under the word “Adjust” will be either the number 1, 2, or 3. Press the “+” or “-” button to select the number “1”. This places the control into Mode 1.

Press the “Select” button to scroll through the menu offerings. Press the “+” or “-” button to change values within each offering.

See TABLE-Q , page 44 for Mode 1 Adjust Menu settings.

Programming For Mode 2, Water Heating Operation

Mode 2 is for base water heating operation. A tank sensor is supplied with the unit. You must connect the supplied tank sensor to the control and install the sensor into the water storage tank. If you do not, the controller will default to either inlet or outlet control (whichever is setup as the controlling sensor). Once the tank sensor is connected, the controller automatically selects that sensor as the controlling sensor. See *Remote Mounting of Sensors* on page 48 for more information on installing the tank sensor.

To program settings for Mode 2 operation, press in and hold the three programming buttons for 3 seconds. The screen will change from the View Menu to the Adjust Menu. “Adjust” will appear in the upper right corner of the screen. Press the “+” or “-” button until the number “2” appears under the word “Adjust”. This places the control into Mode 2.

Press the “Select” button to scroll through the menu offerings. Press the “+” or “-” button to change values within each offering.

See TABLE-Q, page 44 for Mode 2 Adjust Menu settings.

TABLE-S Programming Worksheet	
Stage 1:	
Set Point 1 _____	Off at _____
Differential 1 _____	On at _____
Stage 2:	
Set Point 2 _____	Off at _____
Differential 2 _____	On at _____
Stage 3:	
Set Point 3 _____	Off at _____
Differential 3 _____	On at _____
Stage 4:	
Set Point 4 _____	Off at _____
Differential 4 _____	On at _____

Programming For Mode 3, Sequenced Operation

Mode 3 is for sequenced operation. A Building Management System will sequence the operation of the unit. Most of the control of the unit will be handled by the Building Management System.

To program settings for Mode 3 operation, press in and hold the three programming buttons for 3 seconds. The screen will change from the View Menu to the Adjust Menu. “Adjust” will appear in the upper right corner of the screen. Press the “+” or “-” button until the number “3” appears under the word “Adjust”. This places the control into Mode 3.

Press the “Select” button to scroll through the menu offerings. Press the “+” or “-” button to change values within each offering.

See TABLE-Q, page 44 for Mode 3 Adjust Menu settings. Refer to FIG. 42 for various mode terminal strip connection options.

Remote Mounting of Sensors

You must mount the outside air temperature sensor outside the building. To mount remote sensors, follow the guidelines below. Take care to correctly wire sensors to the unit. Erratic temperature readings can be caused by poor wiring practices. Twist the wires between the unit and the remote sensor. Turn wires at least three or four turns per linear foot of wiring. This provides common mode rejection of some types of electrical interferences.

1. Do not route temperature sensor wiring with building power wiring.
2. Do not locate temperature sensor wiring next to control contactors.

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3. Do not locate temperature sensor wiring near electric motors.
4. Do not locate temperature sensor wiring near welding equipment.
5. Make sure good mechanical connections are made to the sensor, any interconnecting wiring and the controller.
6. Do not mount sensor with leadwire end pointing up in an area where condensation can occur.
7. Use shielded wiring to connect the sensor to the control when the possibility of an electrically noisy environment exist. Shielded cable is recommended on all cable runs of more than 25 feet in length.

Note: Ground the cable shield at the connection to the boiler/electronic temperature control only. Do not ground the shielded cable at the sensor end.

To maintain temperature accuracy, sensor wires should be at least 18 AWG. See Table T below.

TABLE-T Remote Wire Connection	
Wire Gauge	Maximum Allowable Length
12 GA	100 ft
14 GA	75 ft
16 GA	50 ft
18 GA	30 ft

Error and Warning Messages

The temperature control will enumerate errors on the display when it senses any. If a sensor is shorted, the display will show “SHr” and an identification of which sensor is effected. If a sensor has an open circuit, the display will show “OPn” and an identification of the sensor effected. If freeze protection is active, the display will show “E02”. If the control read an error at power-up, the display will show “E01” (simply turn the power OFF and then ON again to reset the control). If ΔT MAX is utilized and the outlet temperature exceeds this value, the display will show “Err”.

HOT SURFACE IGNITION SYSTEM

Hot Surface Igniter and Ignition Control Module

The 399,999 - 750,000 Btu/hr models have one ignition module and one hot surface igniter. The 990,000 - 2,070,000 Btu/hr models have two ignition modules and two hot surface igniters.

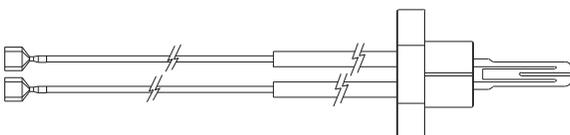


FIG. 51 Hot Surface Igniter

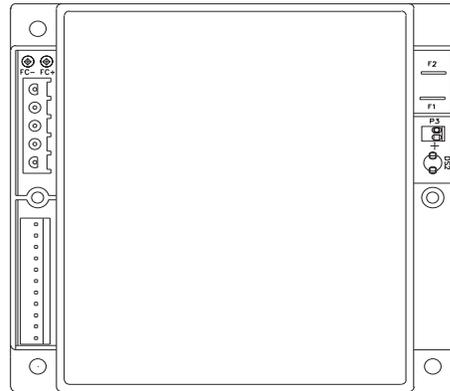


FIG. 52 Hot Surface Ignition Control Module

Hot Surface Ignition Control Module

Ignition Module Lockout Functions

The ignition module(s) may lockout in either a hard-lockout condition, requiring pushing of the reset button to recycle the control, or a soft-lockout condition which may recycle after an approximate five-minute waiting period. This soft-lockout condition is intended to allow self-correcting faults to correct themselves and permit normal operation. A typical hard-lockout fault is a flame failure condition. An ignition module that is in a hard-lockout condition may only be reset by pushing the reset button for the ignition control. The reset buttons are located on the front of the control panel. Upon a flame failure, the reset button is only active after the control module has completed its post-purge cycle. Turning main power “OFF” and then “ON” or cycling the thermostat will not reset a hard-lockout condition. Wait five seconds after turning on main power before pushing the reset button when the ignition module is in a hard lockout. The ignition module will go into a soft lockout if conditions of low air, low voltage or low hot surface igniter current. A soft-lockout condition will operate the combustion air fans for the post purge cycle and then the ignition module will pause for approximately five minutes. At the end of this timed pause, the ignition module will attempt a new trial for ignition sequence. If the soft-lockout fault condition has subsided or has been corrected at the end of the timed pause, main burner ignition should be achieved with the resumption of the normal trial for ignition sequence. If the control sensed fault is not corrected, the ignition module will continue in the soft-lockout condition. If the electronic thermostat opens during the soft-lockout period, the ignition module will exit soft lockout and wait for a new call for heat from the thermostat. A soft-lockout condition may also be reset by manually cycling the electronic thermostat or turning the main power switch “OFF” and then “ON” after the control sensed fault has been corrected.

Hydronic Heating Boilers and Domestic Water Heaters

OPERATION Continued

Diagnostic Status Indication

The ignition module has an LED which indicates the status of the safety circuits. A remote Ignition Module Status indicating light(s) is wired from the ignition module Status LED and mounted on the front control panel. The flashing operation of these light(s)/LED indicates the diagnostic status of the ignition control module. The status LED, mounted on the ignition module, flashes a code sequence from the Ignition Module to indicate the status of the ignition process. See TABLE-U, this page for the flashing diagnostic status codes as signaled by the ignition module.

Access to Internal Control Panel

The control panel is accessed by turning the mounting screw located at the bottom center of the exterior control panel. Pull the panel out at the bottom. The door will tilt into unit until it comes free from the outer top. The outer control panel has an overlay attached to the exterior surface which indicates the function of

each of the boiler's indicating lights and a clear window to view the digital temperature display from the electronic temperature control. The thermostat and diagnostic light board are mounted to the back of the control panel door.

The control panel assembly is mounted on a slide out chassis to allow easy access to the components on the panel. The control panel contains the ignition module, transformer for the 24 VAC control circuit, circuit breaker for the control circuit, switching relays for component operation and wiring harness connections to the unit's components. The control panels are common and may be switched between units for troubleshooting.

Removing the Control Panel

1. Pull the control panel out as far as it will go.
2. Remove the multi-pin connector blocks from the top and right side of the control panel.
3. Use a 1/2" box wrench or socket wrench to remove the bolt on the right side of the control panel.
4. Remove the entire control panel.
5. Reinstall the control panel in the reverse order.

TABLE-U
Ignition Control Diagnostic Codes

Code Sequence	Condition
Constant ON	System OK, no faults present.
Constant OFF	Possible control fault, check power; LED may be effective, do not replace control if all operational sequences function properly, see TroubleShooting Guide.
One Flash	Low Air, check air pressure switch and hoses to pressure sensing points, fan, venting and sealing of pressurized chamber. Note: Brief flashing normal on fan start-up/proving.
Two Flashes	Flame without call for heat, check for a gas valve stuck in the open position, air, venting, burners and the combustion process. Fan will remain on.
Three Flashes	Lockout due to flame failure, push reset button on inner control panel after correcting ignition problem. Initial heater start up without properly bleeding air from the gas line may require multiple reset functions to achieve proper ignition.
Four Flashes	Igniter failure, igniter will not maintain minimum 2.75 amp current draw, caused by low voltage, bad wiring/continuity, high resistance or igniter failure.
Five Flashes	Power supply problem, check for low supply voltage or transformer output less than 18VAC.
Six Flashes	Replace ignition module, internal fault.

Installation and Service Manual

⚠ CAUTION: Control panel is heavy and awkward to handle when removed. Carefully support the control panel when removing.

Ignition and Control Timings

Proven Pilot Hot Surface Ignition System M-9 on 990,000 through 2,070,000 Btu/hr models with two hot surface ignition modules.

Hot Surface Ignition Module Timings (Nominal)

Prepurge:

15 Seconds

Hot Surface Igniter Heat-up Time:

25- 35 seconds

Main Burner Flame Establishing Period:

4 Seconds

Failure Response Time:

0.8 Seconds at less than 0.5 μ A flame current

Flame Current:

5 - 15 μ A

Time Delay Between Stages 1&2 and 3&4*:

15 Seconds

399,999 - 750,000 TIME DELAY stages 1 and 2 ONLY.

Note: Delay starts from the beginning of the ignition process. In order to achieve a 15 second delay, a 60 second delay would have to be programmed. Allow 45 seconds for the ignition process.

Post-purge:

30 Seconds

Pump Delay Timing:

30 seconds minimum after burner shutdown up to a value of ΔT MIN (adjustable from 1°F to 20°F)

* You can program a time delay of up to five minutes into the temperature controller. This only applies to Mode 1 and Mode 2 operation. Mode 3 does not have any stage delay capability. It is recommended, but not required, that the building control system have a delay between the stages to allow time for the system temperature to settle before additional stages are applied to the load. This will help prevent short cycling.

OPERATION AND DIAGNOSTIC LIGHTS

The control panel has up to 11 indicating and diagnostic lights to show all major steps of operation and control sensed malfunctions.

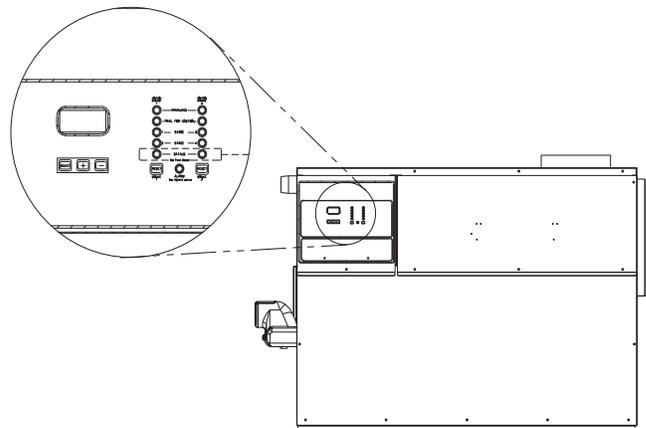


FIG. 53 Exterior Control Panel with Operation/Diagnostic Lights and LCD Display

TABLE-V
Status LED Diagnostic Codes

Code Sequence	Condition Lights
Prepurge 1	Operation of combustion air fans before ignition on stages 1 and 2.
Prepurge 2	Operation of combustion air fans before ignition on stages 3 and 4.
Trial for Ignition 1	Hot surface igniter 1 preparing to light burners.
Trial for Ignition 2 (if equipped)	Hot surface igniter 2 preparing to light burners.
Stage 1 On	Burners for stage 1 operating.
Stage 2 On	Burners for stage 2 operating.
Stage 3 On (if equipped)	Burners for stage 3 operating.
Stage 4 On (if equipped)	Burners for stage 4 operating.
Status 1	Remote status light for ignition module #1.
Status 2 (if equipped)	Remote status light for ignition module #2.
Alarm	Indicates flame failure on either ignition module and will indicate additional alarms if the alarm on any failure option is purchased.

Hydronic Heating Boilers and Domestic Water Heaters

DOMESTIC WATER HEATERS

This section applies only to those units used to supply potable hot water for domestic use. The hot water supply boiler must be installed with a storage tank.

This section contains specific instructions for those units used to supply domestic hot water. All warnings, cautions, notes and instructions in the general installation and service sections apply to these instructions. Hot water supply heaters are designed for installation with a properly sized storage tank. The use of a properly sized pump and the control of water velocity, as explained below, are important for correct operation of your water heater.

Water Velocity Control

IMPORTANT: To ensure proper velocity through the heat exchanger, you must regulate the temperature rise across the heat exchanger from inlet to outlet. Do this upon initial installation and periodically recheck. The correct temperature rise across the heat exchanger ensures proper velocity in the tubes. This will yield long life and economical operation from your hot water heater. Excessive lime build-up in the tube is caused by too little velocity through the tubes. Excessive pitting or erosion in the tube is caused by too much velocity through the tubes. Take care to measure temperature rise and maintain a velocity as follows:

1. With the pump running and the water heater off, the inlet and outlet thermometers should read the same temperatures. If they do not, an adjustment must be made to your final calculation.
2. Turn the water heater boiler on and allow time for the temperature to stabilize. Record the difference between the inlet and outlet temperatures. This difference will be the "temperature rise."
3. Compare the temperature rise on the heater with the required temperature rise in TABLE-W. Should adjustment be needed, proceed as follows:

If the temperature rise is too high, the water velocity is too low. Check the following:

1. Check for restrictions in the outlet of the water heater.
2. Be sure all valves are open between the water heater and the tank.

3. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction (see arrow on volute housing).
4. Be sure the installed circulation pipes between the water heater and storage tank are not less than 2" in diameter on 399,999 - 750,000 Btu/hr models and 2 1/2" in diameter on 990,000 - 2,070,000 Btu/hr models.
5. Common manifold piping for multiple unit installations will require larger minimum pipe sizes and tank circulating tappings to ensure proper flow. See TABLE-X, page 53.

If the temperature rise is too low, the water velocity is too high. Adjust as follows:

1. Slowly throttle the valve on the outlet side of the water heater until the temperature rise is steady at the required temperature rise as noted in TABLE-W.
2. Sustained high water velocity and low temperature rise may result in pitting or erosion of the copper tubes in the heat exchanger. This is a non-warrantable failure. Temperature rise must be properly adjusted to achieve the specified flow rate.

Required Temperature Rise

Based on heating potable water with a hardness of 5 to 25 grains per gallon and/or total dissolved solids not exceeding 350 ppm. See *Water Chemistry*, page 52.

TABLE-W Temperature Rise Chart	
Btu/hr Input	Temperature Rise °F
399,999	12
500,000	15
650,000	20
750,000	23
990,000	19
1,260,000	24
1,440,000	27
1,800,000	34
2,070,000	39

Water Chemistry

The required temperature rise and the standard pump sizing are based on the heating of potable water with a hardness of 5 to 25 grains per gallon and a total dissolved solids not exceeding 350 ppm. Consult the appliance manufacturer when heating

Installation and Service Manual

potable water exceeding these specifications. Heating of high hardness and/or high total dissolved solids water will require a larger circulating pump, an optional cupro-nickel heat exchanger and a revised temperature rise specification based on the water chemistry of the water to be heated. Water with a hardness of less than 5 grains per gallon will usually have a low pH which can be aggressive and corrosive causing non-warrantable damage to the heater, pump and associated piping. Corrosion due to water chemistry generally shows up first in the hot water system because heated water increases the rate of corrosive chemical reactions.

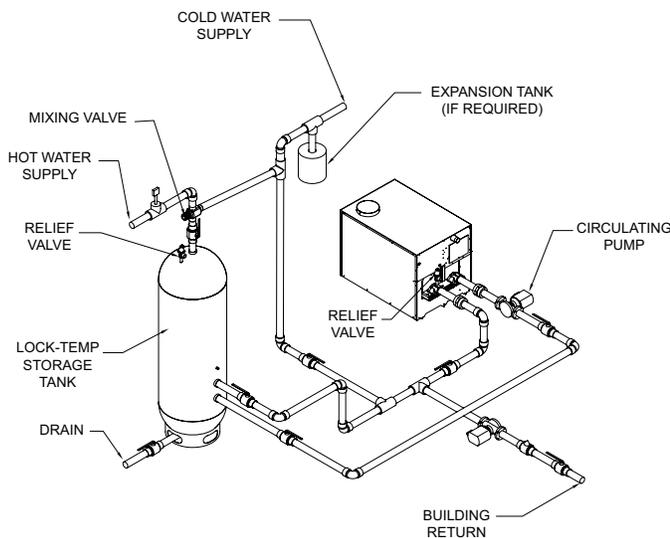


FIG. 54 Typical Water Heater Piping with Storage Tank

Pipe Size Requirements

The pipe sizing chart provides minimum pipe size for common manifold piping to ensure adequate flow.

TABLE-X	
Number of Units 399,999 - 750,000 Btu/hr Models	Common Manifold Size (Min.)
1	2"
2	3"
3	3 1/2"
4	4"
5	5"
6	5"
Number of Units 990,000 - 2,070,000 Btu/hr Models	Common Manifold Size (Min.)
1	2 1/2"
2	4"
3	4"
4	5"
5	6"
6	6"

Circulating Pump

1. The water heater must be connected to a properly sized pump that circulates water between the heater and storage tank.
2. Pump is sized to heater input and water hardness. Care should be taken to size pump correctly. See *Water Chemistry* on page 52.
3. The water heater is equipped with a factory-supplied pump delay system in accordance with the requirements of the latest edition of ASHRAE 90.1.
4. Lubricate pump to manufacturers recommendations. Pump damage due to inadequate lubrication is non-warrantable.
5. Standard water heaters are furnished with the following circulating pump. Mount pump on unit's inlet water connection.

399,999 - 750,000 Btu/hr Models
1/4 HP, 120 VAC, 5.8 Amp

990,000 - 2,070,000 Btu/hr Models
1/2 HP, 120 VAC, 7.4 Amp

Hydronic Heating Boilers and Domestic Water Heaters

DOMESTIC WATER HEATERS Continued

This pump is sized based on installation of a single storage tank and heater in close proximity. If the number of fittings and straight pipe exceeds the quantities shown in this section, a larger pump will be required.

The standard pump selection is based on the following pipe and fittings from the unit to the storage tank:

6 - 90° elbows 2 - ball valves
2 - unions 1 - cold water tee
Not more than 45 feet of straight pipe.

IMPORTANT: For every elbow and tee in excess of those shown above, deduct 5 feet from maximum allowable straight pipe in heater to tank circulating loop.

Minimum Pump Performance

This is based on heating potable water with a hardness of 5 to 25 grains per gallon and/or total dissolved solids not exceeding 350 ppm. See *Water Chemistry*, page 52.

TABLE-Y Minimum Pump Performance		
Btu/hr Input	GPM	Ft.Hd.
399,999 - 750,000	55	10
990,000 - 2,070,000	90	15

Heat Exchanger

This is a highly sophisticated heat exchanger, designed to carry water in such a way that it generates a scouring action which keeps all interior surfaces free from build-up of impurities. The straight-line, two pass design of the tubes sends water into the headers at a properly rated velocity. The configuration of the headers, in turn, creates a high degree of turbulence which is sufficient to keep all contaminants in suspension. This “scouring action” provides greater cost savings for owners. Tubes are always able to transfer heat at peak efficiency. Every surface within this water containing section is of a non-ferrous material, providing clear, clean, rust-free hot water. Straight copper tubes-finned on the outside for maximum heat transfer-coated cast iron one piece cored headers make up an entirely rust-proof unit. On all models, header inspection plugs can be removed for field inspection and cleaning of copper tubes. The entire heat exchanger may be easily removed from the unit.

Potable Hot Water Temperature Control Settings

Domestic Water Temperatures

⚠ WARNING: You must take adequate care to prevent scald injury when storing water at elevated temperatures for domestic use.

This unit has an adjustable temperature control to maintain the desired water temperature set point. See *Programming Temperature Control*, page 43, for instructions to program the digital temperature control. The immersion thermostat or electronic control is factory pre-set at approximately 125°F (52°C) or less. Households with small children or invalids may require 120°F (49°C) or lower temperature hot water to reduce risk of scald injury.

Operate this high efficiency hot water heater at a temperature setting high enough to prevent condensing of the products of combustion on the unit’s heat exchanger or in the attached venting system. A water temperature setting that is above the dew point of the gas combustion products should prevent condensate formation.

⚠ WARNING: To guard against scald injury, you must use a properly-sized thermostatic mixing valve to supply domestic hot water at temperatures less than 125°F (52°C).

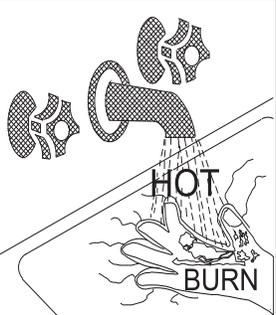
Storing the water at a higher temperature and thermostatically mixing the water increases the available quantity of mixed hot water, greatly reducing the possibility of condensate forming on the heat exchanger or in the venting system and helps prevent water born bacteria growth.

Some states may require a lower water temperature setting for specific applications. Check local codes or your gas supplier for domestic hot water temperature requirements. Remember, no water heating system provides exact temperatures at all times. Let system operate a few days at your programmed settings to determine correct settings for your needs.

1. These units are equipped with an electronic operating temperature control.
2. The electronic control set points are pre-programmed to a low test setting when shipped from the factory.
3. Reprogram the temperature set points to the lowest settings which will satisfy hot water demands, eliminate a possible condensate problem and prevent a risk of scald injury.

Installation and Service Manual

▲ D A N G E R



- Water temperature over 125°F (52°C) can cause severe burns instantly or death from scalds.
- Children, disabled and elderly are at highest risk of being scalded.
- See instruction manual before setting temperature at heating appliance.
- Feel water before bathing or showering.
- If this appliance is used to produce water that could scald if too hot, such as domestic hot water use, adjust the outlet control (limit) or use temperature limiting valves to obtain a maximum water temperature of 125°F (52°C).

▲ WARNING: Return water temperatures must not be less than 140°F (60°C). If lower return water temperatures are required, follow the instructions for *Low Temperature Return Water Systems*, page 36.

4. The temperature set points for all stages should be set at the same temperature when supplying potable hot water for domestic use.
5. Stage firing is achieved by setting the differentials at approximately 3°F, 5°F, 7°F and 9°F for stages 1, 2, 3, and 4. Stage firing of a potable water heater should only be used to replace system standby heat loss.
6. All stages of burner operation should fire when there is a major draw from the potable hot water storage system. This prevents possible condensate problems and ensures a rapid recovery of the hot water used.

IMPORTANT: When water is stored at temperatures above 125°F (52°C), a thermostatic mixing valve must be installed on the hot water outlet from the storage tank to supply lower temperature water and prevent the risk of a scald injury.

Note: This water heater, when set at a lower temperature setting, is not capable of producing hot water of sufficient temperature for sanitizing purposes.

Location of Cold Water Supply Piping Connections

Incorrect piping of the cold water supply to the system may result in excessive low temperature operation causing condensate formation on the heat exchanger and operational problems. You must install the cold water supply piping in the discharge piping from the heater to the storage tank. This allows the cold water to

be tempered in the storage tank before entering the heater. See FIG. 54 and typical installation drawings provided with the unit for correct piping. Higher water temperatures reduce condensate formation.

High Water Temperature Limit Control

The unit is equipped with an adjustable setting, manual-reset high water temperature limit control. The hot water heater temperature limit control has a maximum limit setting of 200°F (93°C). If water temperature exceeds the set point, the limit will break the control circuit and shut down the unit. The limit control will only be reset after the water temperature has cooled below the set point of the limit. The high water temperature limit control is mounted in the outlet side of the front header.

Optional Relief Valve

This water heater is normally supplied with a temperature and pressure relief valve(s) sized in accordance with applicable codes. Units may be supplied with an optional pressure only relief valve(s). When a water heater equipped with this optional relief valve is piped to a separate storage vessel, the storage vessel must have a properly installed temperature and pressure relief valve which complies with local codes.

Thermal Expansion

A relief valve which discharges periodically may be due to thermal expansion in a closed system. A hot water supply boiler installed in a closed system, such as one with a backflow preventer or check valve installed in the cold water supply, shall be provided with means to control expansion. Contact the water supplier or local plumbing inspector on how to correct this situation. Do not plug or cap the relief valve discharge!

Cathodic Protection

Hydrogen gas, which is extremely flammable, can be produced in a hot water system that has been unused for a long period of time (generally two weeks or more). To prevent the possibility of injury under these conditions, open the kitchen sink hot water faucet for several minutes before using any electrical appliance connected to the hot water system. If hydrogen is present, there will be an unusual sound such as air escaping through the pipe as the hot water begins to flow. Do not smoke or have open flames near the faucet at this time.

Hydronic Heating Boilers and Domestic Water Heaters

CLEANING AND MAINTENANCE

Listed below are items that must be checked to ensure safe reliable operations. Verify proper operation after servicing.

⚠ CAUTION: Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.

Appliance Area

Keep appliance area clear and free from combustible materials, gasoline and other flammable vapors and liquids.

Water Circulating Pump

Inspect pump every six months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by pump manufacturer.

Burner Flames

Visually check main burner flames at each start up after long shutdown periods or at least every six months. Burner viewports are located on the right and left sides of the unit.

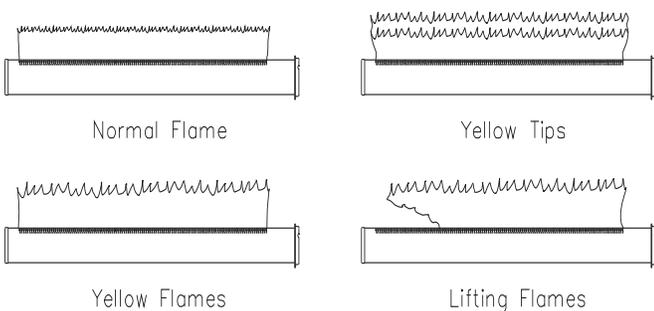


FIG. 55 Flame Pattern Illustration

Normal Flame: A normal flame is blue with slight yellow tips, has a well-defined inner cone, and displays no lifting flames.

Yellow Tips: The usual causes for yellow tips on the burner flame are burner air flow blockage or partial obstruction.

Yellow Flames: The usual causes for yellow flames are primary air flow blockage to the burner(s) or excessive gas input. Correct this condition immediately.

Lifting Flames: The usual causes for lifting flames are over firing the burner(s), excessive primary air, or high draft.

If you observe improper flame patterns, examine the venting system, ensure proper gas supply, and ensure adequate supply of combustion and ventilation air.

Flue Gas Passageways Cleaning Procedures

Any sign of soot around the outer jacket, at the burners or in the areas between the fins on the copper heat exchanger indicates a need for cleaning. The following cleaning procedures must only be performed by a qualified serviceman or installer. Proper service is required to maintain safe operation. Properly installed and adjusted units seldom need flue cleaning.

IMPORTANT: All gaskets on disassembled components must be replaced with new gaskets on reassembly. Gasket kits are available from your distributor.

Burner Removal and Cleaning

1. Turn off main power to unit.
2. Turn off main manual gas shutoff to unit.
3. Remove the front outer jacket panels.
4. Disconnect manifold from gas train using union(s) just below each gas valve(s).
5. Remove mounting screws from manifold mounting brackets. Pull the manifold/orifice assembly away from burners. Repeat for each manifold assembly.
6. Remove two mounting screws from burner and slide burner out toward front of unit. Use caution to prevent damage to burners, refractory, hot surface igniter or wiring.
7. Remove soot from burners with a stiff bristle brush. Dirt may be removed from burner ports by rinsing the burner thoroughly with water. Drain and dry burners before re-installing. Damaged burners must be replaced.

When installed in a dusty and dirty location, the burners may require cleaning on a 3 to 6 month schedule or as needed, based on severity of contamination. Contaminants can be drawn in with the combustion air. Non-combustible particulate matter such as dust, dirt, concrete dust or dry wall dust can block burner ports and cause non-warrantable failure. The standard inlet air filter will help eliminate dust and dirt from entering the unit. Use extreme care when operating a unit for temporary heat during new construction. The burners could require a thorough cleaning before the unit is placed in service.

Installation and Service Manual

Heat Exchanger Cleaning

1. While burners are removed, check the heat exchanger surface for sooting. If present, heat exchanger must be cleaned and problem corrected. Proceed as follows.
2. Remove gas manifold(s)/orifice assemblies as described in steps 1 through 5 in *Burner Removal and Cleaning*, page 56.
3. Disconnect wiring from hot surface igniter(s) and hoses from burner pressure taps.
4. Remove inner jacket panel mounting screws and slide door assembly out toward front of the unit. Use caution to prevent damage to the refractory and hot surface igniters.
5. Check “V” baffles and frame runners along front and back edges of heat exchanger. Remove and clean if necessary.
6. Remove soot from heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.
7. The heat exchanger can be removed by sliding towards the front of the unit. Once the heat exchanger is removed from the unit, a garden hose can be used to wash the tubes to ensure that all soot is removed from the heat exchanger surfaces. **Note:** Do not wet the unit’s refractory.
8. Ensure that all burner ports are cleaned to remove any soot. See *Burner Removal and Cleaning*, page 56.
9. Carefully reinstall the heat exchanger, “V” baffles, and frame runners if removed from the unit. **Note:** Make sure frame runners seal securely where they contact the front and rear compartment refractory.
10. Carefully reinstall inner jacket panels, burners, manifolds, wires and hoses. Use new gasket material to ensure a proper air seal.
11. Reassemble all gas and water piping. Test for gas leaks.
12. Reassemble outer jacket panels.
13. Cycle unit and check for proper operation.

Electrical

This unit uses a transformer to supply a low voltage control circuit. The voltage on the secondary side should be 24 to 28 VAC when measured with a volt meter. The 399,999 - 750,000 Btu/hr models have a 5 AMP circuit breaker provided on the secondary side of the transformer and the 990,000 - 2,070,000 Btu/hr models have a 7 AMP circuit breaker provided on the secondary side of the transformer. A tripped circuit breaker indicates a short in the 24VAC controls that must be corrected.

Combustion and Ventilation Air

Combustion Air Filter

This unit has a standard air filter located at the combustion air inlet. This filter helps ensure clean air is used for the combustion process. Check this filter every month and replace when it becomes dirty. The filter size on the 399,999 - 750,000 Btu/hr models is 12" x 12" x 1" (30.5cm x 30.5cm x 2.5cm) and 16" x 16" x 1" (40.6cm x 40.6cm x 2.5cm) on the 990,000 - 2,070,000 Btu/hr models. You can find these commercially available filters at any home center or HVAC supply store.

Venting System

Examine the venting system at least once a year. Check more often in the first year to determine inspection interval. Check all joints and pipe connections for tightness, corrosion or deterioration. Clean screens in the venting air intake system as required. Have the entire system, including the venting system, periodically inspected by a qualified service agency.

Air Flow

Check frequently to be sure the flow of combustion and ventilation air to the unit is not obstructed.

Combustion Air Fans

Both the 399,999 - 750,000 Btu/hr models and the 990,000 - 2,070,000 Btu/hr models use a fan-assisted combustion process. The 399,999 - 750,000 Btu/hr models have one fan and the 990,000 - 2,070,000 Btu/hr models use two fans to supply combustion air to the burners.

Fan Cleaning

Check each combustion air fan every six months. Clean fan as required when installed in a dusty or dirty location. Oiling is not required.

Combustion Air Fan Adjustment

The combustion air fans are factory pre-set and should not need adjustment in most cases. Follow the steps below to adjust the fan if a continuous Low Air status code occurs.

Note: On the 399,999 - 750,000 Btu/hr models the air shutter is adjusted on the side of the fan duct as depicted in FIG. 56. On the 990,000 - 2,070,000 Btu/hr models the air shutter is adjusted on the rear of the fan duct as depicted in FIG. 58.

1. Check for proper installation and draft in venting system. Correct as required.
2. The following pressure settings are for installations up to 2000 feet altitude. Contact the factory for high altitude air pressure settings.

Hydronic Heating Boilers and Domestic Water Heaters

CLEANING AND MAINTENANCE Continued

Adjusting Differential Air Pressure

The following is a recommended method for setting the differential air pressure (ΔP) for each fan.

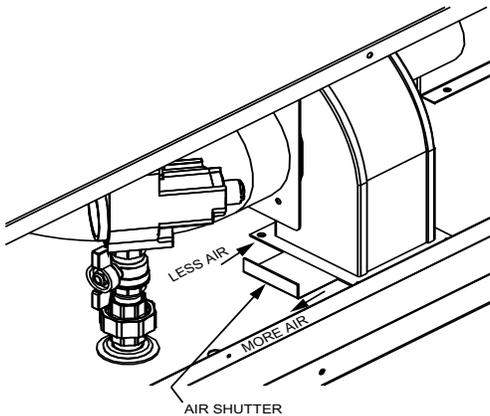


FIG. 56 Adjusting Air Shutter 399,999 - 750,000 Btu/hr Models

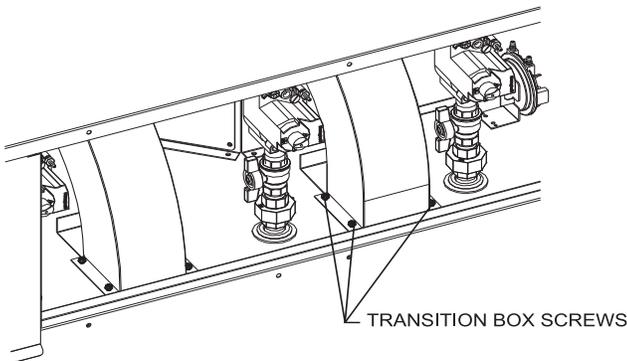


FIG. 57 Loosening Fan Transition Box Screws

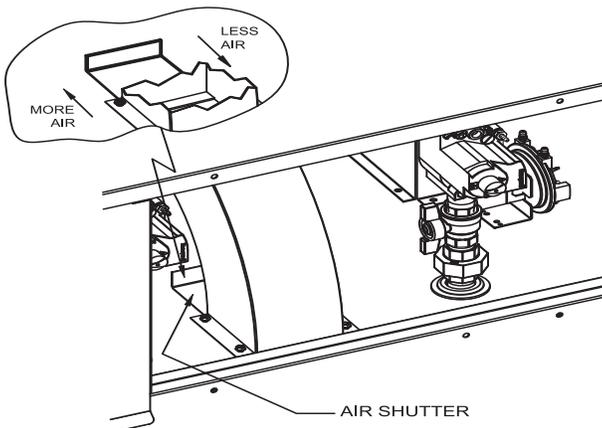


FIG. 58 Adjusting Air Shutter 990,000 - 2,070,000 Btu/hr Models

Set Up Procedure

Beside each fan duct is an air pressure switch with a large and a small tube delivering pressure from points inside the unit (see FIG. 59). The pressure in the large tube is the chamber pressure. The pressure in the small tube is the burner pressure. They act together to make the pressure switch. By disconnecting the caps from the tees in the pressure switch hoses and connecting them to either side of a manometer, you can read the differential pressure to the switch.

The “ (+) ” connection on the manometer connects to the tee in the tubing from the units front chamber and the “ (-) ” connection on the manometer connects to the tee in the small tubing from the burner.

If the air pressure switch does not make within 60 seconds from the time the fans turn ON, the ignition module will go into a soft lockout period (approximately five minutes in duration) during which time the fans are turned OFF and the module shows the **Low Air** flash code. If necessary, soft lockout can be circumvented by cycling power to the ON/OFF switch to cycle power to the unit.

Note: If the unit has been firing recently, allow the unit to cool for five minutes with the fans running before beginning the adjustment procedure.

Retain the plastic caps removed from the tees for reinstallation when complete.

Adjustment Procedure

1. Remove the upper front jacket panels from the unit to access the upper chamber.
2. Slightly loosen screws that attach fan transition box to metal base (see FIG. 57).
3. Depending on model, the air shutter(s) may be located either on the side or the rear of the fan duct. Locate the air shutter at the side/rear of the fan duct (see FIG. 56 and 58). Move the air shutter towards the rear or left side of the unit to increase air pressure. Move the air shutter towards the front or right side of the unit to decrease air pressure.
- 4a. On the 990,000 - 2,070,000 Btu/hr models adjust the air shutter on the left fan until the differential pressure is nominally 1.1 - 1.3 inches water column. **Note: The air chamber pressure is 1.2 inches water column for liquefied petroleum (L.P.) and 1.4 inches water column for natural.**
- 4b. The 399,999 - 750,000 Btu/hr models have one fan with a side mounted air shutter. The differential for these models is nominally 1.5 - 1.65 inches water column.
5. Reattach the hoses to the pressure switch and locate the air switch adjacent to the right fan and connect the tubes to either side of your manometer.

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- Adjust the air shutter on the right fan until the differential pressure is nominally 1.1-1.3 inches water column.
- Once the adjustment procedure is complete, reattach the caps to the tees in the hoses to the pressure switches and check all tubing and wire connections for snug fit. Test fire the unit. Install upper panels.
- Turn on gas supply.
- Press the module reset buttons (located on the front of the unit) to reset modules.
- If ignition system fails to operate properly, repair work must be performed by a qualified service person or installer.

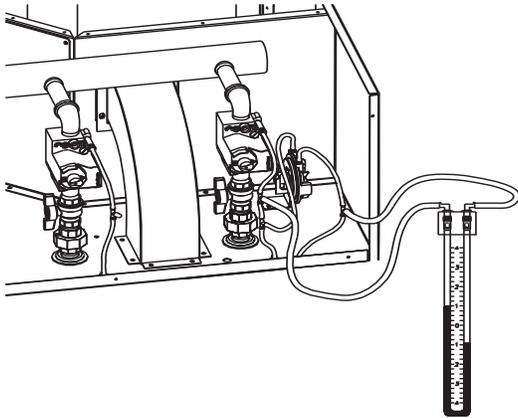


FIG. 59 Combustion Air Adjustment with a Manometer to set Differential Pressures

Servicing Hot Surface Igniter and Ignition Module

This unit uses a proven hot surface ignition control module and a hot surface igniter. The hot surface ignition module is not repairable. Any modification or repairs will invalidate the warranty.

⚠ WARNING: Do not attempt to repair a faulty hot surface igniter or ignition module. Any modification or repairs may create hazardous conditions that result in property damage, personal injury, fire, explosion and/or toxic gases.

A faulty hot surface igniter or ignition module must be replaced with an identical part. A specification igniter and ignition control module for this specific unit is available from your local distributor. Do not use general purpose field replacement ignition modules or igniters.

Ignition System Checkout

- Turn off gas supply to unit.
- Turn electric power on.
- Program each stage of the temperature control to settings above water temperature or to the highest safe setting.
- Each igniter will cycle on trial(s) for ignition.
- Each ignition module will lock out and turn the alarm light on.
- Program each stage of the temperature control to the desired temperature set points.

SEQUENCE OF OPERATION

OVERVIEW

This sequence of operation can be considered the order of events in sequential order that occur after the unit has received a call for heat. The process begins with 120VAC power entering the unit and ends with the unit going into an idle state after completion of a successful call for heat. *Note:* The following descriptions do not include remotely connected devices that may be connected to the unit. Refer to the wiring diagram for actual point to point wiring connections that show power delivery.

POWER SUPPLY

120VAC/60Hz/1PH power connects to black (line) and white (neutral) wires located within an electrical wiring box located on the left side of the unit. A green chassis grounding wire is also provided for connection to earth ground.

ON/OFF ROCKER SWITCH

The black line voltage wire runs directly to a single pole, single throw On/Off rocker switch located behind the front cover accessible by a thumb screw. Turning ON the rocker switch delivers line voltage to the low voltage transformer and ignition modules. *Note:* The On/Off switch does not provide for disconnection of power being supplied to any remotely connected devices that may be connected to the unit (i.e. pumps, louvers, power venters, etc.). As such, it may be necessary to locate and turn off power to these items before attempting to service the unit.

LOW VOLTAGE SUPPLY TRANSFORMER

A 120VAC to 24VAC transformer located within the control panel provides 24VAC/60Hz to many of the components located on the unit. One of its 24VAC outputs (blue) is connected to a circuit breaker and the other (yellow) is connected to chassis ground.

24VAC CIRCUIT BREAKER

A circuit breaker is provided for protection of the low voltage supply transformer from overloads and short circuits. The breaker is located inside the unit on the right rear of the control panel. Power from this breaker goes to the electronic temperature controller, ignition module and various other components and/or options on the unit. When tripped, all factory-installed 24VAC components will lose their 24VAC power.

Hydronic Heating Boilers and Domestic Water Heaters

SEQUENCE OF OPERATION Continued

MANUAL RESET HIGH-LIMIT THERMOSTAT

A manual reset high limit thermostat is provided as backup for the electronic adjustable temperature controller. An adjustable dial thermostat will trip and require resetting should water temperature exceed its settings. When tripped, all controls remain powered, but 24VAC is prevented from being delivered to the ignition module's thermostat input.

EMS/SEQUENCER/REMOTE AQUASTAT TERMINALS

The EMS/sequencer/remote aquastat terminals are provided for connection of the unit to an external energy management system or sequencer and are located along the top edge of the terminal strip located within the electrical wiring box. In addition to providing a means to externally stage fire the unit, these terminals also provide for remote shutdown and override by routing through dry contacts from external devices. Connection of the external dry contacts to these terminals requires the removal of one or more factory installed jumpers located on the terminal strip.

SAFETY DEVICE TERMINALS

The safety device terminals ensure that no power can be delivered to the ignition module unless factory/field-installed safety devices such as flow switches and gas pressure switches are closed. These safety device terminals are located below the EMS/Sequencer/Remote Aquastat terminals located within the electrical wiring box.

Two types of connections are offered: Continuous terminals provide for connection of safety devices that are desired to be constantly monitored. Intermittent terminals are provided for devices that are only monitored during a "call for heat" cycle. Connection to either of these terminals requires the removal of a factory-installed jumper located on the terminal strip.

ELECTRONIC TEMPERATURE CONTROLLER

(Operator) A multiple stage electronic temperature controller is provided on the unit and it serves to maintain a user selectable temperature set point. In addition to maintaining a set point, it can provide for various desired modes of operation. Ultimately, the temperature controller delivers 24VAC to the ignition module and pressure switch when it senses heat mode is desired.

IGNITION MODULE

(Controlled by Electronic Temperature Controller)

Upon sensing the 24VAC delivered to the ignition module by the electronic controller, the ignition modules check for a shorted

pressure switch and then, provided the air switch isn't shorted, supplies 120VAC to its blower output relay and waits for a pressure switch signal.

TWO SPEED BLOWER(S)

(Controlled by Ignition Module and Relay Board)

Two-speed blower(s) serve to provide combustion air to the unit. The blower is provided with a high and low speed tap. Depending upon the number of stages in operation, a blower's speed may increase or decrease accordingly. Stage 2 will increase the blower's speed to high.

PRESSURE SWITCH

(Activated by Blower Turning On)

One pressure switch is provided per blower to monitor its on/off operation. Upon a call for heat, 24VAC is delivered to the pressure switch. If the blower being monitored generates adequate air pressure, the pressure switch closes to deliver 24VAC to their respective ignition module's pressure switch monitoring input terminal.

PREPURGE

(Ignition Module Function)

Once an ignition module sees a 24VAC input from its pressure switch, it runs the blowers for approximately 15 seconds in order to purge the combustion chamber of any unburned fuel/air mixture.

TRIAL FOR IGNITION

(Ignition Module Function)

Once an ignition module has completed its prepurge period, it turns on a hot surface igniter. Once the hot surface igniter's current draw reaches a proper level, the ignition module begins a trial for ignition period of approximately 25 seconds to allow time for the igniter to reach the ignition temperature necessary to ignite the fuel/air mixture.

IGNITER

(Controlled by Ignition Module)

One igniter per ignition module is provided in order to ignite the fuel/air mixture and its on/off operation is controlled by the ignition module.

RELAYS

(Controlled by Electronic Temperature Controller and Ignition Module)

A relay is provided to switch each blower from low to high speed and to deliver power from the primary stages to the secondary stages depending upon the electronic thermostat's settings. The relay also serves to override the pressure switch proving function of the second ignition control (if equipped) to activate during a call for heat because both blowers run whenever any or all stages

Installation and Service Manual

are energized. This does not interfere with the safety functionality of either pressure switch or the ignition modules.

IGNITION

(Ignition Module Function)

Once the trial for ignition period has been completed, the ignition module sends 24VAC to the gas valves on one or the other of the primary stages. Gas valves should open and allow gas to flow to the burners in the stages being energized. The fuel/air mixture should ignite from the hot surface igniter. Once this voltage has been sent to the valves, the hot surface igniter is turned off. The ignition module then monitors the status of the flame and will either allow ignition to continue or shut down the gas valves should flame not be proven and proceed to a Flame Failure condition. If flame was proven briefly during the ignition period, the module may not proceed to Flame Failure, but rather post-purge and then go into another trial for ignition.

HEAT TRANSFER PROCESS

(Gas Valves, Burner and Heat Exchanger)

Once flame has been proven, the ignition module will hold the gas valves open as long as there is proof of flame and a call for heat is present. Depending upon the number of stages being called upon by the electronic thermostat controller, more or less B.T.U.'s are delivered to the water within the heat exchanger. Once the temperature rise is sufficient to allow stages to be turned off, the electronic thermostat will begin to shut down stages in preprogrammed order to prevent the set point from being exceeded. When the temperature of the water reaches that of the highest programmed set point, all stages will be shut down.

POST-PURGE

(Ignition Module Function) When 24VAC is removed from the ignition module's thermostat input, the module turns off the gas valves and maintains the blowers for approximately 25 seconds in order to allow the combustion chamber to be purged of all combustion by-products.

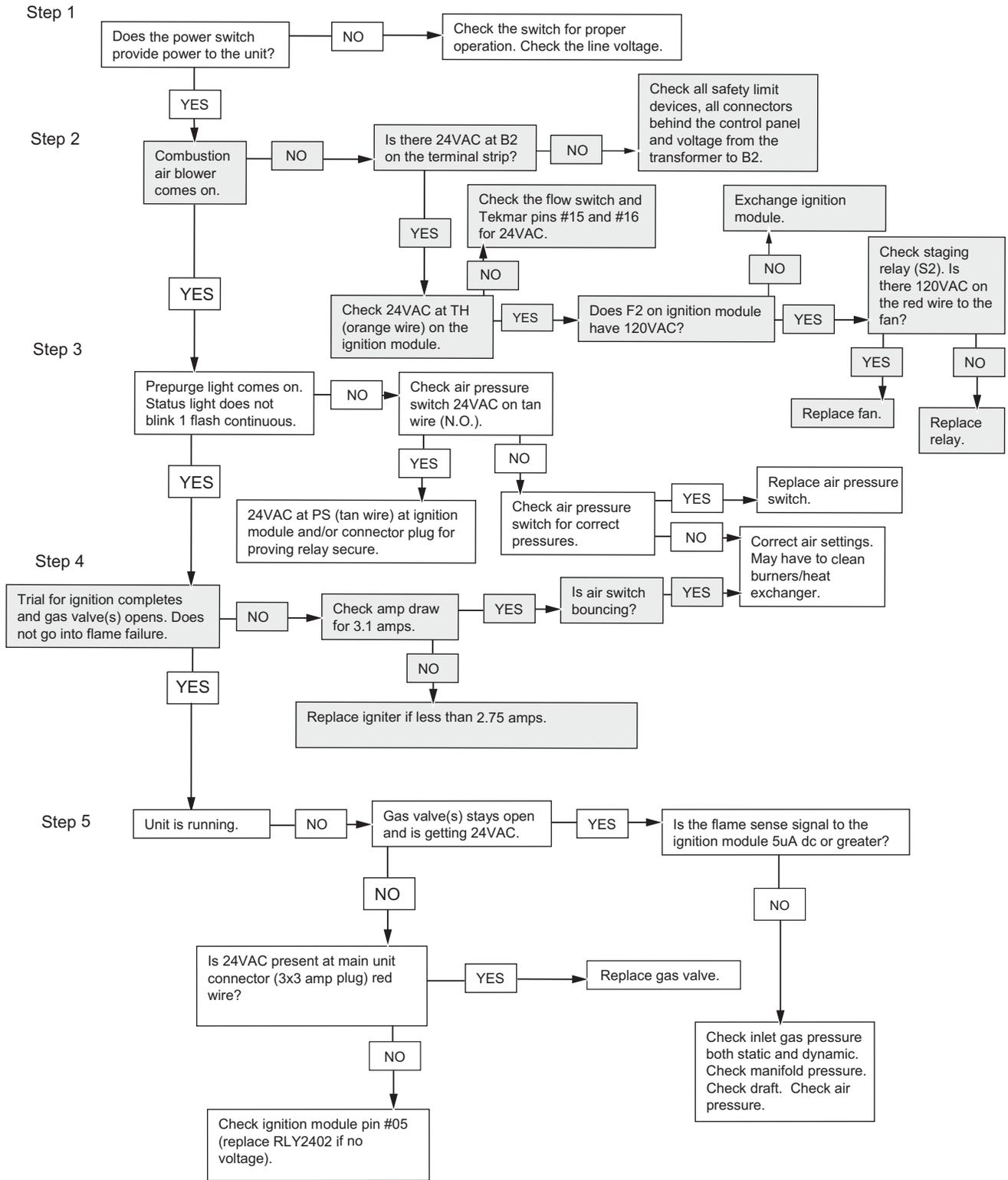
IDLE

(Electronic Thermostat Function)

After completion of the post-purge cycle, the unit will go into an idle state whereby the electronic thermostat continuously monitors the water temperature until the water temperature drops to levels that require additional heat.

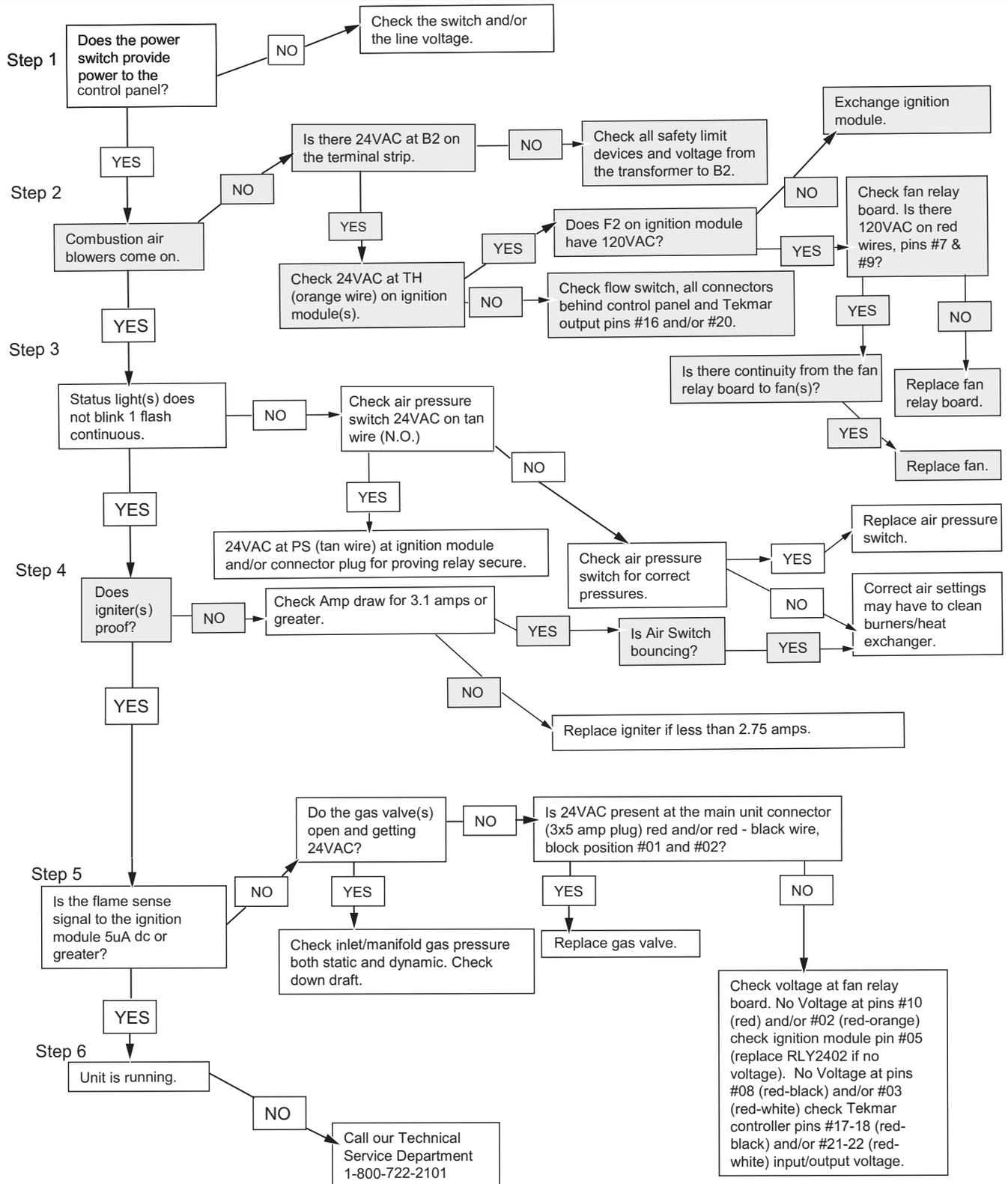
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TROUBLESHOOTING GUIDE 399,999 - 750,000 Btu/hr Models



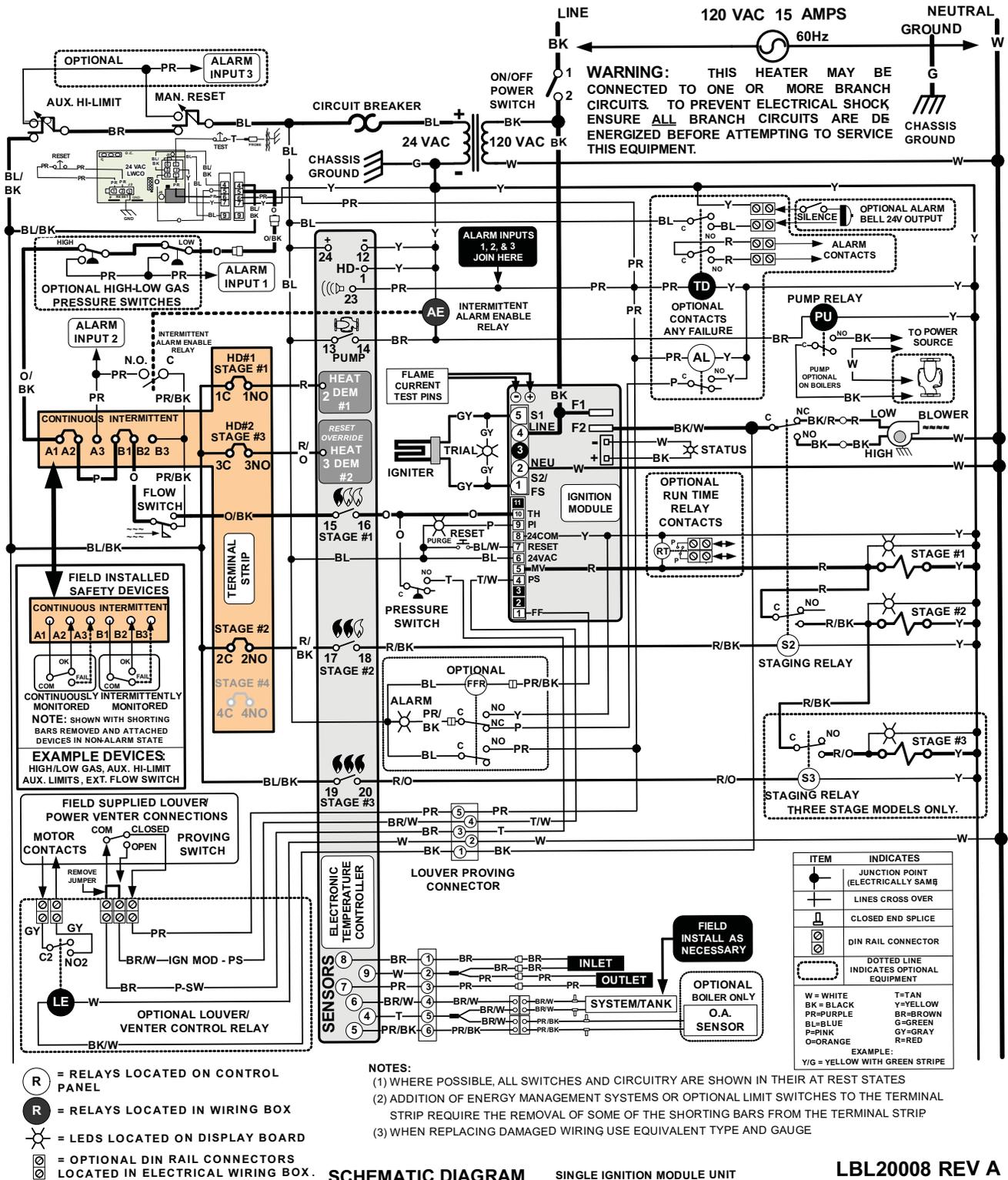
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TROUBLESHOOTING GUIDE 990,000 - 2,070,000 Btu/hr Models



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LADDER DIAGRAM 399,999 - 750,000 BTU/HR MODELS



SCHEMATIC DIAGRAM

SINGLE IGNITION MODULE UNIT

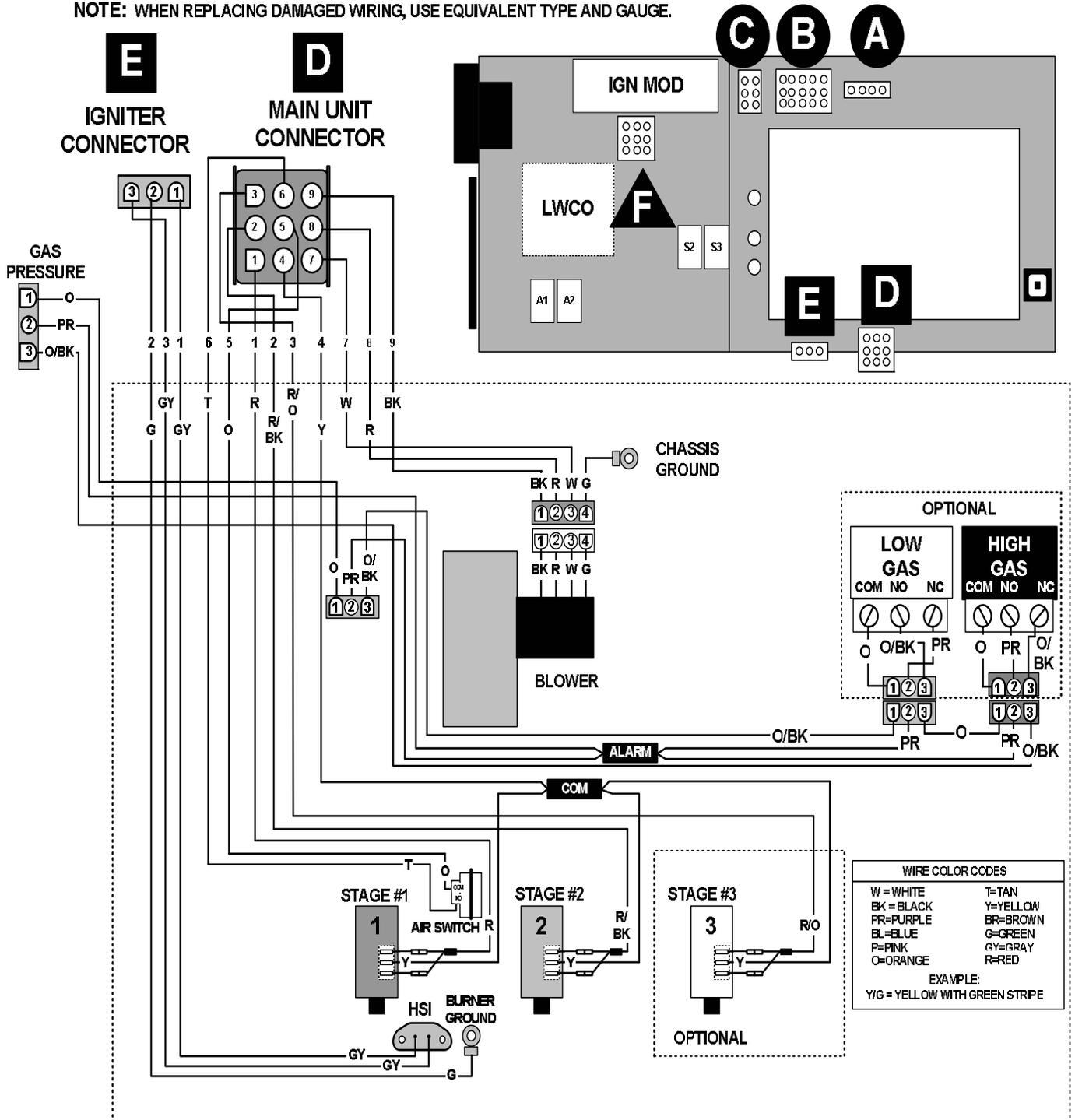
LBL20008 REV A

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WIRING BOX CONNECTIONS - WIRING DIAGRAM B (CONTINUED) 399,999 - 750,000 BTU/HR MODELS

MAIN UNIT CONNECTIONS

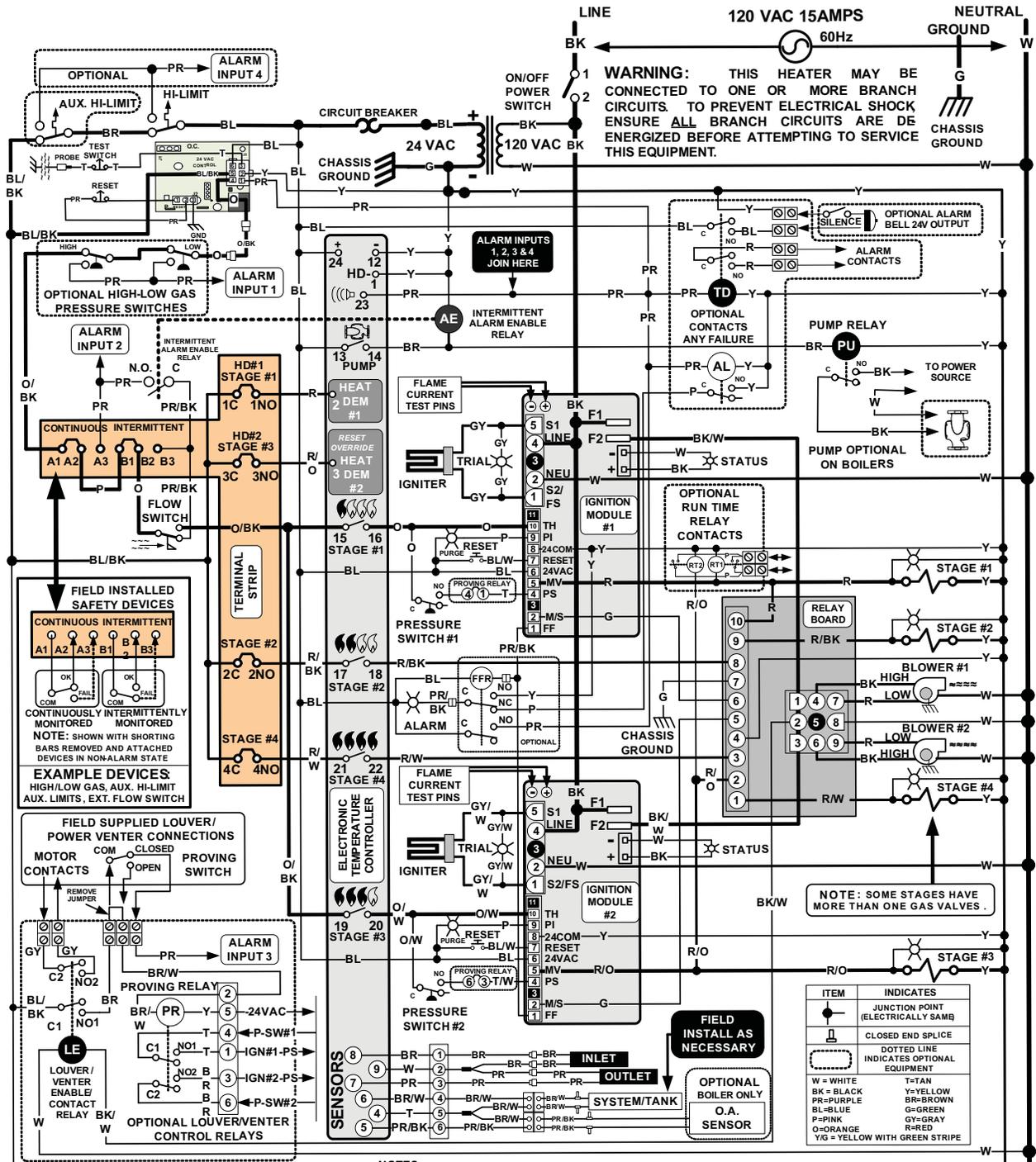
NOTE: WHEN REPLACING DAMAGED WIRING, USE EQUIVALENT TYPE AND GAUGE.



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Hydronic Heating Boilers and Domestic Water Heaters

LADDER DIAGRAM 990,000 - 2,070,000 BTU/HR MODELS



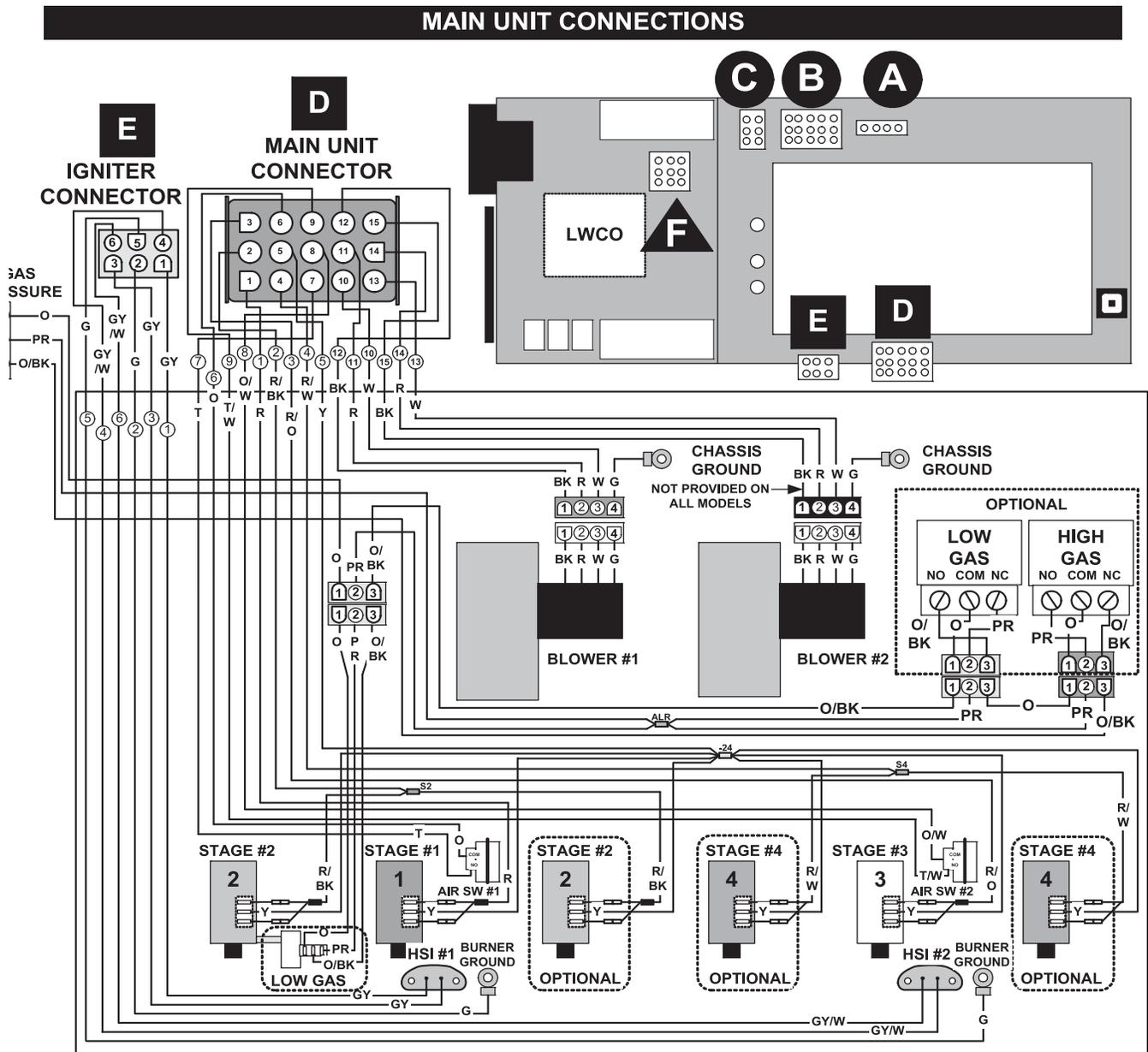
NOTES:

- (1) WHERE POSSIBLE, ALL SWITCHES AND CIRCUITRY ARE SHOWN IN THEIR AT REST STATES
- (2) ADDITION OF ENERGY MANAGEMENT SYSTEMS OR OPTIONAL LIMIT SWITCHES TO THE TERMINAL STRIP REQUIRE THE REMOVAL OF SOME OF THE SHORTING BARS FROM THE TERMINAL STRIP
- (3) SCHEMATIC IS WIRING DIAGRAM REFER TO ACTUAL COMPONENTS FOR EXACT TERMINAL LOCATIONS
- (4) WHEN REPLACING DAMAGED WIRING USE EQUIVALENT TYPE AND GAUGE

LBL2012 REV A

Installation and Service Manual

DIAGRAM B CONNECTIONS 990,000 - 2,070,000 BTU/HR MODELS (CONTINUED)



LBL2183 Rev-

Revision 6 (CF-CH(E)-i&s-06) reflects changes made to text on Page 33 and the LBLs on pages 64-65, 68-69.

Revision 7 (ECO C02822) reflects moving FIG. 22A (page 20) to page 23 and adding Aire-Lock to the title.

Revision 8 (ECO #C02870) reflects the addition of a mixing valve to FIG. 54 (page 53) and edits made to the scald warnings.