

INSTALLATION AND SERVICE MANUAL



Hot Water Heating Boiler Hot Water Supply Boiler 100,000 through 300,000 Btu/hr Models



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

WARRANTY

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

Experience has shown that improper installation or system design, rather than faulty equipment, is the cause of 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 manufacturer's warranty. (See Water Treatment and Water Chemistry)
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 manufacturer's warranty (See Boiler Flow Rates and Temperature Rise for flow requirements).

SPECIAL INSTRUCTIONS TO OWNER

NOTE:

Retain this manual for future reference.

This manual supplies information for the installation, operation and servicing of the appliance. It is strongly recommended that this manual be reviewed completely before proceeding with an installation.

WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Refer to this manual for assistance or additional information, consult a qualified installer, service agency or the gas supplier. This unit contains material that have been identified as carcinogenic, or possibly carcinogenic to humans.

CHECKING EQUIPMENT

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 carrier.

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

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.

CONTENTS

Warranty	1
Safety Warnings	1
Codes	2
Location	2
Clearances	3
Combustion/Ventilation Air Requirements	3
Venting - General	5
Conventional Venting	7
E+Venting	9
Direct Vent Sidewall	13
Direct Vent Vertical	17
Gas Supply	21
Gas Pressures & Piping	21
Manifold Pressure Adjustment	24
Supply Pressure Measurement	25
Water Connections	26
Relief Valve	26
Flow Switch	26
Gas Valve	26
Electrical Requirements	27
Temperature Adjustment	27
Temperature Limit Control	27
Lighting Instructions	28
Hot Surface Ignition Control	29
Operation & Diagnostic Lights	29
Ignition & Control Timings	29
Freeze Protection	30
Maintenance	30
Flame Patterns	31
Combustion Air Adjustments	31
Burner Cleaning	32
Heat Exchanger Inspection	33
Lubrication	33
Gas Train	33
Heating Boiler	33
Typical Piping	33
Pump Requirements	34
Temperature Rise Chart	34
Pressure Drop Curve	34
Boiler Pump Operation	35
Bypass Requirements	35
Low Temperature Systems	36
Boiler Flow Rates	36
Placing Boiler in Operation	37
Boiler Temperature Control	38
Remote Thermostat Connection	39
Domestic Hot Water Supply Boiler	39
Pump Delay	39
Water Velocity Control	40
Temperature Rise	41
Water Chemistry	41
Piping Requirements	41
Pump Requirements	42
Thermostat Adjustment	42
Relief Valve	43
Troubleshooting Charts	44

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 appliance.

WARNING

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

1. Always keep the area around your boiler free of combustible materials, gasoline, and other flammable liquids and vapors.
2. 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.

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. Where required by the authority having jurisdiction in Canada, the installation must comply with the CSA International CAN/CGA-B149 Installation Code and/or local codes.

This appliance 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.

INSTALLATION PROCEDURE

LOCATION OF UNIT

1. Locate the unit so that if water connections should leak, water damage will not occur. When such locations cannot be avoided, it is recommended that a suitable drain pan, adequately drained, be installed under the

unit. The pan must not restrict combustion air flow. Under no circumstances is the manufacturer to be held responsible for water damage in connection with this unit, or any of its components.

2. The appliance must be installed indoors where it is protected from exposure to wind, rain and weather.
3. The unit must be installed so that the ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service (circulator replacement, control replacement, etc.).
4. Units located in a residential garage shall be installed so that all burners and burner ignition devices have a minimum clearance of 18" (46 cm) above the floor. The unit shall be located or protected so that it is not subject to physical damage by a moving vehicle.
5. The appliance must be installed on a level floor. A combustible wood floor may be used without additional bases or special floor buildup. Maintain required clearances from combustible surfaces.
6. The appliance must not be installed on carpet or other combustible material other than wood flooring.

CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

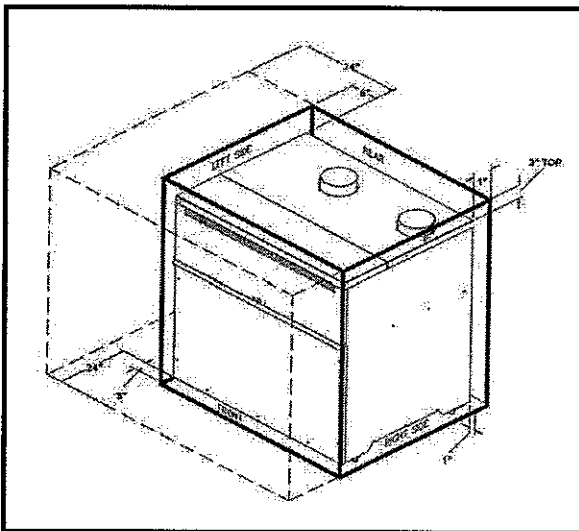


FIG. 1 Installation Clearances Drawing

Clearances from Combustible Construction:

- Right Side - 1" (25.4 mm)
- Rear - 1" (25.4 mm)
- Left Side - 6" (15 cm) (24" (61 cm) suggested for service)
- Front - 3" (76.2 mm) (24" (61 cm) suggested for service) suitable for closet installation
- Top - 3" (76.2 mm)

Allow sufficient space for servicing pipe connections, pump and other auxiliary equipment, as well as the appliance.

COMBUSTION AND VENTILATION AIR REQUIREMENTS FOR CONVENTIONALLY VENTED APPLIANCES

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 CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of the local building codes.

The equipment room **MUST** be provided with properly sized openings to assure adequate combustion air and proper ventilation when the unit is installed with conventional venting.

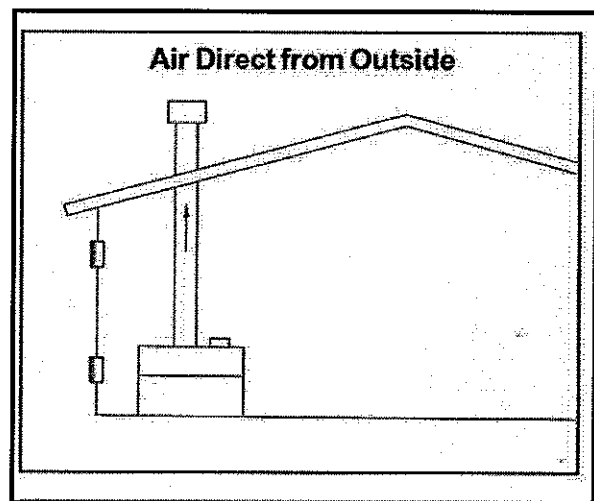


FIG. 2 Air Direct from Outside

1. If air is taken directly from outside the building with no duct, provide two permanent openings:
 - a. Combustion air opening, with a minimum free area of one square inch per 4000 Btu/hr input. This opening must be located within 12" (30 cm) of the top of the enclosure.
 - b. Ventilation air opening, with a minimum free area of one square inch per 4000 Btu/hr input. This opening must be located within 12" (30 cm) of the bottom of the enclosure.

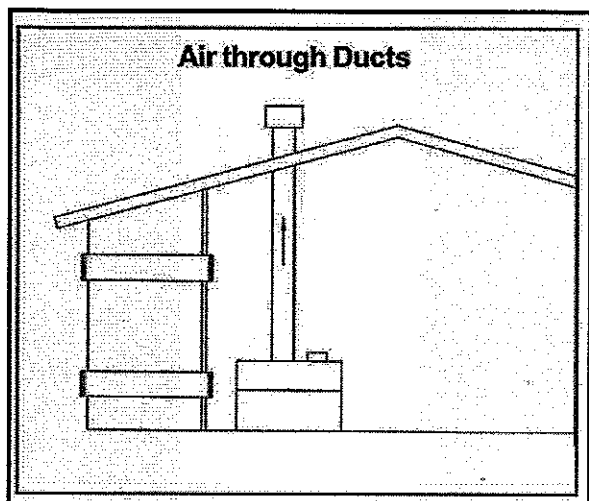


FIG. 3 Air through Ducts

2. If combustion and ventilation air is taken from the outdoors using a duct to deliver the air to the mechanical room, each of the two openings should be sized based on a minimum free area of one square inch per 2000 Btu/hr.

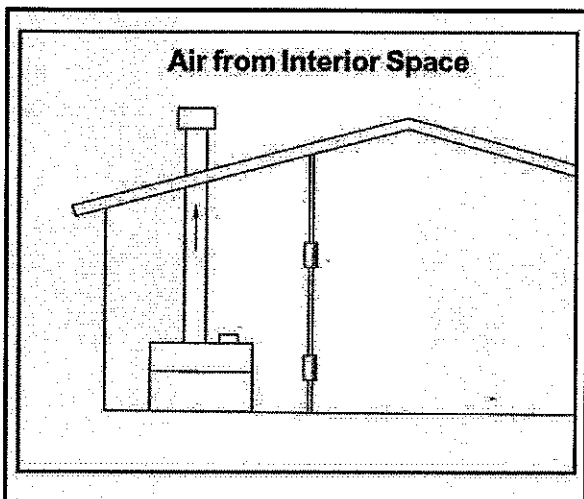


FIG. 4 Air from an Interior Space

3. If air is taken from another interior space, each of the two openings specified above should have a net free area of one square inch for each 1000 Btu/hr of input.

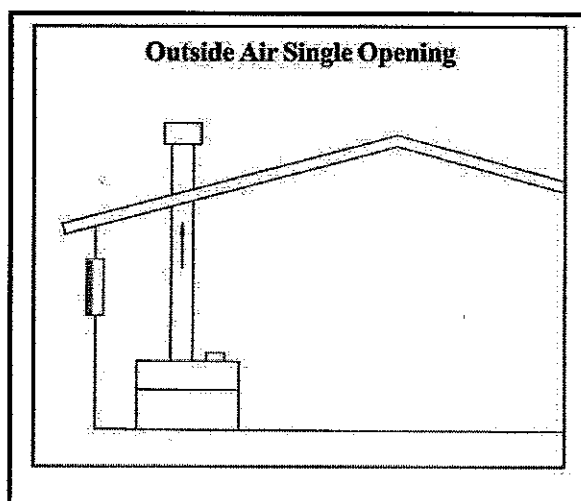


FIG. 5 Air from Outside - Single Opening

4. If a single combustion air opening is provided to bring combustion air in directly from the outdoors, the opening must be sized based on a minimum free area of one square inch per 3000 Btu/hr. This opening must be located within 12" (30 cm) of the top of the enclosure.
5. See venting section for combustion air requirements on E+Venting and direct vent applications.

**TABLE - A
MINIMUM RECOMMENDED
COMBUSTION AIR SUPPLY TO
EQUIPMENT ROOM**

Boiler Input	Outside Air* 2 Openings	Outside Air* 1 Opening	Inside Air 2 Openings
100,000	25 in ²	33 in ²	100 in ²
150,000	38 in ²	50 in ²	150 in ²
199,999	50 in ²	67 in ²	200 in ²
250,000	63 in ²	83 in ²	250 in ²
300,000	75 in ²	100 in ²	300 in 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 opening must have twice (2 times) the free area required for each Outside Air Openings. The above requirements are for the boiler only, additional gas fired appliances in the boiler room will require an increase in the net free area to supply adequate combustion air for all appliances. Combustion air requirements are based Section 5.3, Air for Combustion and Ventilation, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada refer to CSA International CAN/CGA B149 Installation Code for Gas Burning Appliances and Equipment. Check all local code requirements for combustion air.

All dimensions 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 net free area as specified in Table A. Single openings shall commence within 12" (30 cm) of the ceiling.

CAUTION

Under no circumstances should the equipment 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 rob air from the unit.

The combustion air supply must be completely free of any chemical fumes which may be corrosive to the boiler. Common chemical fumes which must be avoided are fluorocarbons and other halogenated compounds, most commonly present as refrigerants or solvents, such as Freon, trichlorethylene, perchlorethylene, chlorine, etc. These chemicals, when burned form acids which quickly attack the boiler tubes, tube sheets, flue collectors, and the boiler stack. The result is improper combustion and a non-warrantable, premature boiler failure.

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.

E+Vent and Direct Vent venting systems have specific requirements for combustion air ducts from the outside which are directly connected to the boiler. See the requirements for this combustion air duct in the venting section for each specialized vent system.

VENTING

General

Vent installations for connection to gas vents or chimneys must be in accordance with Part 7, "Venting of Equipment," 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.

Conventionally vented applications where outside air is used must have adequate combustion and ventilation air supplied to the mechanical room in accordance with 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.

The distance of the vent terminal from adjacent buildings, windows that open and building openings **MUST** comply with 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.

Vent connection is made directly to the top of the unit. No additional draft diverter is required. The connection from the appliance vent to the stack must be made as direct as possible.

The negative draft in conventional vent installations must be within the range of a negative 0.02 to 0.05 inches water to ensure proper operation. All draft readings are made while unit is in stable operation (approximately 2 to 5 minutes).

Locate units as close as possible to chimney or gas vent.

See the vent material requirements for each of the specific venting options. Conventional venting systems use Type "B" double wall vent material. Direct vent systems have specific vent kits and material requirements noted for each application.

Any vent materials not provided or specified must be listed by a nationally recognized test agency for use as vent material.

Avoid long horizontal runs of the vent pipe, 90° elbows, reductions and restrictions. Horizontal portions of the venting system shall be supported to prevent sagging. Horizontal runs must slope upwards not less than 1/4 inch per foot (21 mm per meter) from the appliance to the vent terminal. Follow manufacturers instructions.

The weight of the venting system must not rest on the unit. Adequate support of the venting system must be provided in compliance with local codes and other applicable codes. All connections should be secured with rustproof sheet metal screws.

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 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 weights on damper to ensure that draft is maintained within the specified range.

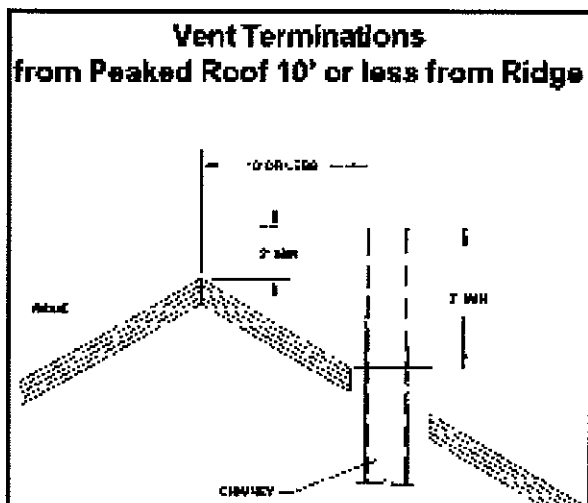


FIG. 6 Vent Termination from a Peaked roof 10' or less from Ridge

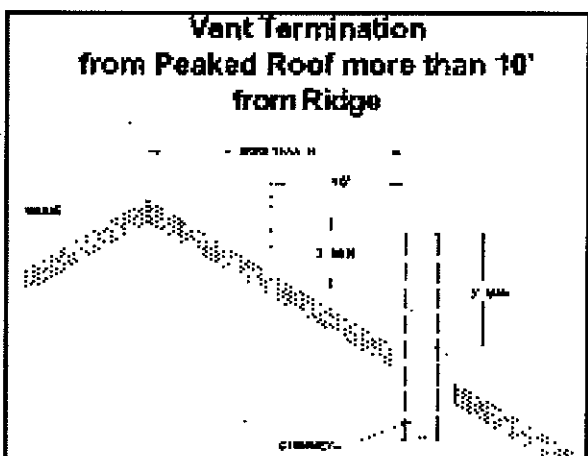


FIG. 7 Vent Termination from a Peaked roof more than 10' from Ridge

The vertical vent terminal should exhaust outside the building at least 2 feet (61 cm) above the highest point of the roof within a 10 foot (3.05 m) radius of the termination.

The vertical termination must be a minimum of 3 feet (91 cm) above the point of exit.

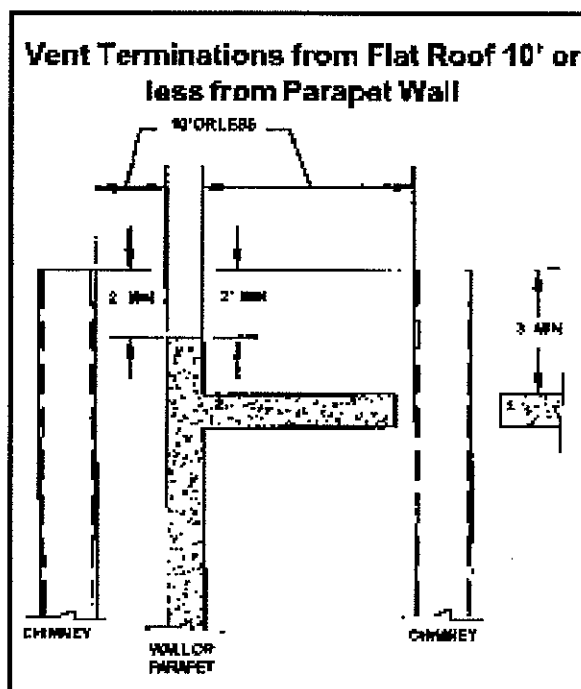


FIG. 8 Vent Termination from a Flat Roof 10' or less from Parapet Wall

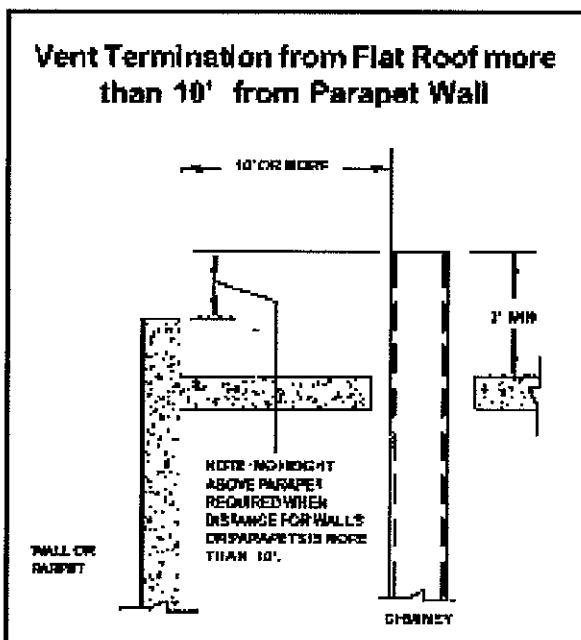


FIG. 9 Vent Termination from a Flat Roof more than 10' from Parapet Wall

A vertical termination less than 10 feet (3.05 m) from a parapet wall must be a minimum of 2 feet (61 cm) higher than the parapet wall.

The vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below,

unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

Do not terminate the vent in a window well, stairwell, alcove, courtyard or other recessed area. **The vent can not terminate below grade.**

Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney.

To avoid a blocked flue condition, keep the vent cap clear of snow, ice, leaves, debris, etc.

Flue gases will form a white plume in winter. Plume could obstruct window view.

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

IMPORTANT:

Examine the venting system at least once a year. Check all joints and vent pipe connections for tightness. Also check for corrosion or deterioration. Immediately correct any problems observed in the venting system.

VENT SYSTEM OPTIONS

This boiler has four venting options. They are:

1. Conventional negative draft venting with vertical termination.
2. E+Vent with a vertical conventional vent for flue products and a combustion air pipe from either the sidewall or roof top.
3. Direct vent with sidewall terminations for flue products and combustion air and
4. Direct vent with vertical through-roof terminations for flue products and combustion air.

All boilers are shipped from the factory equipped for conventional negative draft venting. The optional direct vent systems and E+Vent with conventional vent and a separate combustion air pipe require 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.

E+ Conventional Venting

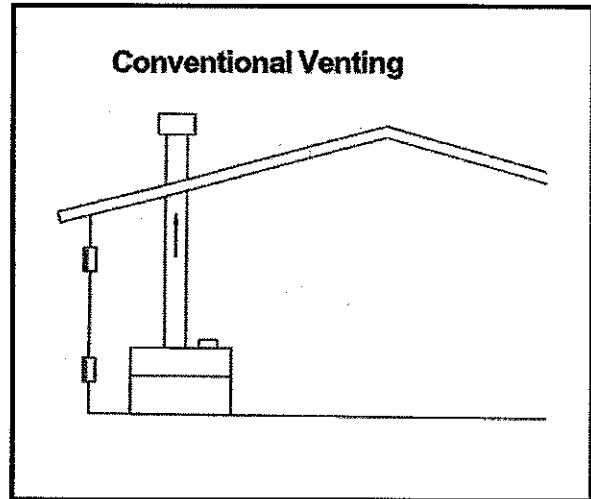


FIG. 10 Conventional Venting Installation

A CONVENTIONAL NEGATIVE DRAFT VENTING SYSTEM

Follow all requirements in the General Venting section for venting flue products to the outdoors, obtaining adequate combustion and ventilation air and general installation instructions. All conventionally vented boilers must have combustion and ventilation air supplied to the mechanical room 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.

A bell increaser is installed directly on the boiler vent outlet. The bell increaser increases the boiler vent size by 1 inch (25.4 mm) in diameter. The bell increaser **MUST** be installed on the boiler vent outlet for all conventional negative draft vent systems. Vent connection is made directly to the bell increaser on 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 within the specified range of a negative 0.02 to 0.05 inches water. Multiple unit installations with combined venting or common venting with other negative draft appliances require that each boiler must have a barometric damper installed to regulate draft within the proper range. If the draft in a dedicated stack for a single unit installation exceeds the specified draft, a barometric damper must be installed to control draft.

A dust shield is installed over the combustion air inlet on the unit to help limit the entry of airborne dust or dirt to the combustion chamber and fan. **DO NOT** remove the dust shield.

The flue pipe sizes are:

TABLE - B
CONVENTIONAL VENT FLUE SIZE

Input Btu/hr	Flue Size*
100,000	4"
150,000	5"
199,999	5"
250,000	6"
300,000	6"

*Vent size with 1" bell increaser installed for conventional negative draft venting

On a conventionally vented, negative draft unit, the connection from the vent to the stack or vent termination outside the building **MUST** be made with listed Type "B" double wall (or equivalent) vent connectors and must be 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. The Type "B" vent and accessories, such as firestop spacers, thimbles, caps, etc., **MUST** be installed in accordance with the manufacturers listing. The vent connector and firestop must provide correct spacing to combustible surfaces and seal to the vent connector on the upper and lower sides of each floor or ceiling through which the vent connector passes.

Locate units as close as possible to chimney or gas vent.

Horizontal runs must slope upwards not less than 1/4 inch per foot (21 mm per meter) from the appliance to the vent terminal. Follow manufacturers instructions.

Vent connectors serving appliances vented by natural draft shall not be connected to any portion of a mechanical draft system operating under positive pressure. Connection to a positive pressure stack may cause flue products to be discharged into the living space causing serious health injury.

Any vent materials not provided or specified must be listed by a nationally recognized test agency for use as vent material.

The vent terminal should be vertical and exhaust outside the building at least 2 feet (61 cm) above the highest point of the roof within a 10 foot (3.05 m) radius of the termination.

The vertical termination must be a minimum of 3 feet (91 cm) above the point of exit.

A vertical termination less than 10 feet (3.05 m) from a parapet wall must be a minimum of 2 feet (61 cm) higher than the parapet wall.

The vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below, unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

MASONRY CHIMNEY INSTALLATIONS **(Conventional Venting Only)**

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 the masonry flue/tile, insufficient draft and possible spillage of flue products into an occupied living space. Carefully inspect all chimney systems before installation. If there is any doubt about the sizing or condition of a masonry chimney, it must be relined with a properly sized and approved chimney 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. **An unlined masonry chimney must not be used** to vent flue products from this high efficiency appliance. 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.

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 and determine there is no blockage or restriction, leakage, corrosion and other unsafe condition.
3. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. 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. Close fire place dampers.
4. Place in operation, the appliance being inspected. Follow the lighting instructions. Adjust thermostat so appliance will operate continuously.
5. 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.
6. After it has been determined 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 there previous conditions of use.
7. Any improper operation of the common venting system should be corrected 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 Standard B149 Installation Code for Gas Burning Appliances and Equipment. When resizing any portion of the common venting system, the common venting system should be resized to approach the minimum size as determined using the appropriate tables in Appendix G 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.

A CONVENTIONAL VERTICAL NEGATIVE DRAFT VENTING SYSTEM WITH COMBUSTION AIR PROVIDED FROM A SIDEWALL OR ROOF TOP INLET CAP

Follow all requirements in the General Venting section and Conventional Negative Draft Venting for venting flue products to the outdoors and general installation instructions.

This vent system uses two pipes, one vertical pipe with a roof top termination for the flue products and one pipe for combustion air. The combustion air pipe may terminate horizontally with a sidewall air inlet or vertically with a roof top air inlet. A bell increaser is installed directly on the boiler vent outlet. This bell increases the boiler vent size by 1" (25.4 mm) in diameter. The bell increaser **MUST** be installed on the boiler vent outlet for all conventional negative draft vent systems. Vent connection is made directly to the bell increaser on 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 0.02 to 0.05 inches water. The flue may be combined with the vent from any other negative draft, Category I appliances. Multiple unit installations common vented with other negative draft appliances require that each boiler must have a barometric damper installed to regulate draft within the proper range. The common vent and connectors from multiple boilers must be sized per the requirements of the venting tables for type "B" double wall vents in the latest edition of the National Fuel Gas Code, ANSI Z223.1.

The sidewall or vertical roof top E+Vent 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 dust shield, installed over the air inlet connection on the boiler must be removed. The dust shield is **NOT USED** with the sidewall or vertical roof top E+Vent system. In most installations, the combustion air inlet pipe will be a dedicated system with one air inlet pipe per boiler. Multiple air inlets may be combined if the guidelines in "Combined Air Inlet Points" are followed. The air inlet pipe will be connected to a combustion air inlet cap as specified in this section.

Combustion air supplied from outdoors must be free of contaminants (See Combustion and Ventilation Air).

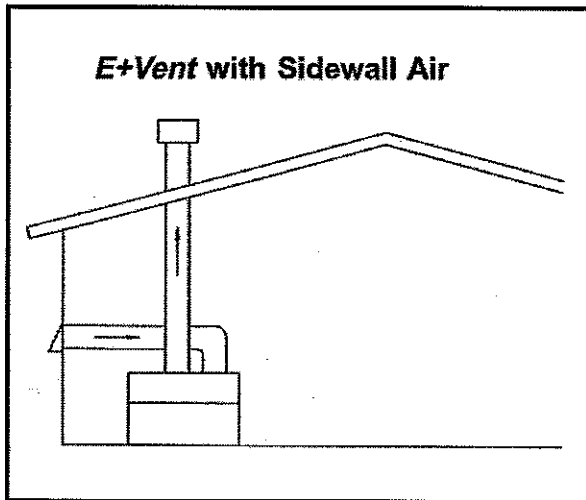


FIG. 11 E+Vent with Sidewall Air

Sidewall Air Inlet

The sidewall air inlet cap is supplied in the E+Sidewall Vent Kit which should be ordered from the manufacturer. This sidewall cap will supply combustion air for a single unit only.

Locate units as close as possible to sidewall where the combustion air supply system will be installed.

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 instructions in this manual.

The combustion air inlet cap must be installed at least one foot (30 cm) above ground level and above normal snow levels.

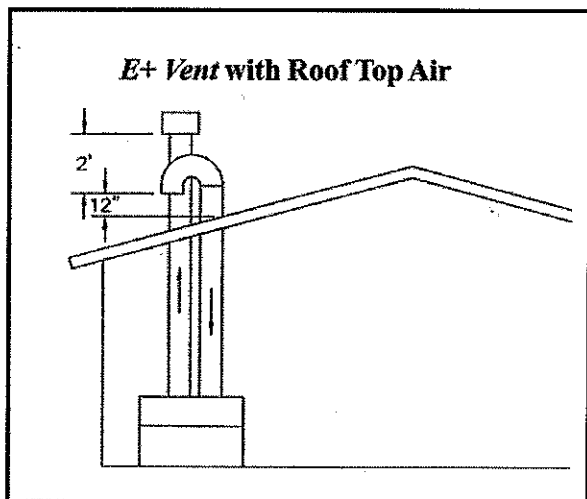


FIG. 12 E+Vent with Roof Top Air

Vertical Roof Top Air Inlet

The air inlet cap for the vertical roof top air inlet is assembled from components purchased locally. The air inlet cap consist of two 90° ells installed at the point of termination for the air inlet pipe. The first 90° ell is installed on the roof top at the highest vertical point of the air inlet pipe and turned horizontal, the second 90° ell is installed on the horizontal outlet of the first ell and turned down. A 90° ell and a 90° street ell may be used to make this assembly. If a straight piece of pipe is used between the two ells, it should not exceed 6" (51 mm) in length. The termination ell on the air inlet must be located a minimum of 12" (30 cm) above the roof or above normal levels of snow accumulation.

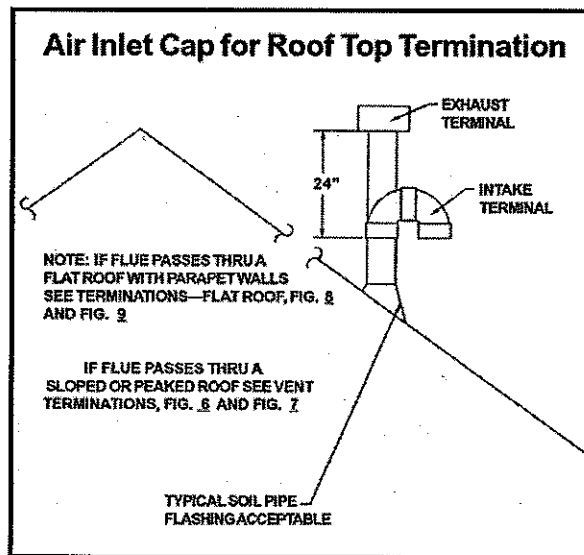


FIG. 13 Air Inlet Cap for Roof Top Termination

The point of termination for the combustion air inlet cap **MUST** be at least 2 feet (61 cm) below the point of flue gas termination (vent cap) if it is located within 10' (3.05 m) of the flue outlet. Use care to ensure that the 90° ell assembly is properly installed on the air inlet pipe.

The combustion air inlet cap must not be installed closer than 10 feet (3.05 m) from an inside corner of an L-shaped structure.

The combustion air inlet cap must be installed at least one foot (30 cm) above the roof top and above normal snow levels.

Incorrect installation and/or location of the air inlet cap can allow the discharge of flue products to be drawn into the combustion process on the heater. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the heater and possible spillage of flue products which can cause personal injury, death or property damage

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 5" air inlet pipes (19.6 in² area each) have a total area of 39.2 in² require a 8"(50.3 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 (15.25 m) equivalent feet. 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.

Air Inlet Pipe Materials

The air inlet pipe(s) must be sealed. Choose acceptable combustion air inlet pipe materials from those specified in this section.

Select air inlet pipe material from the following specified materials:

PVC, CPVC or ABS (4", 5" or 6" I.D.)*

Dryer Vent (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 requires an adapter (not provided) to transition between the air inlet and cap.

WARNING

Using other vent or air intake materials, failure to properly seal all seams and joints or failure to follow vent pipe manufacturer's instructions can result in personal injury, death or property damage. Mixing of venting materials will void the warranty and certification of the boiler.

NOTE:

The use of double wall vent material for the combustion air inlet pipe is recommended in cold climates to prevent the condensation of airborne moisture in the incoming combustion air.

Length of Air Inlet Pipe

The total equivalent length of the sidewall or vertical roof top E+Vent combustion air inlet pipe must not exceed a maximum of 50 (15.24 m) equivalent feet in length. Subtract 5 feet (1.52 m) for each elbow in the air intake system. Do not exceed limits for the combustion air inlet piping lengths.

Sealing of Type "B" double wall vent material or galvanized vent pipe material used for air inlet pipe on a sidewall or vertical roof top E+Vent Combustion Air Supply System

1. Seal all joints and seams of the air inlet pipe using either Aluminum Foil Duct Tape meeting UL Standard 723 or 181A-P or a high quality UL Listed silicon sealant such as those manufactured by Dow Corning or General Electric.
2. Do not install seams of vent pipe on the bottom of horizontal runs.
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.

The PVC, CPVC or ABS air inlet pipe should be cleaned and sealed with the pipe manufacturers recommended solvents and standard commercial pipe cement for the material used. The PVC, CPVC, ABS or Dryer Vent air inlet pipe should use a silicone sealant to ensure a proper seal at the boiler connection and the air inlet cap connection. Dryer vent should use a screw type clamp to seal the vent to the boiler and air inlet cap. Proper sealing of the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

When a sidewall or vertical roof top E+Vent combustion air supply system is disconnected for any reason, the air inlet pipe must be resealed to ensure that combustion air will be free of contaminants and supplied in proper volume.

WARNING

Failure to properly seal all joints and seams as required in the air inlet piping may result in flue gas recirculation, spillage of flue products and carbon monoxide emissions causing severe personal injury or death.

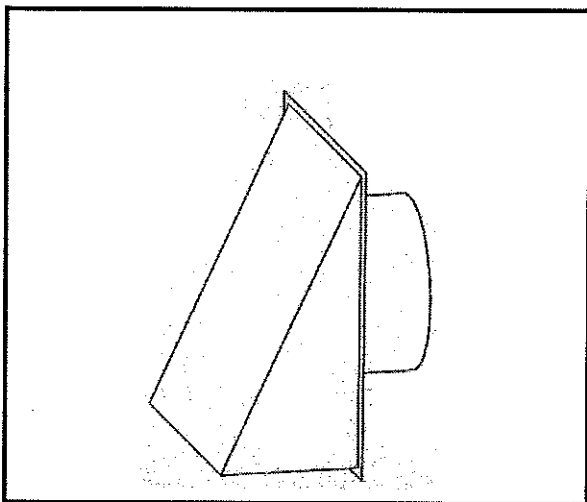


FIG. 14 Sidewall Air Inlet Cap

Vent Kits

The sidewall E+Vent Kit must be ordered from the manufacturer for single unit installations with sidewall air inlet. The part number for each kit is listed by unit size. Each kit includes a sidewall combustion air inlet cap to supply air to a single boiler and instructions for proper installation. The flue pipe, roof top vent cap and air inlet pipes are purchased locally. The air inlet cap for a vertical roof top termination is fabricated from materials purchased locally. The air inlet cap for the combined air supply from multiple boilers must be purchased locally.

TABLE - C
SIDEWALL VENT KITS

Input Btu/hr	Conventional Vent Flue Size*	Air Inlet Pipe**	Sidewall E+Vent Kit
100,000	4"	3"	SVK3025
150,000	5"	4"	SVK3020
199,999	5"	4"	SVK3020
250,000	6"	5"	SVK3021
300,000	6"	5"	SVK3021

*Vent size with 1" increaser installed for conventional negative draft venting.

**Minimum diameter, installer may increase diameter one pipe size for ease of installation if needed. A 6" diameter air inlet cap may be ordered as Sidewall E+Vent Kit SVK3022.

The sidewall air inlet cap supplied in the Sidewall E+Vent Kit is used to supply combustion air to a single boiler. The roof top vent cap for flue products should be a standard commercial cap purchased locally. The use of a sidewall air inlet cap other than the manufacturers recommended cap for single boiler installations or use of a common air inlet cap for multiple boilers with insufficient free area and/or protection from wind and weather may result in operational problems with the boiler or potentially hazardous spillage of flue products which can cause personal injury, death or property damage.

Venting of Flue Products

On a conventionally vented, negative draft unit, the connection from the vent to the stack or vent termination outside the building **MUST** be made with listed Type "B" double wall (or equivalent) vent connectors and must be direct as possible with no reduction in diameter. The bell increaser, factory installed on the flue outlet, **MUST** be used. Use the National Fuel Gas Code venting tables for double wall vent to properly size all vent connectors and stacks. The type "B" vent and accessories, such as firestop spacers, thimbles, caps, etc., **MUST** be installed in accordance with the manufacturers listing. The vent connector and firestop must provide correct spacing to combustible surfaces and seal to the vent connector on the upper and lower sides of each floor or ceiling through which the vent connector passes. The vertical flue of an E+Vent must maintain a negative draft within the specified range.

A unit installed in an application such as a restaurant or industrial installation where exhaust fans, air handlers or other mechanical equipment are creating an excessive negative pressure in the mechanical room may require that the boiler be installed with an optional direct vent system. Local codes which require the installation of a certified direct vent system must use one of the ANSI tested direct vent systems. The direct vent system uses a sealed AL29-4C stainless steel vent material and a sealed combustion air inlet pipe. See E+Vertical Direct Vent System or E+Sidewall Direct Vent System installation requirements in this manual.

The connection from the vent to the vent termination outside the building **MUST** be made with type "B" double wall vent materials and must be direct as possible with no reduction in diameter. The vent accessories, such as firestop spacers, thimbles, caps, etc., **MUST** be from the same vent material and installed in accordance with the manufacturers listing. The vent connection through the roof must provide correct spacing to combustible surfaces.

Horizontal runs must slope upwards not less than 1/4 inch per foot (21 mm per meter) from the appliance to the vent terminal. Follow manufacturers instructions.

The vent cap shall terminate at least 3 feet (91 cm) above any forced air inlet within 10 feet (3.05 m).

The vent shall terminate at least 4 feet (1.22 m) below, 4 feet (1.22 m) horizontally from or 1 foot (30 cm) above any door, window or gravity air inlet to the building.

Do not terminate the vent in a window well, stairwell, alcove, courtyard other recessed area. The vent can not terminate below grade.

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 surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below, unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

Locate units as close as possible to chimney or gas vent.

Vent connectors serving appliances vented by natural draft shall not be connected to any portion of a mechanical draft system operating under positive pressure. Connection to a positive pressure stack may cause flue products to be discharged into the living space causing serious health injury.

The Vent terminal should be vertical and exhaust outside the building at least 2 feet (61 cm) above the highest point of the roof within a 10 foot (3.05 m) radius of the termination.

The vertical termination must be a minimum of 3 feet (91 cm) above the point of exit in the rooftop.

A vertical termination less than 10 feet (3.05 m) from a parapet wall must be a minimum of 2 feet (61 cm) higher than the parapet wall.

The vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below, unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

CAUTION

Boilers which are shut down or will not operate may experience freezing due to convective air flow in the air inlet pipe connected to the unit. Proper freeze protection must be provided, see Freeze Protection.

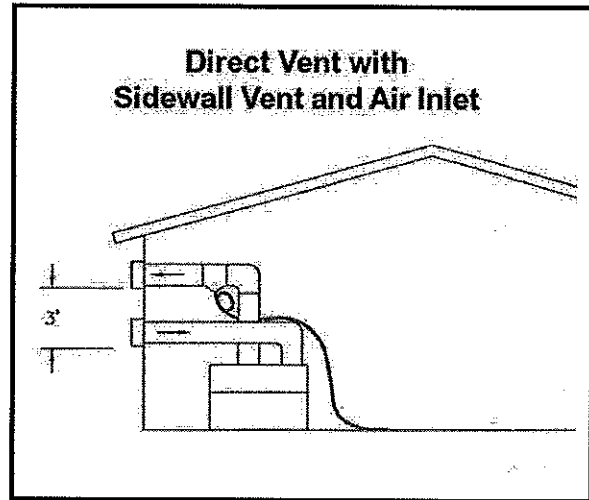


FIG. 15 E+Vent Sidewall Direct Vent System

The E+Sidewall Direct Vent System

A DIRECT VENT SYSTEM WITH SIDEWALL TERMINATIONS

Follow all requirements in the General Venting section for venting flue products to the outdoors and general installation instructions. All direct vent boilers must have combustion air supplied directly to the boiler with a separate air pipe.

The bell increaser, installed on the boiler vent outlet, must be removed. The bell increaser is **NOT USED** with the direct vent system. Vent connection is made directly to the top of the unit. No additional bell increaser, draft diverter or barometric damper is required. The direct vent system uses a two pipe system, one pipe for the flue products and one pipe for the combustion air supply. The sidewall vented flue **MUST** be a dedicated stack. The flue can **NOT** be combined with any other appliance vent or common vent from multiple boilers. The vent on a direct vent system may have a positive pressure in the flue which requires all vent joints and seams to be sealed gas-tight. The sidewall direct vent system has specific vent material and installation requirements. The flue from a direct vent system must have a condensate drain with provisions to properly collect and dispose of any condensate that may occur in the venting system. Choose acceptable vent materials from those listed below.

Sidewall Air Inlet for Direct Vent

The combustion air inlet pipe must also be a dedicated system with one air inlet pipe per boiler. The air inlet pipes from multiple boilers can **NOT** be combined to a single common connection. The air inlet pipe connects directly to the boiler to supply combustion air. The dust shield, installed over the air inlet connection on the boiler, must be removed. The dust shield is **NOT USED** with the direct vent system. The air inlet pipe must be sealed. Choose acceptable combustion air pipe materials from those specified in this section.

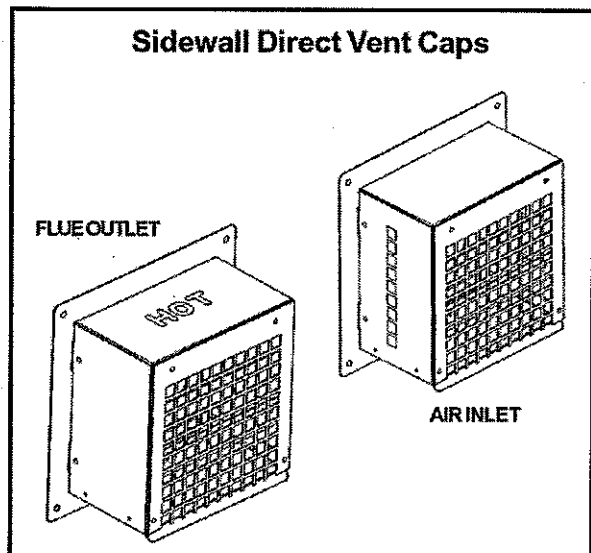


FIG 16 Sidewall Direct Vent Caps

Sidewall Direct Vent Kits

The sidewall direct vent kit must be ordered from the boiler manufacturer. The part number for each kit is listed by unit size. Each kit includes a sidewall vent cap for flue products, a firestop, a combustion air inlet cap and instructions for proper installation. The flue pipe and air inlet pipes are purchased locally.

TABLE - D
SIDEWALL DIRECT VENT KITS

Input Btu/hr	Direct Vent Flue Size*	Air Inlet Pipe*	Sidewall E+ Vent Kit
100,000	3"	3"	HDK3017
150,000	4"	4"	HDK3013
199,999	4"	4"	HDK3013
250,000	5"	5"	HDK3014
300,000	5"	5"	HDK3014

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

The sidewall vent cap and sidewall air inlet cap supplied in the Sidewall Direct Vent Kit **MUST** be used to vent the flue products to the outdoors and supply combustion air. Use of a vent cap and/or air inlet cap other than the manufacturers recommended caps may result in operational problems with the boiler or potentially hazardous spillage of flue products which can cause personal injury, death or property damage

Flue Pipe Materials

Select venting material from the following specified vent materials:

Heat-Fab Saf-T CI Vent with AL29-4C stainless steel
(Call 800-772-0739 for nearest distributor)

Z-Flex Z-Vent with AL29-4C stainless steel
(Call 1-800-654-5600 for nearest distributor)

Protech Systems Inc. Fas-N-Seal Vent with AL29-4C stainless steel (Call 1-800-766-3473 for nearest distributor)

Flex-L International, Inc. Star-34 Vent with AL29-4C stainless steel
(Call 1-800-561-1980 for nearest distributor)

Metal-Fab Corr/Guard Vent with AL29-4C stainless steel
(Call 1-800-835-2830 for nearest distributor)

or other listed AL29-4C vent systems suitable for positive pressure

Air Inlet Pipe Materials

Select air inlet pipe material from the following specified materials:

PVC, CPVC or ABS (4", 5" or 6" I.D.)*

Dryer Vent

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 requires an adapter (not provided) to transition between the air inlet and cap.

NOTE:

The use of double wall vent material for the combustion air inlet pipe is recommended in cold climates to prevent the condensation of airborne moisture in the incoming combustion air.

WARNING

Using other vent or air intake materials, failure to properly seal all seams and joints or failure to follow vent pipe manufacturer's instructions can result in personal injury, death or property damage. Mixing of venting materials will void the warranty and certification of the boiler.

Length of Flue Pipe and Air Inlet Pipe

The total equivalent length of the direct vent flue pipe or the air inlet pipe must not exceed a maximum of 50 (15.24 m) equivalent feet in length for each pipe. Subtract 5 feet (1.52 m) for each elbow in the vent pipe or air intake system. Do not exceed limits for piping lengths.

Sealing of Type "B" double wall vent material or galvanized vent pipe material used for air inlet pipe on a Direct Vent System

1. Seal all joints and seams of the air inlet pipe using either Aluminum Foil Duct Tape meeting UL Standard 723 or 181A-P or a high quality UL Listed silicon sealant such as those manufactured by Dow Corning or General Electric.
2. Do not install seams of vent pipe on the bottom of horizontal runs.
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.

The PVC, CPVC or ABS air inlet pipe should be cleaned and sealed with the pipe manufacturers recommended solvents and standard commercial pipe cement for the material used. The PVC, CPVC, ABS or Dryer Vent air inlet pipe should use a silicone sealant to ensure a proper seal at the boiler connection and the air inlet cap connection. Dryer vent should use a screw type clamp to seal the vent to the boiler and air inlet cap. Proper sealing of the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

Sealing of vent material for use with the Sidewall Direct Vent system

The vent materials, Heat-Fab Saf-T CI Vent, Z-Flex Z-Vent, Protech Systems Fas-N-Seal Vent, Flex-L Star-34 Vent, Metal-Fab Corr/Guard Vent or listed AL29-4C vent system suitable for positive pressure, must be installed and sealed per the vent manufacturers installation instructions.

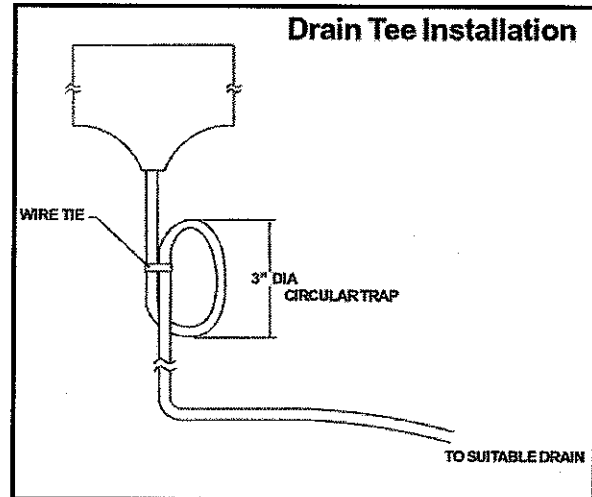


FIG. 17 Drain Tee Installation

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 the typical vent installation drawings. Plastic drain tubing, sized per the vent manufacturers instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (76 mm) 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. See "Freeze Protection" for more information.

When a direct vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturers instructions. The air inlet pipe must also be resealed to ensure that combustion air will be free of contaminants and supplied in proper volume.

DANGER

Failure to properly seal all vent joints and seams may result in flue gas spillage and carbon monoxide emissions causing severe personal injury or death.

The connection from the vent to the vent termination outside the building **MUST** be made with one of the specified vent materials and must be direct as possible with no reduction in diameter. The vent accessories not otherwise provided, such as firestop spacers, thimbles, caps, etc., **MUST** be from the same vent material manufacturer and installed in accordance with the manufacturers listing. The vent connection through the sidewall must provide correct spacing to combustible surfaces. The vent pipe connection to the sidewall vent cap **MUST** have a gas-tight seal to prevent the leakage of flue products.

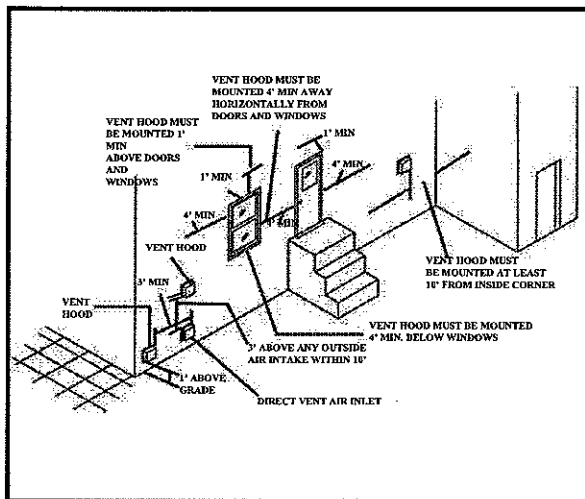


FIG. 18 Outdoor Vent Location

Venting of Flue Products

Locate units as close as possible to the sidewall where the vent for flue products will be installed.

Horizontal runs must slope upwards not less than 1/4 inch per foot (21 mm per meter) from the appliance to the vent terminal. Follow manufacturers instructions.

The vent cap shall terminate at least 3 feet (91 cm) above any forced air inlet within 10 feet (3.05 m).

The vent shall terminate at least 4 feet (1.22 m) below, 4 feet (1.22 m) horizontally from or 1 foot (30 cm) above any door, window or gravity air inlet to the building.

The vent system shall terminate at least 1 foot (30 cm) above grade and above normal snow levels.

The vent for a direct vent system shall **NOT** terminate above public walkways.

The vent shall not be installed closer than 10 feet (3.05 m) from an inside corner of an L-shaped structure.

Do not terminate the vent in a window well, stairwell, alcove, courtyard, or other recessed area. The vent can not terminate below grade.

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 surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below, unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

Combustion Air Inlet

Combustion air supply pipes can **NOT** be combined into a single pipe for multiple unit installations.

Combustion air supplied from outdoors must be free of contaminants (See Combustion and Ventilation Air). To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

To help prevent recirculation of flue products:

The combustion air inlet cap **MUST NOT** be installed above the flue outlet cap.

The combustion air inlet cap must be installed horizontally or below the flue outlet and **MUST** maintain a minimum 3 foot (91 cm) radius clearance from the flue outlet cap.

The combustion air inlet cap and vent cap for flue outlet **MUST** be located on the same sidewall and in the same pressure zone.

The combustion air inlet cap must not be installed closer than 10 feet (3.05 m) from an inside corner of a L-shaped structure.

The combustion air inlet cap must be installed at least 1 foot (30 cm) above ground level and above normal snow levels.

Multiple Sidewall Direct Vent Installations

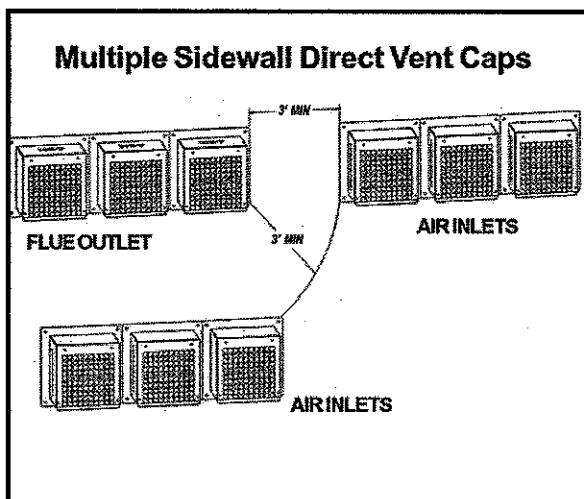


FIG. 19 Installation of Multiple Direct Vent Caps

The combustion air inlet caps for multiple unit installations must maintain the minimum 3 foot (91 cm) radius clearance below or horizontally from the closest flue outlet. Multiple flue outlet caps may be installed side by side and multiple air inlet caps may be installed side by side but the 3 foot (91 cm) radius minimum clearance between air inlet and flue outlet must be maintained. All clearance and installation requirements in this section and the applicable portions of the general venting section must be maintained on multiple unit installations.

CAUTION

Boilers which are shut down or will not operate may experience freezing due to convective air flow in the air inlet pipe connected to the unit. Proper freeze protection must be provided, see Freeze Protection.

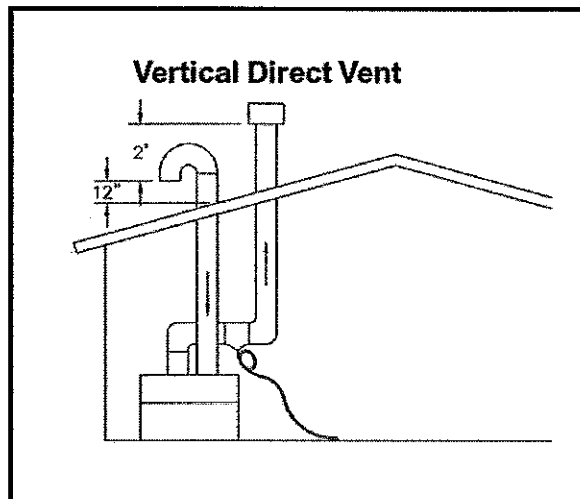


FIG. 20 Vertical Direct Vent Installation

The E+Vertical Direct Vent System

A DIRECT VENT SYSTEM WITH VERTICAL THROUGH-ROOF TERMINATIONS

Follow all requirements in the General Venting section for venting flue products to the outdoors and general installation instructions. All direct vent boilers must have combustion air supplied directly to the boiler with a separate air pipe.

The bell increaser, installed on the boiler vent outlet, must be removed. The bell increaser is **NOT USED** with the direct vent system. Vent connection is made directly to the top of the unit. No additional bell increaser, draft diverter or barometric damper is required. The direct vent system uses a two pipe system, one pipe for the flue products and one pipe for the combustion air supply. The vertical through-roof vented flue **MUST** be a dedicated stack. The flue can **NOT** be combined with any other appliance vent or common vent from multiple boilers. The vent on a direct vent system may have a positive pressure in the flue which requires all vent joints and seams to be sealed gas-tight. The direct vent vertical through-roof venting system has specific vent material and installation requirements. The flue from a direct vent system must have a condensate drain with provisions to properly collect and dispose of any condensate that may occur in the venting system. Choose acceptable vent materials from those listed below.

The combustion air inlet pipe must also be a dedicated system with one air inlet pipe per boiler. The air inlet pipes from multiple boilers can **NOT** be combined to a single common connection. The air inlet pipe connects directly to the boiler to supply combustion air. The dust shield, installed over the air inlet connection on the boiler, must be removed. The dust shield is **NOT USED** with the direct

vent system. The air inlet pipe must be sealed. Choose acceptable combustion air pipe materials from those specified in this section.

The direct vent vertical through-roof vent system **DOES NOT** require the purchase of a special vent kit from the manufacturer. The specified flue pipe, vertical through-roof flue outlet cap, air inlet pipe and components to assemble the through-roof combustion air inlet cap are purchased locally.

**TABLE - E
DIRECT VENT FLUE
AND AIR PIPE SIZES**

Input Btu/hr	Direct Vent Flue Size *	Air Inlet Pipe*
100,000	3"	3"
150,000	4"	4"
199,999	4"	4"
250,000	5"	5"
300,000	5"	5"

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

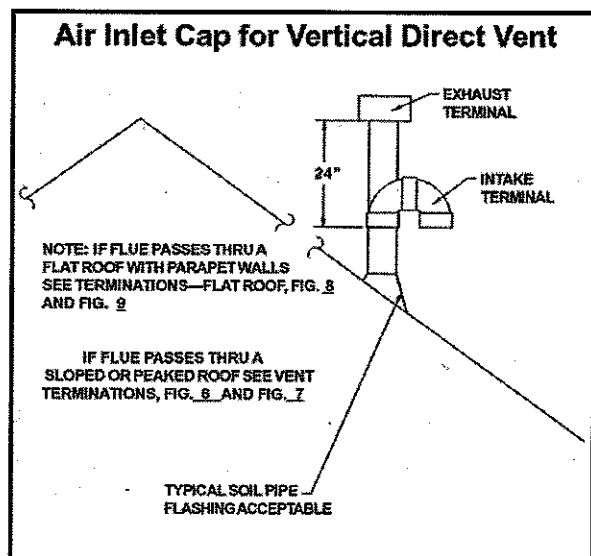


FIG. 21 Air Inlet Cap for Vertical Direct Vent System

Roof Top Air Inlet Cap for Vertical Direct Vent

The air inlet cap for the vertical through-roof direct vent system is assembled from components purchased locally. The air inlet cap consist of two 90° ells installed at the point of termination for the air inlet pipe. The first 90° ell

is installed on the roof top at the highest vertical point of the air inlet pipe and turned horizontal, the second 90° ell is installed on the horizontal outlet of the first ell and turned down. A 90° ell and a 90° street ell may be used to make this assembly. If a straight piece of pipe is used between the two ells, it should not exceed 6" (51 mm) in length. The termination ell on the air inlet must be located a minimum of 12" (30 cm) above the roof or above normal levels of snow accumulation. The point of termination for the air inlet must be 24" (61 cm) lower than the point of flue gas termination if it is located within 10' (3.05 m) of the flue outlet. Use care to ensure that the 90° ell assembly is properly installed on the air inlet pipe. Incorrect installation and/or location of the air inlet cap can allow the discharge of flue products to be drawn into the combustion process on the heater. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the heater and possible spillage of flue products which can cause personal injury, death or property damage

A vertical vent cap as specified by the vent material manufacturer **MUST** be used to vent the flue products to the outdoors. The vent cap for the flue products is purchased locally. The point of discharge for the flue products in a vertical direct vent system must terminate a minimum of 24" (61 cm) above the point where the air inlet is located if the air inlet is within a 10' (3.05 m) radius of the flue discharge. Incorrect installation and/or location of the vent cap for flue products can allow the discharge of flue products to be drawn into the combustion process on the heater. This can result in incomplete combustion and potentially hazardous levels of carbon monoxide in the flue products. This will cause operational problems with the heater and possible spillage of flue products which can cause personal injury, death or property damage

Flue Pipe Materials

Select venting material from the following specified vent materials:

Heat-Fab Saf-T CI Vent with AL29-4C stainless steel
(Call 1-800-772-0739 for nearest distributor)

Z-Flex Z-Vent with AL29-4C stainless steel
(Call 1-800-654-5600 for nearest distributor)

Protech Systems Inc. Fas-N-Seal Vent with AL29-4C stainless steel
(Call 1-800-766-3473 for nearest distributor)

Flex-L International, Inc. Star-34 Vent with AL29-4C stainless steel
(Call 1-800-561-1980 for nearest distributor)

Metal-Fab Corr/Guard Vent with AL29-4C stainless steel (Call 1-800-835-2830 for nearest distributor)

or other listed AL29-4C vent systems suitable for positive pressure

Air Inlet Pipe Materials

Select air inlet pipe material from the following specified materials:

PVC, CPVC or ABS (4", 5" or 6" I.D.)*

Dryer Vent

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 requires an adapter (not provided) to transition between the air inlet and cap.

WARNING

Using other vent or air intake materials, failure to properly seal all seams and joints or failure to follow vent pipe manufacturer's instructions can result in personal injury, death or property damage. Mixing of venting materials will void the warranty and certification of the boiler.

Length of Flue Pipe and Air Inlet Pipe

The total equivalent length of the direct vent flue pipe or the air inlet pipe must not exceed a maximum of 50 (15.24 m) equivalent feet in length for each pipe. Subtract 5 feet (1.52 m) for each elbow in the vent pipe or air intake system. Do not exceed limits for piping lengths.

Sealing of Type "B" double wall vent material or galvanized vent pipe material used for air inlet pipe on a Direct Vent System

1. Seal all joints and seams of the air inlet pipe using either Aluminum Foil Duct Tape meeting UL Standard 723 or 181A-P or a high quality UL Listed silicon sealant such as those manufactured by Dow Corning or General Electric.
2. Do not install seams of vent pipe on the bottom of horizontal runs.
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 vent pipe and air inlet pipes are properly supported.

The PVC, CPVC or ABS air inlet pipe should be cleaned and sealed with the pipe manufacturers recommended solvents and standard commercial pipe cement for the material used. The PVC, CPVC, ABS or Dryer Vent air inlet pipe should use a silicone sealant to ensure a proper seal at the boiler connection. Dryer vent should use a screw type clamp to seal the vent to the boiler and the assembly of 90° ells which make up the air inlet cap. Proper sealing of the air inlet pipe ensures that combustion air will be free of contaminants and supplied in proper volume.

Sealing of vent material for use with the Vertical Direct Vent System

The vent materials, Heat-Fab Saf-T CI Vent, Z-Flex Z-Vent, Protech Systems Fas-N-Seal Vent, Flex-L Star-34, Metal-Fab Corr/Guard Vent or listed AL29-4C vent system suitable for positive pressure, must be installed and sealed per the vent manufacturers installation instructions.

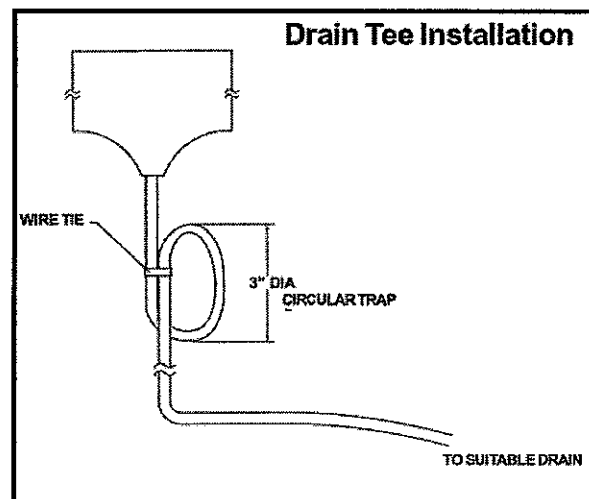


FIG. 22 Drain Tee Installation

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 the typical vent installation drawings. Plastic drain tubing, sized per the vent manufacturers instructions, shall be provided as a drain line from the tee. The drain tubing must have a trap provided by a 3" (76 mm) 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. See "Freeze Protection" for more information.

When a direct vent system is disconnected for any reason, the flue must be reassembled and resealed according to the vent manufacturers instructions. The air inlet pipe must also be resealed to ensure that combustion air will be free of contaminants and supplied in proper volume.

DANGER

Failure to properly seal all vent joints and seams may result in flue gas spillage and carbon monoxide emissions causing severe personal injury or death.

The connection from the vent to the vent termination outside the building **MUST** be made with one of the specified vent materials and must be direct as possible with no reduction in diameter. The vent accessories, such as firestop spacers, thimbles, caps, etc., **MUST** be from the same vent material manufacturer and installed in accordance with the manufacturers listing. The vent connection through the roof top must provide correct spacing to combustible surfaces. The vent pipe connection to the roof top vent cap **MUST** have a gas-tight seal to prevent the leakage of flue products.

Venting of Flue Products

Locate units as close as possible to the vertical through-roof vent for flue products.

Horizontal runs must slope upwards not less than 1/4 inch per foot (21 mm per meter) from the appliance to the vent terminal. Follow manufacturers instructions.

The vertical through-roof vent cap shall terminate at least 3 feet (91 cm) above any forced air inlet within 10 feet (3.05 m).

The vertical through-roof vent shall terminate at least 4 feet (1.22 m) below, 4 feet (1.22 m) horizontally from or 1 foot (30 cm) above any door, window or gravity air inlet to the building.

The vent terminal shall not be installed closer than 10 feet (3.05 m) from an inside corner of an L-shaped structure.

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 surfaces can be expected. Adjacent brick or masonry surfaces should be protected with a rust resistant sheet metal plate.

The vertical through-roof vent cap should have a minimum clearance of 4 feet (1.22 m) horizontally from and in no case above or below, unless a 4 foot (1.22 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

Combustion Air Inlet

Combustion air supply pipes can **NOT** be combined into a single pipe for multiple unit installations.

Combustion air supplied from outdoors must be free of contaminants (See Combustion and Ventilation Air). To prevent recirculation of flue products into the combustion air inlet, follow all instructions in this section.

The combustion air inlet cap **MUST** be at least 2 feet (61 cm) below the vertical through-roof flue outlet cap, if within 10 feet (3.05 m).

The combustion air inlet cap and vent cap for the flue outlet **MUST** be located on the same roof top surface and in the same pressure zone.

The combustion air inlet cap must not be installed closer than 10 feet (3.05 m) from an inside corner of a L-shaped structure.

The combustion air inlet cap must be installed at least one foot (30 cm) above the roof top and above normal snow levels.

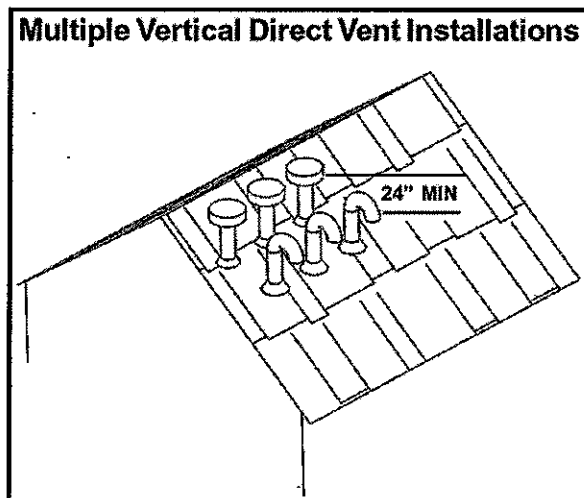


FIG. 23 Multiple Vertical Direct Vent Installations

Multiple Vertical Direct Vent Installations

The combustion air inlet caps for multiple unit installations must maintain the minimum 2 foot (61 cm) clearance below the closest vertical flue outlet if within 10 feet (3.05 m). Multiple flue outlet caps may be installed side by side and multiple air inlet caps may be installed side by side but the air inlet must always be at least 2 feet (61 cm) below the closest flue outlet if the outlet is within 10 feet (3.05 m). All clearance and installation requirements in this section and the applicable portions of the general venting section must be maintained on multiple unit installations..

CAUTION:

Boilers which are shut down or will not operate may experience freezing due to convective air flow in the air inlet pipe connected to the unit. Proper freeze protection must be provided, see Freeze Protection.

GAS SUPPLY

Verify unit is supplied with type gas specified on rating plate. This unit is orificed for operation up to 4000 feet altitude. Consult factory for installations above 4000 feet elevation. The unit will be marked to indicate suitability for high altitude operation.

INLET GAS PRESSURE: Measured at the inlet pressure tap located upstream of the combination gas valve.

TABLE - F
INLET GAS PRESSURE

	Nat. Gas	LPG
Max. (Inches-Water Column)	10.5" w.c.	13" w.c.
Min. (Inches-Water Column)	4.7" w.c.	8" w.c.

Maximum inlet gas pressure must not exceed the value specified. Minimum value listed is for the purposes of input adjustment.

MANIFOLD PRESSURE: Measured at the pressure tap on the downstream side of the combination gas valve. The gas regulator on the unit's combination gas valve is referenced to the fan pressurized chamber in the jacket. The regulator pressure must be added to the chamber pressure to obtain actual manifold pressure for normal operation. Chamber pressure may vary based on elevation, vent length and model. For information on chamber pressure, see Combustion Air Adjustment. If adjustment of regulator pressure is required, see Manifold Adjustment

Procedure. Do not increase regulator pressure beyond specified pressure setting.

TABLE - G
MANIFOLD GAS PRESSURE

Btu/hr Input 100,000 - 300,000	Nat. Gas Regulator Setting 1.8" w.c.
Btu/hr Input 100,000 - 300,000	LP Gas Regulator Setting 4.6" w.c.

GAS PRESSURE TEST

1. The appliance must be disconnected from the gas supply piping system during any pressure testing of that system at a test pressure in excess of 1/2 PSIG (3.5 kPa).
2. The appliance must be isolated from the gas supply piping system by closing a manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 PSIG (3.5 kPa).
3. The appliance and its gas connection must be leak-tested before placing it in operation.

GAS CONNECTION

1. Safe operation of unit requires properly sized gas supply piping. See data below.
2. Gas pipe size may be larger than heater connection.
3. Installation of a union is suggested for ease of service.
4. Install a manual main gas shutoff valve, outside of the appliance gas connection and before the gas valve, when local codes require.
5. A trap (drip leg) **MUST** be provided in the inlet of the gas connection to the unit.
6. The combination gas valve has an integral vent limiting device and does 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.
7. Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.
8. Inlet gas connections to the gas valve are 1/2" NPT for the 100,000 Btu/hr models and 3/4" NPT for the 150,000 through 300,000 Btu/hr models.

TABLE - H
MULTIPLE UNIT INSTALLATIONS GAS PIPING SIZE CHART

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/hr per hour for gas pressures of 14 Inches Water Column (0.5 PSIG) or less and a pressure drop of 0.5 Inch Water Column (Based on NAT GAS, 1025 Btu/hr per Cubic Foot of Gas and 0.60 Specific Gravity)

TABLE - I
SINGLE UNIT INSTALLATIONS
SUGGESTED GAS PIPE SIZE

Btu/hr Input	DISTANCE FROM METER				
	0 - 50'	51' - 100'	101' - 200'	201' - 300'	301' - 500'
100,000	1/2"	3/4"	1"	1 1/4"	1 1/4"
150,000	1"	1"	1 1/4"	1 1/2"	1 1/2"
199,999	1"	1"	1 1/4"	1 1/2"	2"
250,000	1"	1 1/4"	1 1/4"	1 1/2"	2"
300,000	1 1/4"	1 1/2"	1 1/2"	1 1/2"	2"

TABLE - J
90° 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 1/2'	3 1/2'	4'	5'	10'	14'	20'

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

GAS PIPING

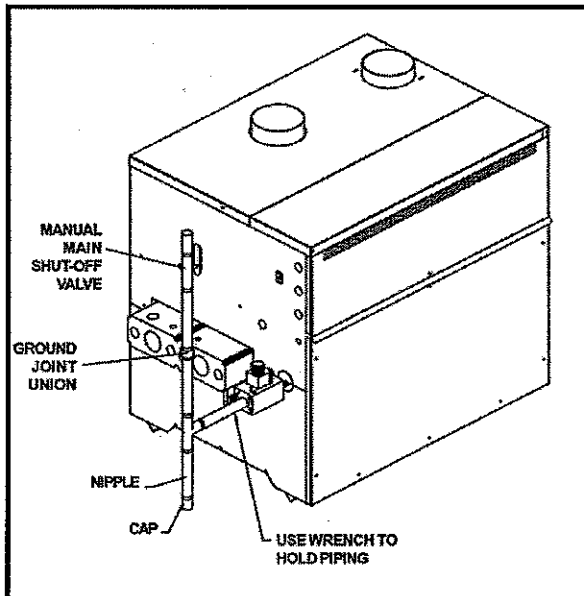


FIG. 24 Gas Piping to Heater

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

Install Piping to Control

1. The gas line should be a separate line direct from the meter unless the existing gas line is of sufficient capacity. Verify pipe size with your gas supplier.
2. Use new, properly threaded black iron pipe free from chips. If tubing is used, make sure the ends are square, deburred and clean. All tubing bends must be smooth and without deformation. Avoid flexible gas connections.
3. Run pipe or tubing to the control. If tubing is used, obtain a tube to pipe coupling to connect the tubing to the control.
4. Install a sediment trap in the supply line to the gas control. (See Figure 28)
5. Thread pipe the proper amount for insertion into gas valve. Effective length of standard 1/2" NPT thread is 1/2", overall length of thread is 3/4"; effective length of 3/4" NPT thread is 9/16", overall length of thread is 3/4". **DO NOT THREAD PIPE TOO FAR.** Valve distortion or malfunction may result if the pipe is inserted too deeply.
6. Apply a moderate amount of good quality pipe compound (**DO NOT** use Teflon tape) to pipe only, leaving two end threads bare.

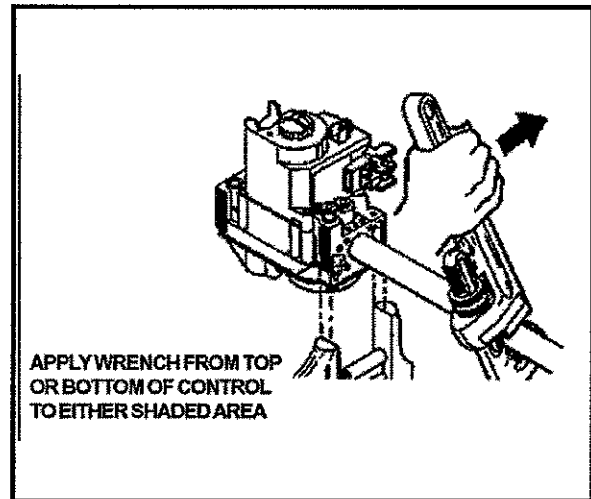


FIG. 25 Wrench to Support Gas Valve for Piping Connection

7. Remove seal over control inlet.
8. Connect pipe to control inlet. Use wrench to square ends of the control.
9. For LP gas, consult your LP gas supplier for expert installation.

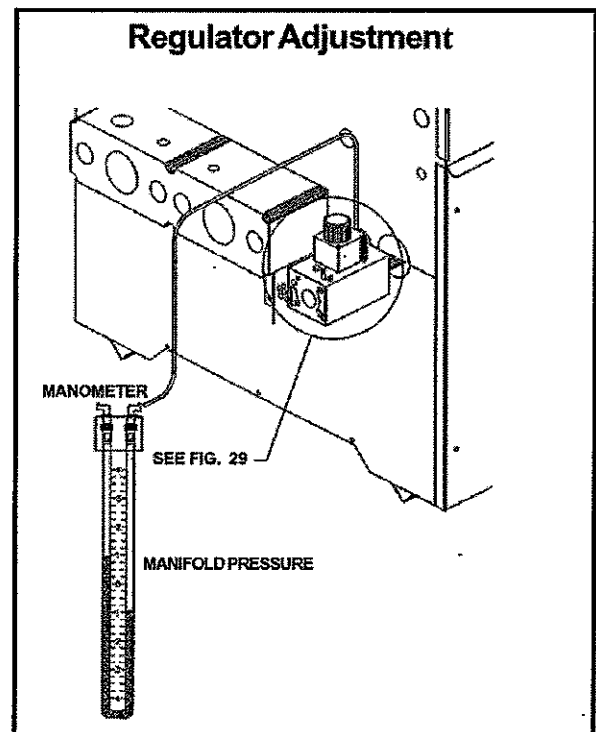


FIG. 26 Manometer Connection for Manifold Pressure Adjustment

GAS MANIFOLD PRESSURE ADJUSTMENT PROCEDURE

IMPORTANT:

The gas valve is 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 left side of the jacket. The regulator pressure must be added to the referenced chamber pressure to obtain actual manifold pressure for normal operation. The regulator cover screw on the gas valve must be in place and tight for the appliance to operate properly.

1. Turn the power switch to "OFF" position.
2. Turn gas valve knob to "OFF" position.
3. Open the top front jacket panel to access the Ignition Module. Disconnect the power wires to the hot surface igniter from the plug in terminal labeled **IGNR** on the ignition module.
4. Remove the 1/8" hex plug, located on "outlet" side of the gas valve and install a fitting suitable to connect to a manometer or magnahelic gauge. See Figure 26. Minimum range of scale should be up to 5" w.c. for natural gas and 10" w.c. for propane gas.
5. Disconnect the reference pressure hose from the barbed connection on the gas valve before adjusting the regulator.
6. Turn the power switch to "ON" position.
7. Turn gas valve knob to "ON" position.
8. Set the thermostat(s) to call for heat.
9. Before the valve opens, the manometer or magnahelic gauge will read the positive air pressure in the jacket as supplied by the combustion air fan. There is no gas flow at this point. This reading is normal
10. Observe gas regulator pressure when Valve/Flame "LED" on ignition control module lights up. The gas valve will open for the 6 second trial for ignition period. Burners will not fire. You will read only the regulator pressure setting with the reference hose disconnected from the gas valve. Allow unit to run through the post purge sequence.

TABLE - K
MANIFOLD PRESSURE

	Regular Setting
Nat. Gas Pressure	1.8" w.c.
LP Gas Pressure	4.6" w.c.

NOTE:

The regulator pressure must be added to the chamber pressure to obtain actual manifold pressure for normal operation. Chamber pressure may vary based on elevation, vent length and model. For information on chamber pressure, see Combustion Air Adjustment. Do not increase regulator pressure beyond specified pressure setting.

11. If adjustment is necessary, remove the regulator cover screw on the gas valve.
12. Turn the power switch to "OFF". Turn regulator adjustment screw clockwise to raise regulator gas pressure, counter clockwise to lower gas pressure, to proper setting.
13. Replace cover screw and turn the power switch to "ON" position. Observe gas regulator pressure again when Valve/Flame "LED" lights up. Repeat sequence until proper regulator setting has been obtained.

NOTE:

If the regulator cover screw is not in place and tight, the unit will not function properly.

14. Turn the power switch to "OFF" position.
15. Turn gas valve knob to "OFF" position.
16. Reconnect the power wires for the hot surface igniter to terminal labeled **IGNR** on the ignition module. Replace the top front jacket panel.
17. Remove fitting from the gas valve and replace with 1/8" hex plug (that was previously removed) & tighten.
18. Reconnect the chamber pressure reference hose to the gas valve.
19. Turn the gas valve knob to "ON" position.

20. Turn the power switch to "ON" position. The appliance is now ready to operate.

If manifold pressure can not be properly adjusted, check gas supply pressure with a manometer connected to the inlet pressure tap on the gas control.

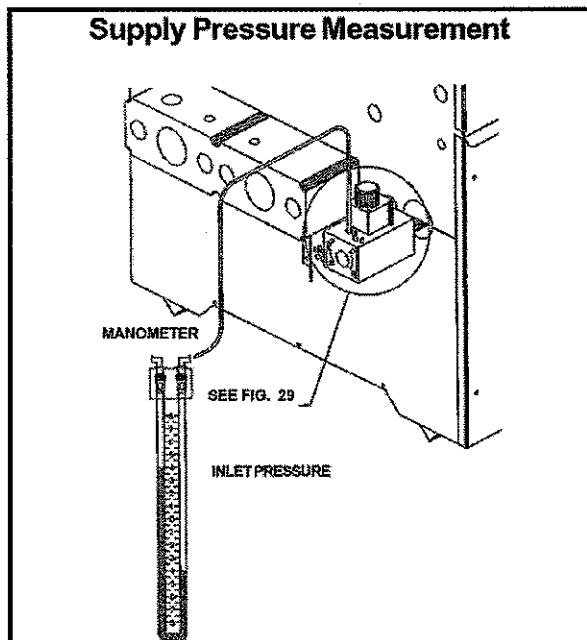


FIG. 27 Manometer Connection for Gas Supply Pressure Measurement

CHECKING GAS SUPPLY PRESSURE

1. Turn the power switch to "OFF" position.
2. Turn gas valve knob to "OFF" position.
3. Shut off gas supply at the manual valve in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
4. Remove the 1/8" hex plug, located on "inlet" side of the gas valve and install a fitting suitable to connect to a manometer or magnahelic gauge. Range of scale should be 14" w.c. or greater to check inlet pressure.
5. Turn on gas supply at the manual valve, turn on LP gas at tank if required.
6. Turn the power switch to "ON" position
7. Turn the gas valve knob to "ON" position
8. Set the thermostat(s) to call for heat.

9. Observe the gas supply pressure as the burners are firing. Ensure inlet pressure is within specified range.

TABLE - L MINIMUM AND MAXIMUM GAS SUPPLY PRESSURES

	Nat. Gas	LPG
Max. (Inches-Water Column)	10.5" w.c.	13" w.c.
Min. (Inches-Water Column)	4.7" w.c.	8" w.c.

10. 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.
11. If gas supply pressure is within normal range, proceed to remove gas manometer and replace pressure tap fittings in the gas control.
12. Turn the power switch to "OFF" position.
13. Turn gas valve knob to "OFF" position.
14. Shut off gas supply at the manual valve in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
15. Remove the manometer and related fittings from "inlet" side of the gas valve, replace 1/8" hex plug in gas valve.
16. Turn on gas supply at the manual valve, turn on LP gas at tank if required.
17. Turn the power switch to "ON" position.
18. Turn the gas valve knob to "ON" position.
19. Set the thermostat(s) to call for heat.

IMPORTANT:

Upon completion of any testing on the gas system, leak test all gas connections with a soap solution while main burners are operating. Immediately repair any leak found in the gas train or related components. Do Not operate an appliance with a leak in the gas train, valves or related piping.

Check burner performance by cycling the system while you observe burner response. Burners should ignite promptly. Flame pattern should be stable, see "Maintenance-Normal Flame Pattern." Turn system off and allow burners to cool, then cycle burners again to ensure proper ignition and flame characteristics.

WATER CONNECTIONS

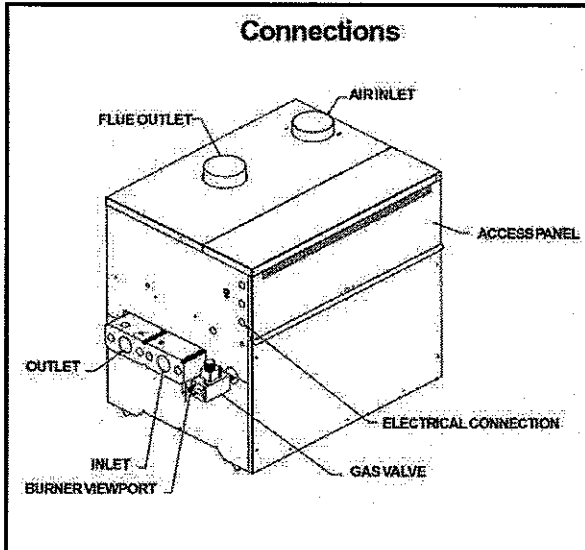


FIG. 28 Connections to the Unit

Inlet and Outlet Connections

For ease of service, install unions on inlet and 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.

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. No valve is to be placed between the relief valve, and the unit. To prevent water damage, the discharge from the relief valve shall be piped to a suitable floor drain for disposal when relief occurs. No reducing couplings or other restrictions shall be installed in the discharge line. The discharge line shall allow complete drainage of the valve and line. Relief valves should be manually operated at least once a year.

CAUTION

Avoid contact with hot discharge water.

A boiler installed above radiation level must be provided with a low water cutoff device either as part of the unit or at the time of installation.

WATER FLOW SWITCH (IF EQUIPPED)

A water flow switch is available as a factory supplied option on 100,000 through 300,000 Btu/hr heating boilers and hot water supply boilers. The flow switch should be wired across the X and B terminals on the unit's internal terminal strip. Remove the jumper between the terminals before connecting flow switch wires to the terminals. This wiring connection installs the flow switch in the 24 VAC safety circuit for the ignition control. A flow switch installed in 1 1/4" pipe requires a minimum flow of 10 GPM to make the flow switch and start burner operation. A flow switch installed in 1 1/2" pipe requires a minimum flow of 13 GPM to make the flow switch and start burner operation. A flow switch installed in 2" pipe requires a minimum flow of 19 GPM to make the flow switch and start burner operation. A water flow switch meets most code requirements for a low-water cut off device on boilers requiring forced circulation for operation.

LOW WATER CUTOFF (IF EQUIPPED)

An electronic or float type low water cut off is available as a factory supplied option on all units. Low water cutoffs should be inspected every six months, including flushing of float types.

COMBINATION GAS VALVES

Each unit has a combination gas valve to cycle the gas supply on and off to the burners. The 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.

The manifold pressure is preset at the factory and adjustment is not usually required. If the manifold pressure is to be adjusted, follow the "Gas Manifold Pressure Adjustment Procedure" for proper adjustment.

OPTIONAL TWO STAGE BURNER CONTROL SYSTEM (M-9)

The unit may be optionally equipped with a two stage burner control system. The unit will be equipped with a split gas manifold and an additional solenoid gas valve to control high fire burner operation. This system is equipped

with two operating temperature controls to fire each burner stage at a different temperature set point. Stage one (Low Fire) must fire before stage two (High Fire) will function. Set Low Fire operator at the desired system set point, Set High Fire operator at a lower setting, approximately 5-15 degrees lower, for staged burner operation.

ELECTRICAL CONNECTIONS

This appliance 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.

1. All wiring between the unit and field installed devices shall be made with type T wire [63°F (35°C) rise].
2. Line voltage wire exterior to the appliance must be enclosed in approved conduit or approved metal clad cable.
3. The pump must run continuously when unit is being fired (hot water supply boilers must use the optional pump delay or intermittent pump controller if the pump is to be cycled).
4. To avoid serious damage, **DO NOT** energize the unit until the system is full of water. Serious damage may result.
5. Provide the unit with proper overload protection.
6. Install wall thermostat on inside wall. **DO NOT** install thermostat in an area affected by drafts, sunlight, light fixtures, hot or cold water pipes or near a fire place.

TABLE - M
AMP DRAW DATA
100,000 through 300,000 Btu/hr Models

Firing Control	FAN	Valve/ Controls	Maximum Total Amps @ 120 VAC
F-9 (Single Stage)	1.15	3.97	5.12
M-9 (Two Stage)	1.15	4.15	5.30

Pump Wiring

When the external power leads for pump delay or intermittent pump operation is used, the maximum current draw for the pump must not exceed 8 AMPS at 120 VAC. This data may be used to determine the minimum wire size for 120 volt service.

TEMPERATURE ADJUSTMENT

Operating Temperature Control

An adjustable immersion operating control is located in the control panel. The control uses a remote sensing bulb mounted in water inlet side of the front header. Turn the control set point dial to adjust the desired operating water temperature of the unit.

High Water Temperature Limit Control

The unit is equipped with a fixed setting, auto-reset high water temperature limit control. The heating boiler temperature limit control has a fixed limit setting of 240°F (115°C); the hot water supply boiler temperature limit control has a fixed 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.

Manual Reset High Water Temperature Limit Control (Optional)

The unit may be optionally equipped with a fixed setting, manual reset high water temperature limit control. This manual reset temperature limit control has a fixed limit setting of 230°F (110°C). If water temperature exceeds this set point, the limit will break the control circuit and shut down the unit. The limit control can only be reset after the water temperature has cooled below the set point of the limit. Reset of the limit control is accomplished by pushing the **Red Reset Button** located on the bottom side of the control.

NOTE:

The limit control will not reset until the water temperature has dropped below the set point of the high limit.

LIGHTING INSTRUCTIONS FOR YOUR SAFETY, READ BEFORE OPERATING

WARNING

If you do not follow these instructions exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

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.
1. 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.
 2. 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.
 3. 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.
 4. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

LIGHTING INSTRUCTIONS

1. **STOP!** Read the safety information above.
2. Turn off all electrical power to the appliance.
3. Turn the power switch on the left side of the cabinet to "OFF" position.
4. Remove the upper front access panel
5. Set the thermostat(s) to the lowest setting. M-9 (2-stage) models are equipped with two thermostats.
6. This appliance is equipped with an ignition device which automatically lights the burners. **DO NOT** try to light the burners by hand.
7. Turn the gas control knob on the gas valve clockwise to the "OFF" position.

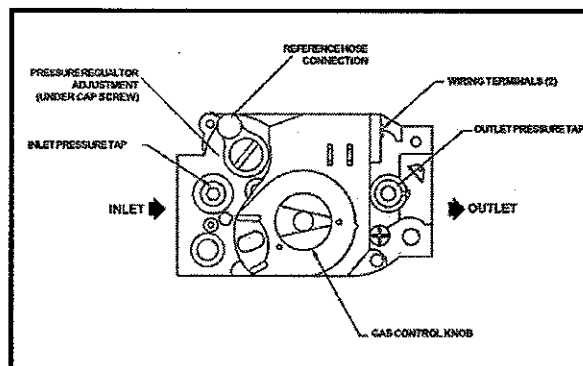


FIG. 29 Combination Gas Valve

8. Wait five (5) minutes to clear out any gas. If you smell gas, STOP! Follow "B" in the safety information above. If you don't smell gas, go on to the next step.
9. Turn the gas control knob on the gas valve counterclockwise to the "ON" position.
10. Set the thermostat(s) to the desired setting.
11. Replace control access panel(s).
12. Turn on all electric power to the appliance.
13. If the appliance will not operate, follow the instructions "To Turn Off Gas To Appliance" and call your service technician or gas supplier.

TO TURN OFF GAS TO APPLIANCE

1. Turn off all electric power to the appliance if service is to be performed.
2. Turn the gas control knob on the gas valve clockwise to the "OFF" position. Do not force.

WARNING

Should overheating occur or the gas fail to shut off, turn off the manual gas control valve to the appliance.

IGNITION SYSTEM CHECKOUT

1. Turn off gas supply to unit.
2. Turn thermostat(s) to highest setting.
3. Turn electric power on.
4. The ignition module will lock out and the Valve/Flame LED will blink.

5. Readjust thermostat(s) to normal setting.
6. Turn on gas supply.
7. Turn power off then on again to reset ignition module.
8. If ignition system fails to operate properly, repair work must be performed by a qualified serviceman or installer.

HOT SURFACE IGNITION SYSTEM

The hot surface ignition module is not repairable. Any modification or repairs will invalidate the warranty and may create hazardous conditions that result in property damage, personal injury, fire, explosion and/or toxic gases. A faulty ignition module must be replaced with a new unit. The hot surface igniter is also the flame sensor.

OPERATION AND DIAGNOSTIC LIGHTS

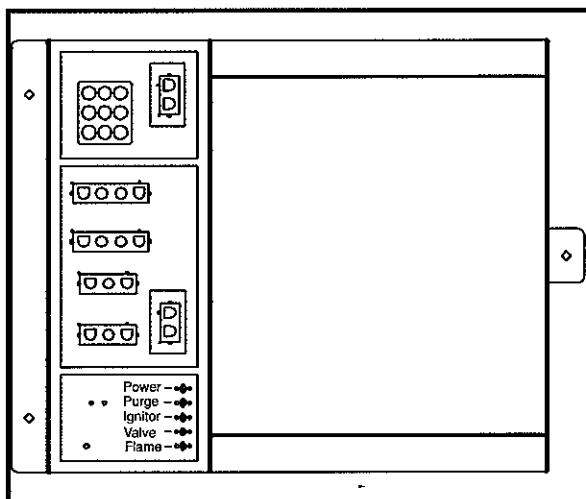


FIG. 30 Ignition Module

The unit has a lighted ON/OFF power switch on the outer cabinet (left side) and five (5) LED indicators on the electronic ignition control module to monitor the units operation.

TABLE - N
IGNITION MODULE
INDICATING LIGHTS

Indicating Light	Function
Power on Switch	- On - 120 VAC supplied to unit
Power LED	- On - Module is powered from 24 VAC system and operating properly - Blinks continuously if voltage is too high on transformer secondary - Off - Module is not powered
Purge LED	- Off - Combustion air fan is not powered OR air flow is not proven - On - When unit is in prepurge or interpurge - Blinks continuously when there is a pressure switch fault
Ignitor LED	- Off - Ignitor is off - On - When hot surface ignitor is on
Valve LED	- Off - Gas valve is closed - On - Control signaling gas valve is on - Blinks continuously when control is in LOCKOUT because it failed ignition
Flame LED	- Off - Flame is not present - On - Control signaling flame is present - Blinks continuously when L1 and neutral are reversed

IGNITION AND CONTROL TIMINGS

Prepurge (Combustion Air Fan Only) - 15 Seconds

Time to Prove Pressure Switch (Airflow) - 5 Minutes Maximum

NOTE:

Pressure switch must open within 45 seconds of call for heat or control will lockout.

Igniter Warm-up Time - 20 Seconds

Trial For Ignition - 6 Seconds

Postpurge (Combustion Air Fan Only) - 30 Seconds

Pump Delay Timing - 30 Seconds after burner shutdown (on units equipped with an optional, factory supplied pump delay or intermittent pump control system).

FREEZE PROTECTION

Proper freeze protection must be provided for 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.

1. If the system pump does not run continuously an additional pump must be installed to provide constant circulation through the unit. This can help prevent freezing.
2. Freeze protection for a hot water heating boiler using an indirect coil can be provided by using hydronic system antifreeze. Follow the manufacturers instructions. **DO NOT** use undiluted or automotive type antifreeze. See "Freeze Protection for Boiler Systems."
3. Ensure that condensate drain lines from the optional direct vent flue are protected from freezing. If required, use a listed self regulating heat tape with not more than 5 watts per square foot rating.
4. A snow screen should be installed to prevent snow and ice accumulation around the appliance venting system.
5. If for any reason the unit is to be shut off, you must:
 - (a) Shut off water supply.
 - (b) Drain unit completely.
 - (c) Drain pump and piping.

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.

CAUTION

DO NOT use undiluted or automotive type antifreeze.

2. A solution of 50% antifreeze will provide maximum protection of approximately -30°F.
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 may be required to maintain desired flow rates 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.

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.

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.

1. Examine the venting system at least once a year. Check more often in 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.
2. Using the view port, located below the water connections, visually check main burner flames at each start up after long shutdown periods or at least every six months.

WARNING

This area is hot and direct contact could result in burns.

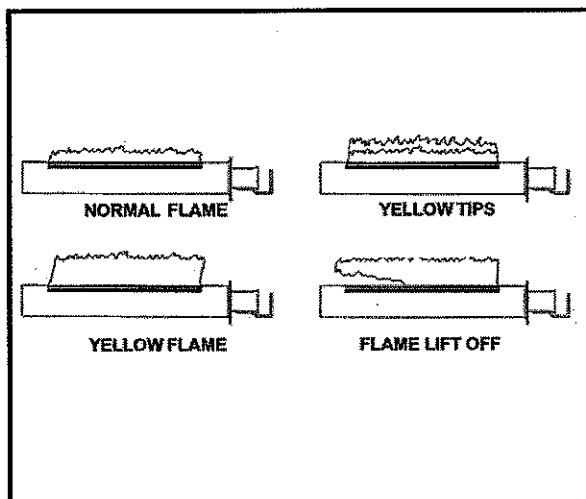


FIG. 31 Burner Flame Patterns

- a. Normal Flame: A normal flame is blue, with slight yellow tips, with a well defined inner cone and no flame lifting.
- b. Yellow Tip: Yellow tip can be caused by blockage or partial obstruction of air flow to the burner(s).
- c. Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner(s) or excessive gas input. This condition **MUST** be corrected immediately.
- d. Lifting Flames: Lifting flames can be caused by over firing the burner(s) or excessive primary air.

If improper flame is observed, examine the venting system, ensure proper gas supply and adjust the combustion air.

3. Combustion Air Shutter Adjustment: This unit uses a fan assisted combustion process. The fan air shutter is factory pre-set and should not need adjustment in most cases. If adjustment is required, the fan air shutter may be manually adjusted to a dimension specified for each model. Follow the steps below to adjust the fan air shutter if the unit does not function properly or a continuous low air condition is observed:

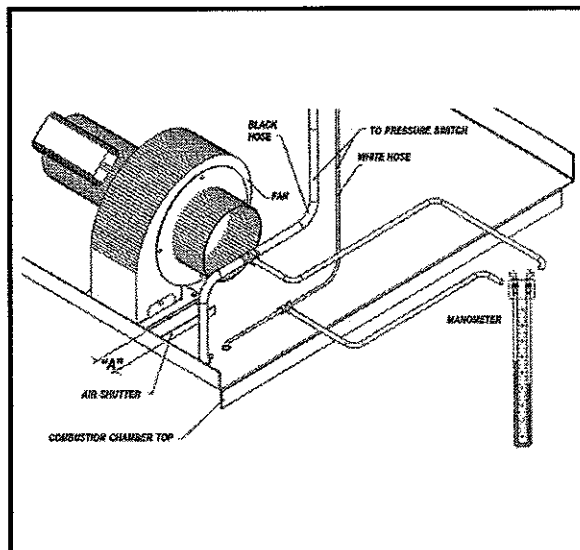


FIG. 32 Combustion Air Shutter Adjustment

- a. Check for proper installation and draft in venting system. Correct as required.
- b. Turn the power switch to the "OFF" position.
- c. Turn the gas valve knob to the "OFF" position
- d. Remove upper front access door.
- e. Use a ruler to measure the distance from the base of the fan to the end of the air shutter. Compare this distance to the specified "A" dimension for the unit.

TABLE - O
AIR SHUTTER
ADJUSTMENT OPENING

Btu/hr Input	"A" Dimension Opening
100,000	7/8"
150,000	1-1/2"
199,999	1-1/4"
250,000	1-11/16"
300,000	1-13/16"

- f. If adjustment is necessary, follow these steps.
If no adjustment is necessary, go to step "i".
1. Loosen two combustion air blower mounting nuts and slide the air shutter to the specified "A" dimension. See chart.

2. Tighten the combustion air fan mounting nuts

3. Proceed to step "n" to check appliance for proper operation.

g. If the unit does not function properly after manually setting the air shutter, use a manahelic or slope gauge to set the air shutter based on differential air pressure.

h. Install a tee in each of the hoses connecting the chamber pressure and burner venturi pressure to the pressure switch. Install a connecting hose from the branch of each tee to a **manometer**, manahelic or slope gauge, legible in 0.1" increments up to 3" w.c.. Connect chamber pressure to the positive pressure side of the gauge "+" and burner venturi pressure to the negative side "-" of the gauge.

i. Turn the power switch to "ON" position. Combustion air fan should start. Leave the gas valve "OFF".

j. With the combustion air fan running, the gauge will read a system differential pressure. The proper differential pressure should be in the following range, depending upon length of pipe used:

TABLE - P DIFFERENTIAL AIR PRESSURE	
Btu/hr Input	Differential Pressure
100,000	1.4 - 1.8" w.c.
150,000	1.4 - 1.8" w.c.
199,999	1.4 - 1.8" w.c.
250,000	1.5 - 1.9" w.c.
300,000	1.5 - 1.9" w.c.

k. If adjustment is necessary, follow these steps. If no adjustment is necessary, go to step "L".

1. Loosen two combustion air blower mounting nuts, to allow the air shutter to slide. See Figure 32.

2. If differential pressure needs increasing, pull the air shutter out with thumb and finger gradually and evenly. Push in the air shutter to decrease differential pressure.

3. If the differential pressure cannot be obtained, shut the appliance down and inspect the vent system (both air and flue gas passageways) for obstructions or leaks.

4. Tighten combustion air blower mounting nuts.

L. Turn the power switch to "OFF" position.

m. Remove gauge and tee connections, ensuring connections are made at the pressure switch correctly; the chamber pressure to the "+" connection and the burner venturi pressure to the "-" connection.

n. Replace upper front access door.

o. Turn the gas valve knob to "ON" position.

p. Turn the power switch to "ON" position.

q. When the main burner lights, observe the burner flame through observation port. Flames should be light blue in color with slight yellow tips; flames should be settled on burner head with no lifting.

r. The appliance is now ready to operate.

BURNER REMOVAL AND CLEANING

4. Flue Gas Passageways Cleaning Procedures: Any sign of soot at burners indicates a need for cleaning. The following cleaning procedure 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.

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

a. Turn off main power to unit.

b. Turn off main manual gas shutoff to unit.

c. Remove the front outer jacket panels.

d. Remove gas valve from the manifold.

e. Remove screws from manifold mounting brackets. Pull manifold(s)/ orifice assembly away from burners. Remove hose from burner tap.

f. Remove mounting screws from each burner and slide burner out toward front of unit. Use caution to prevent damage to burner gaskets, refractory, hot surface igniter or wiring.

g. Remove soot from burners with a stiff bristle brush. Damaged burners or burner gaskets must be replaced.

HEAT EXCHANGER CLEANING

5. Check the heat exchanger surface for sooting. If present, heat exchanger must be cleaned and problem corrected. Proceed as follows.
 - a. Remove manifold/orifice assembly as described in steps "a" through "e" in "Burner Removal".
 - b. Disconnect wiring from hot surface igniter and hose from burner tap.
 - c. Remove inner combustion chamber door mounting screws, tilt slightly and slide door assembly out toward front of unit. Use caution to prevent damage to refractory, hot surface igniter, hose and wiring.
 - d. Check "V" baffles on top of heat exchanger. Remove and clean if necessary.
 - e. Remove soot from heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.
 - f. Carefully reinstall combustion chamber door, jacket panels, dividers, burners, manifolds wires and hoses. Use new gasket material for proper air seal.
 - g. Reassemble and test for gas leaks.
 - h. Cycle unit and check for proper operation.

A unit installed in a dust or dirt contaminated atmosphere will require cleaning of the burners on a 3 to 6 month schedule or more often, 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. Use extreme care when operating a unit for temporary heat during new construction. The burners and fan will probably require a thorough cleaning before the unit is placed in service.

6. **Combustion Air Fan:** The combustion air fan should be checked every 6 months. Clean as required when installed in a dust or dirt contaminated location.
7. **Water Circulating Pump:** Inspect pump every 6 months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by pump manufacturer.
8. Keep appliance area clear and free from combustible materials, gasoline and other flammable vapors and liquids.

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

GAS TRAIN AND CONTROLS

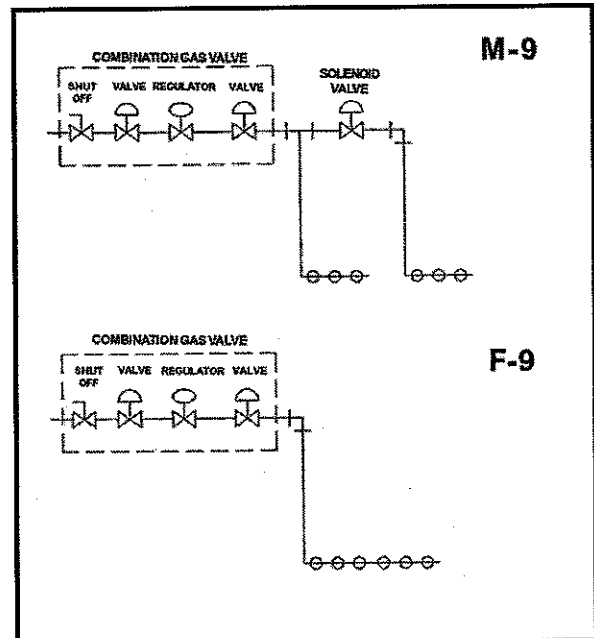


FIG. 33 Gas Train Drawings

PIPING OF THE BOILER SYSTEM

The drawings in this section show typical boiler piping installations. Before beginning the installation, consult local codes for specific plumbing requirements. The installation should provide unions and valves at the inlet and outlet of the boiler so it can be isolated for service. An air separation device must be supplied 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. The expansion tank must be installed close to the boiler and on the suction side of the system pump to ensure proper operation. **Caution: this boiler system should not be operated at less than 12 PSIG.** Hot water piping must be supported by suitable hangers or floor stands, **NOT** by the boiler. Copper pipe systems will be 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. Padding is recommended on rigid hangers installed with a copper system. The boiler pressure relief valve must be piped to suitable floor drain. See the relief valve section in the Installation and Service 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.

WATER CONNECTIONS HEATING BOILERS ONLY

This boiler is shipped from the factory with 1-1/4" inlet and outlet connections on the 100,000 Btu/hr model and 2" NPT inlet and outlet connections on the 150,000 through 300,000 Btu/hr models. If required, field installed reducing bushings may be used to decrease the inlet and outlet water connections to 1 1/2" NPT on the 150,000 and 199,999 Btu/hr models only. Low boiler flow can result in noise on burner operation.

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. Heat exchanger head-loss charts (Tables Q and R) are provided to assist in proper pump selection. Also provided is a System Temperature Rise Chart (Table T). 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. 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

TABLE - Q
PRESSURE DROP CURVE FOR 100,000
BTU/HR MODEL

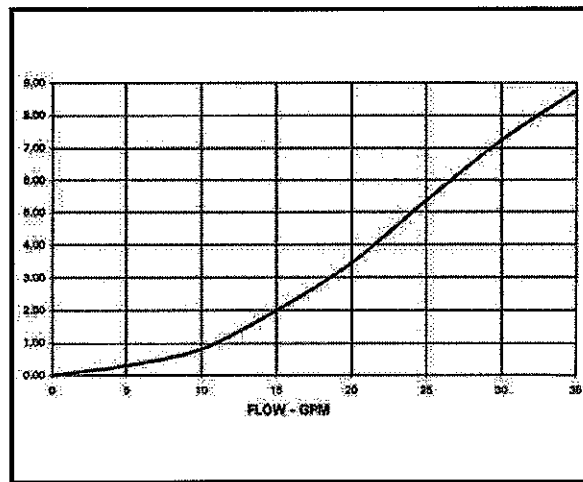
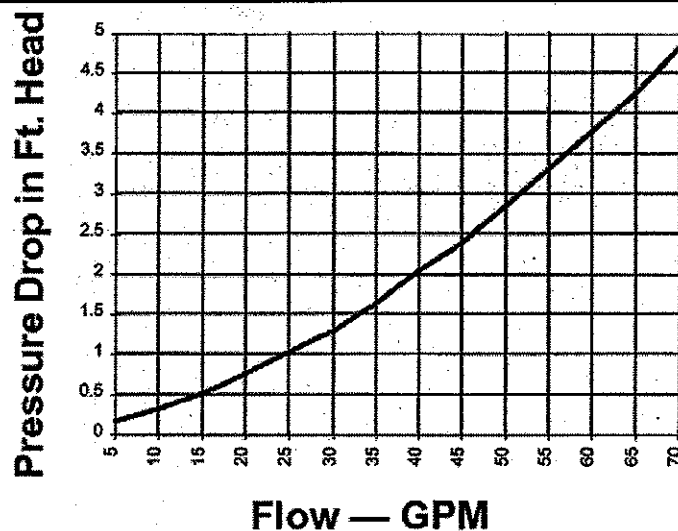


TABLE - R
PRESSURE DROP CURVE FOR
150,000 THROUGH 300,000 BTU/HR MODEL



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. An expansion tank must be installed near the boiler and on the suction side of the pump.

CIRCULATOR PUMP OPERATION (Heating Boilers Only)

A factory wired pump control relay is supplied in the control panel of each heating boiler. External wire leads are provided to supply 120 VAC power to the pump, allowing the control relay to cycle the pump. **Caution: The external power leads for pump operation are "Hot" when the main power switch on the boiler is "ON."** The field installed boiler pump using these wire leads must not exceed 8 AMPS at 120VAC. As shipped from the factory, this control relay is set to cycle the boiler pump on each call for heat with an external room thermostat installed across terminals R1 and W1 on the internal terminal strip. For continuous pump operation, connect the orange jumper on the terminal board between terminals R1 and A. See wiring diagram shipped with the unit. **PUMP INSTALLATION AND MAINTENANCE:** For installation and maintenance information on the circulator pump, refer to pump manufacturers instructions included in the instruction package.

BOILER BYPASS REQUIREMENTS

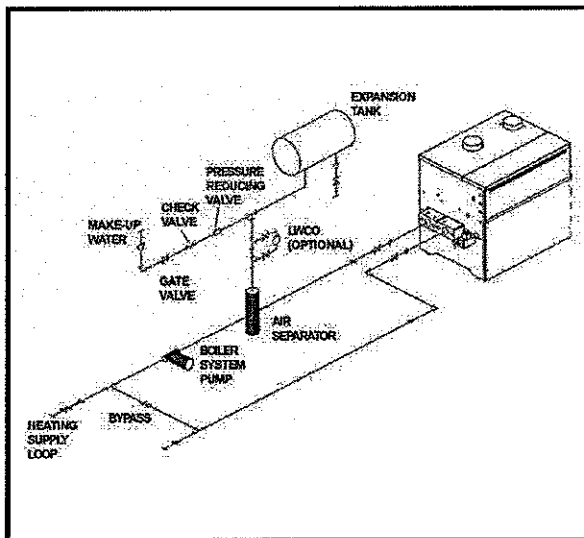


FIG. 34 Boiler with Bypass Installed

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, a properly sized circulator and piping system. The bypass will help to ensure that the boiler can be supplied with adequate water flow. A typical bypass with a valve is shown in Figure 34. If the boiler temperature rise exceeds 40°F (22°C), it is an indication that the boiler may not be receiving adequate flow and adjustment of the bypass is required. If a high temperature rise is experienced, check the pump for proper operation and check the system piping for any obstruction. A larger pump may be necessary. The installation of the recommended system bypass as shown in Figure 34 allows an increased flow through the boiler. If there is any doubt that the pump may not provide adequate flow, bypass piping should be provided at the time the boiler is installed. The bypass should be fully sized with a balancing valve to allow for proper adjustment. The balancing valve allows the flow through the bypass to be adjusted based on the individual system requirements. A bypass is recommended on all multiple zone systems in addition to a properly sized circulator and system piping.

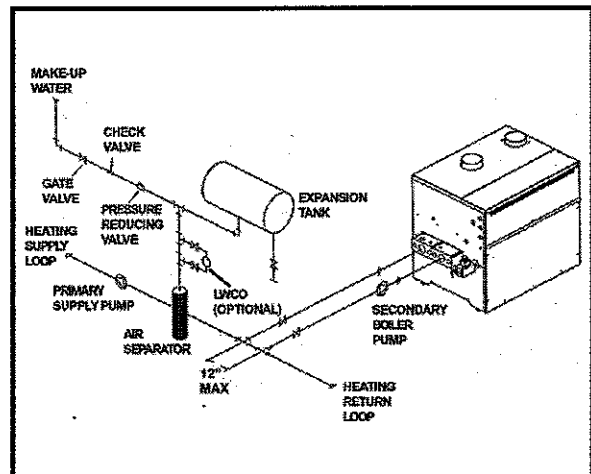


FIG. 35 Boiler with Primary/Secondary Piping

Boilers used with multiple zone systems are recommended to be installed with a primary/secondary piping system as shown in Figure 35. This type of system uses a dedicated pump to supply flow to the boiler only. This pump is sized based on desired boiler flow rate, boiler head loss and head loss in the secondary system piping. A primary/secondary piping system may be installed on smaller input boilers but generally a properly sized system pump with a bypass will provide adequate flow.

The installer must ensure that the boiler has adequate flow without excessive temperature rise. The temperature rise on a multiple zone system should be made when only the zone with the longest length and/or highest head loss is open. 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 open the bypass adjustment valve and/or installation of a larger circulator pump. System noise may also indicate an oversized boiler.

CAUTION

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

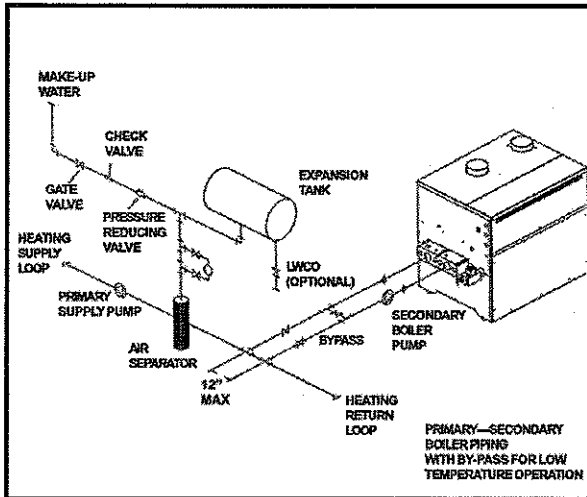


FIG. 36 Boiler with Low Temperature Bypass Piping

LOW TEMPERATURE BYPASS REQUIREMENTS

A boiler operated with an inlet temperature of less than 140°F (60°C) must have a bypass to prevent problems with condensation. A bypass as shown in Figure 36 must be piped into the system at the time of installation. 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. This remote operator should be wired across the R1 and W1 terminals (See Room Thermostat Connection and Terminal Strip instructions).

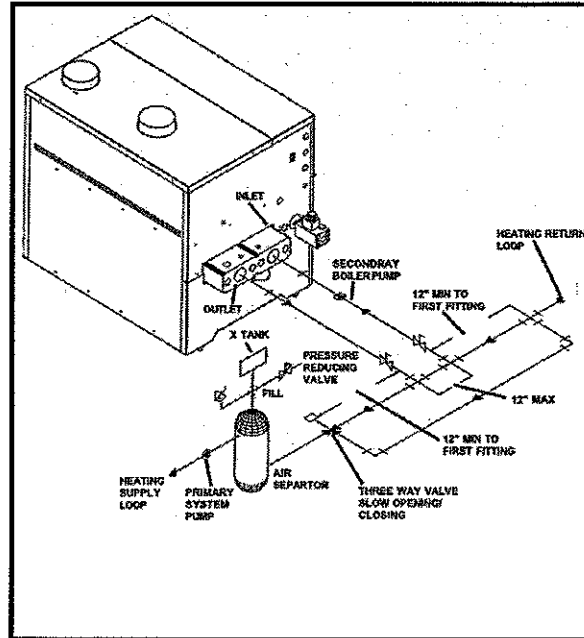


FIG. 37 Boiler with 3-Way Valve Piping

THREE WAY VALVES

The installation of a three way valve on this boiler is not generally recommended because most piping methods allow the three way valve to vary flow to the boiler. This boiler is a low mass, high efficiency unit which requires a constant water flow rate for proper operation. Low flow rates 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 can cause operational problems and non-warrantable failures of the boiler. If a three way valve must be installed, please pipe in a primary/secondary system as shown in Figure 37. Based on boiler sizing and system flow requirements, this piping may still result in boiler short cycling.

BOILER FLOW RATES

CAUTION

The maximum flow rate through the 100,000 Btu/hr boiler must not exceed 30 GPM, maximum flow rate through the 150,000 through 300,000 Btu/hr boilers must not exceed 60 GPM.

The heat exchanger is generally capable of operating within the flow rates of a residential 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.

The basic guide for minimum flow in this boiler is based on a 40°F (22°C) temperature rise in most installations. Lower flow and a higher temperature rise is acceptable if the boiler system is specifically designed for the characteristics of a higher temperature rise. A system not specifically designed for a higher temperature rise may experience overheating of the boiler water. This can cause short burner on cycles, system noise and in extreme cases, a knocking flash to steam. These conditions can lead to operational problems and non-warrantable failures of the boiler. High temperature rise systems must be designed by a qualified engineer.

TABLE - S
MINIMUM REQUIRED FLOW

Model	Flow
100,000 Btu/hr	4 GPM
150,000 Btu/hr	6 GPM
199,999 Btu/hr	8 GPM
250,000 Btu/hr	10 GPM
300,000 Btu/hr	12 GPM

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. The temperature/pressure gauge can be used to determine temperature rise by first recording the temperature of the boiler water with the boiler off. Record the temperature of the boiler water as the boiler fires and the discharge temperature stabilizes. Subtract the boiler water temperature with the boiler off from the stable outlet water temperature with the boiler firing. This temperature difference is the temperature rise.

TYPICAL HEATING BOILER INSTALLATIONS

General Plumbing Rules

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

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.

TABLE - T
SYSTEM TEMPERATURE RISE CHART
Based on Boiler Output in Btu/hr

Btu/hr		10°F		15°F		20°F		25°F		30°F		40°F	
Input	Output	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd	GPM	Ft/hd
100,000	84,000	17.0	1.1	11.3	0.5	8.5	0.4	6.8	0.3	5.7	0.2	4.3	0.2
150,000	126,000	25.2	0.9	16.8	0.5	12.6	0.4	10.1	0.3	8.4	0.2	6.3	0.2
200,000	168,000	33.7	1.4	22.4	0.6	16.8	0.5	13.4	0.4	11.2	0.3	8.4	0.3
250,000	210,000	42.1	1.7	28.0	1.2	21.0	0.7	16.8	0.6	14.0	0.5	10.5	0.4
300,000	252,000	50.5	2.6	33.6	1.6	25.2	1.1	20.2	0.7	16.8	0.6	12.6	0.5

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

NOTE:

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 above.
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 "Start-Up Instructions" in the Installation and Service 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.

INSTALLATION WITH A CHILLED WATER SYSTEM

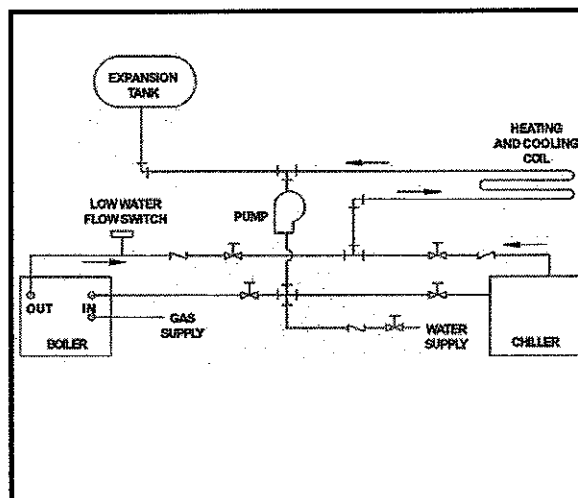


FIG. 38 Installation with a Chilled Water System

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 Figure 38)

BOILER OPERATING TEMPERATURE CONTROL

The operating temperature control is located on the front control panel, behind the front access door. The sensing element for the operator is placed in a bulb well installed in the inlet side of the heat exchanger front header. 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. This sensing element location allows 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 the system's requirements. Turn the control set point dial to the desired operating water temperature. Observe the boiler discharge temperature after each set point adjustment to ensure proper operation.

ROOM THERMOSTAT OR REMOTE THERMOSTAT CONNECTION TO TERMINAL BOARD

A room thermostat or remote temperature control may be connected to the boiler. The room thermostat should be installed on an inside wall, away from the influences of drafts, hot or cold water pipes, lighting fixtures, televisions, sun rays or fireplaces. Follow the manufacturers instructions supplied with the thermostat for proper installation and adjustment. The boiler is equipped with a terminal strip on the left side of the control panel to allow easy connection.

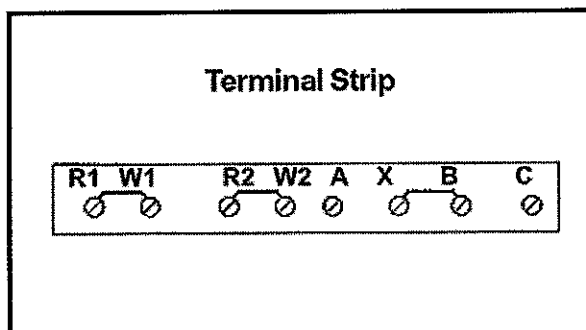


FIG. 39 Terminal Strip

Remove the jumper between the R1 and W1 terminals on the terminal strip. Refer to the chart in this section to determine maximum allowable length and wire gauge recommended to connect the switching contacts of the room thermostat to the R1 and W1 terminals on the terminal strip. Connection to the terminal strip will allow the room thermostat to make and break the 24 VAC boiler control circuit turning the boiler on and off based on the room ambient temperature requirements. Set the boiler operating temperature control as described above.

TABLE - U WIRE GAUGE REQUIREMENTS FOR TERMINAL STRIP CONNECTION

Wire Gauge	Maximum Allowable Length
12 GA	100 ft
14 GA	75 ft
16 GA	50 ft
18 GA	30 ft

DOMESTIC HOT WATER SUPPLY BOILER

This section applies only to those units used to supply domestic hot water, usually in conjunction with a 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 hot water supply boiler.

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 boilers are designed for installation with a storage tank. The use of a properly sized pump and the control of water velocity, as explained below, is important for correct operation of your hot water supply boiler.

PUMP DELAY

This hot water supply boiler is factory equipped with a feature to allow the circulating pump to operate only on a call for heat. The hot water supply boiler is provided with a relay to switch the power "ON" and "OFF" to the pump with each call for heat. The relay is also coupled with a time delay to operate the circulating pump for approximately 30 seconds after the thermostat is satisfied. This time delay allows the circulating pump to remove any residual heat from the combustion chamber before the pump is turned off.

NOTE:

Installation of this hot water supply boiler equipped with a pump delay system requires that a remote tank thermostat **MUST** be installed in the storage tank that is piped to this unit.

When a hot water supply boiler is ordered without a circulating pump, it will be equipped with a pump delay relay and wire leads ONLY. It is the installing contractors responsibility to provide an all bronze circulating pump and a remote tank thermostat.

Proper operation of a pump delay system requires that the unit's operating thermostat sense the temperature of the water in the storage tank. A separate remote mount thermostat will be provided. The remote mount thermostat must be installed in a bulb well in the storage tank. A bulb well is provided on the side of the tank, near the circulating connections. This allows the temperature sensing bulb to be inserted into the lower 25% of the storage tank. The remote mount thermostat must then be wired into the unit's control circuit. This is accomplished by first removing the jumper between the R and W contacts on the unit's terminal strip. Install wiring (18 Ga. Min) from the remote mount thermostat terminals to the R and W terminals. This connects the remote tank thermostat into the unit's 24 VAC control circuit. The enclosure for the remote mount thermostat may be attached to the exterior of the storage tank jacket with self drilling sheet metal screws. The remote mount tank thermostat should be set at the desired water temperature. The existing operating thermostat on the unit must be set at a higher temperature to function as an additional high water temperature limit control. Ensure that the flow switch is wired to the X and B terminals when using the pump delay option. The remote thermostat provided will operate one hot water supply boiler piped to one storage tank. For two heater / one tank systems, a two-stage thermostat must be purchased separately. For three or more heater / one tank systems, a Mod-u-Pak control system must be purchased separately.

NOTE:

These hot water supply boilers are provided from the manufacturer with a single power supply to the unit for operation of both the standard circulating pump and controls.

All circulating pumps shipped with these units equipped with the Pump Delay Systems are all bronze pumps to ensure that no water discoloration can occur in an extended off cycle of the pump.

WATER VELOCITY CONTROL

IMPORTANT:

To ensure proper velocity through the heat exchanger, it is necessary to regulate the temperature rise across the heat exchanger from inlet to outlet. This must be done on initial installation and periodically rechecked. With the correct temperature rise across the heat exchanger, you may be assured of the proper velocity in the tubes. This will yield long life and economical operation from your hot water supply boiler. Excessive lime build-up in the tube is a result of too little velocity in the tubes. Excessive pitting or erosion in the tube is caused by too much velocity through the tubes. Care should be taken to measure temperature rise and maintain a velocity as follows:

1. With the pump running and the hot water supply boiler 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 hot water supply 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 V. 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 hot water supply boiler.
2. Be sure all valves are open between the hot water supply boiler 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.
4. Be sure the circulation pipes between the hot water supply boiler and storage tank are not less than 1 1/4" diameter for a single unit 100,000 Btu/hr installation and 2" diameter for a single unit 150,000 through 300,000 Btu/hr installation.
5. Common manifold piping for multiple unit installations will require larger minimum pipe sizes to ensure proper flow. See Table W.

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 hot water supply boiler until the temperature rise is steady at the required temperature rise as noted in Table V.

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.

**TABLE - V
WATER HEATER
TEMPERATURE RISE**

Btu/hr Input	Temperature Rise °F
100,000	5.7
150,000	4.6
199,999	6.2
250,000	7.7
300,000	9.3

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 manufacturer when heating 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.

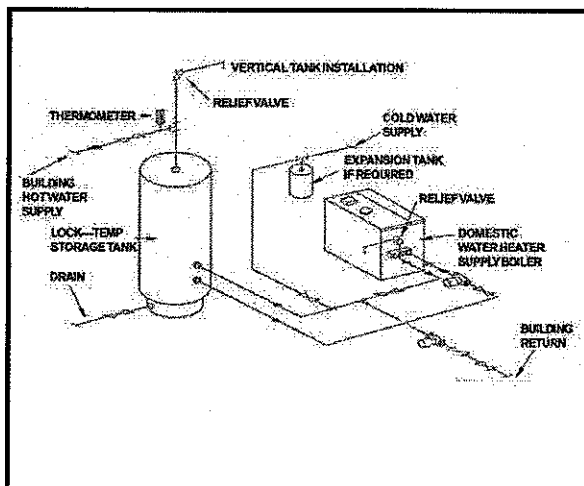


FIG. 40 Typical Water Heater Piping with Storage Tank

**TABLE - W
COMMON WATER MANIFOLD SIZE FOR
MULTIPLE HOT WATER SUPPLY
BOILER INSTALLATIONS**

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

100,000 BTU/HR MODEL	
Number of Units	Common Manifold Size (Min)
1	1 1/2"
2	2"
3	2 1/2"
4	3"
5	3 1/2"
6	3 1/2"

150,000 THROUGH 300,000 BTU/HR MODELS	
Number of Units	Common Manifold Size (Min)
1	2"
2	3"
3	3 1/2"
4	4"
5	5"
6	5"

PUMP OPERATION

1. The hot water supply boiler 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."
3. The hot water supply boiler is equipped with a factory supplied pump delay system.
4. Lubricate pump to manufacturers recommendations. Pump damage due to inadequate lubrication is non-warrantable.

5. Standard 100,000 Btu/hr hot water supply boilers are furnished with a 1/6 HP, 120 VAC, 3.6 Amp circulating pump, 150,000 through 300,000 Btu/hr hot water supply boilers are furnished with a 1/4 HP, 120 VAC, 5.8 Amp circulating pump. The circulating pump must be mounted on the units inlet water connection. The pump is sized based on installation of the 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.

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.

TABLE - X MINIMUM PUMP PERFORMANCE

Based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 PPM. See "Water Chemistry."

Btu/hr Input	GPM	Ft. Hd.
100,000	30	8
150,000 - 300,000	55	10

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.

THERMOSTAT SETTINGS

1. The thermostat(s) are adjusted to a low test setting when shipped from the factory.
2. Set the thermostat(s) to the lowest settings which will satisfy hot water demands and prevent risk of scald injury.

THERMOSTAT ADJUSTMENT (Domestic Hot Water Use)

This unit has an adjustable thermostat to control water temperature. See temperature adjustment procedure in general section of the manual. The thermostat is factory pre-set at approximately 125°F (52°C). Households with small children or invalids may require 120°F (49°C) or lower temperature setting to reduce risk of scald injury. Some states may require a lower temperature setting. Check with your gas supplier for local requirements governing the temperature setting. Remember, no water heating system will provide exact temperature at all times. Allow a few days of operation at this setting to determine the correct temperature setting consistent with your needs.

NOTE:

(1) This water heater, when set at the lower temperature setting, is not capable of producing hot water of sufficient temperature for sanitizing purposes. (2) Higher stored water temperature increases the ability of the water heater to supply desired quantities of hot water, however remember.

CAUTION

Hotter water increases the risk of scald injury.

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. The cold water supply piping must be installed 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 typical installation drawings provided with the unit for correct piping. Higher water temperatures reduce condensate formation.

CAUTION

Setting the temperature selector to higher settings provides hotter water, which increases the risk of scald injury.

The manufacturer recommends the use of a properly sized thermostatic mixing valve to supply domestic hot water at temperatures less than 140°F (60°C). Storing the water at a higher temperature and thermostatically mixing the water will increase the available quantity of mixed hot water, greatly reduce the possibility of condensate formation on the heat exchanger and help prevent the growth of water born bacteria. Adequate care **MUST** be taken to prevent potential scald injury when storing water at 140°F (60°C) and hotter.

ILLUSTRATION HOT WATER DANGER LABEL

WARNING

Should overheating occur or the gas supply fail to shut off, turn off the manual gas control valve to the appliance.

HIGH WATER TEMPERATURE LIMIT CONTROL

The unit is equipped with a fixed setting, auto-reset high water temperature limit control. The hot water supply boiler temperature limit control has a fixed 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 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. A manual reset high water temperature limit control is available as an optional control.

OPTIONAL RELIEF VALVE

This hot water supply boiler 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 hot water supply boiler 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 can be produced in a hot water system that has not been used for a long period of time (generally two weeks or more). Hydrogen gas is extremely flammable. To prevent the possibility of injury under these conditions, we recommend the hot water faucet be open for several minutes at the kitchen sink before you use any electrical appliance which is 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. There should be no smoking or open flames near the faucet at the time it is open.

COMPONENT LOCATIONS

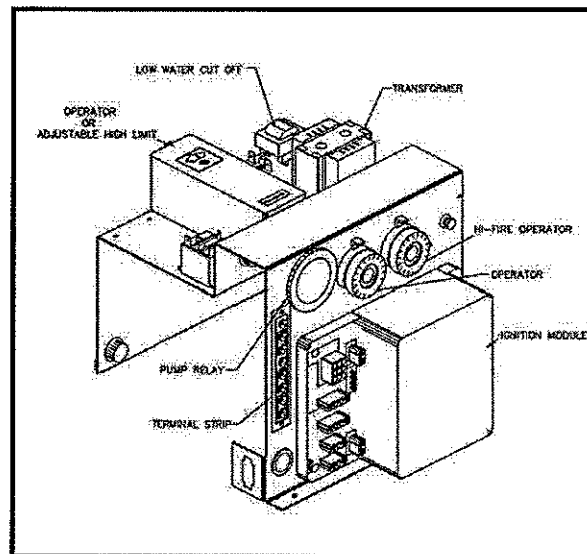


FIG. 41 Control Panel

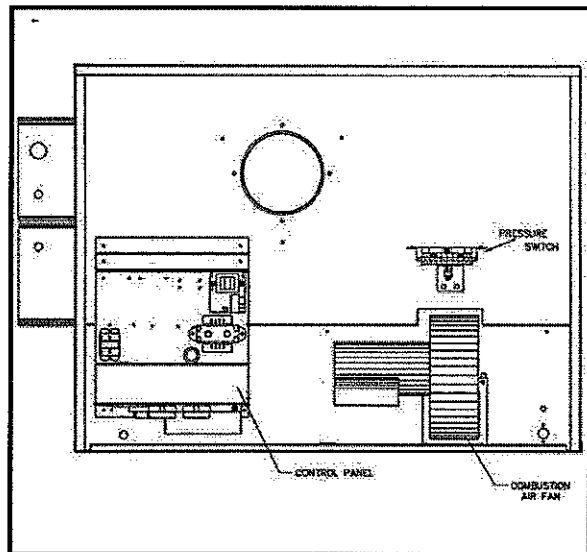
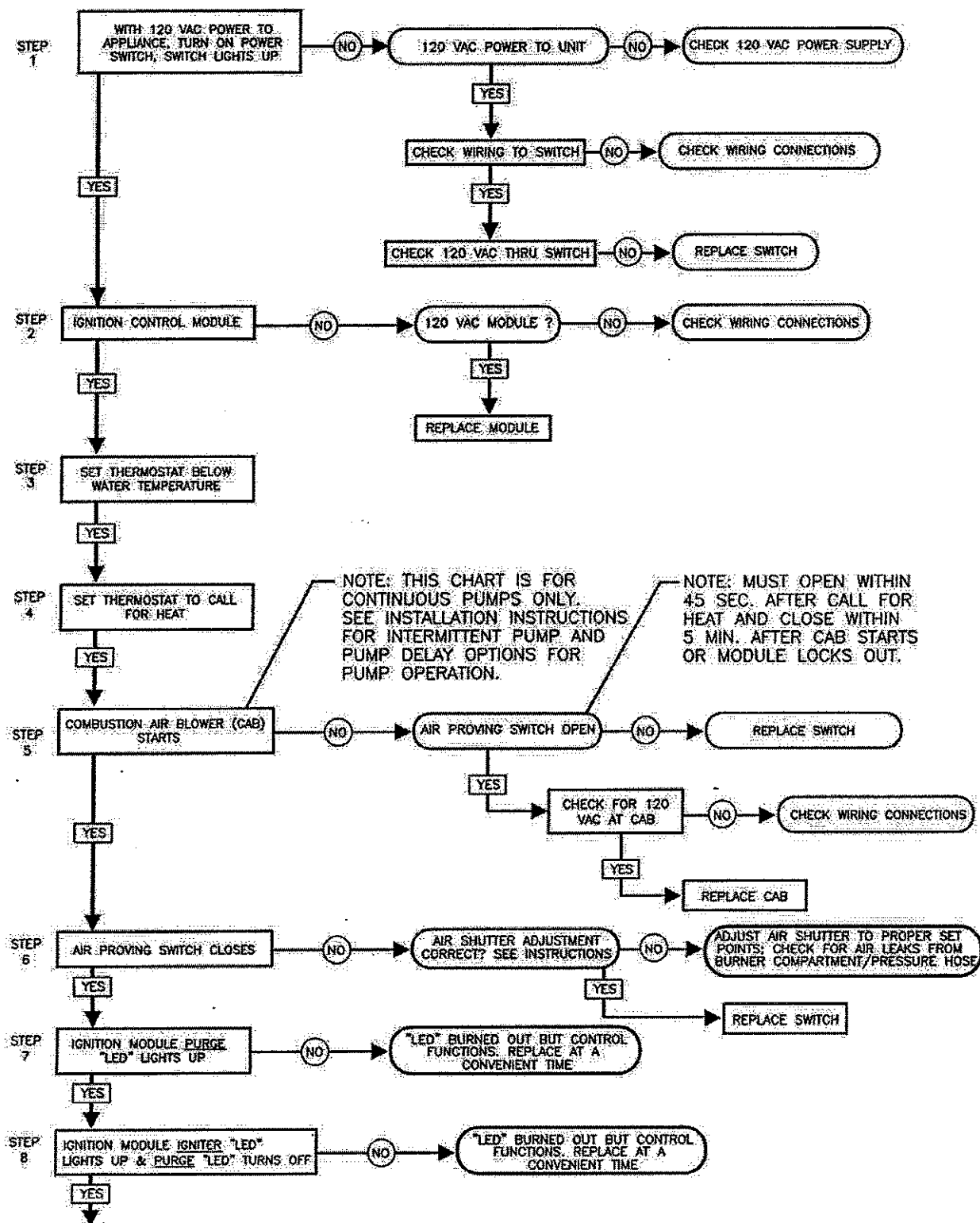


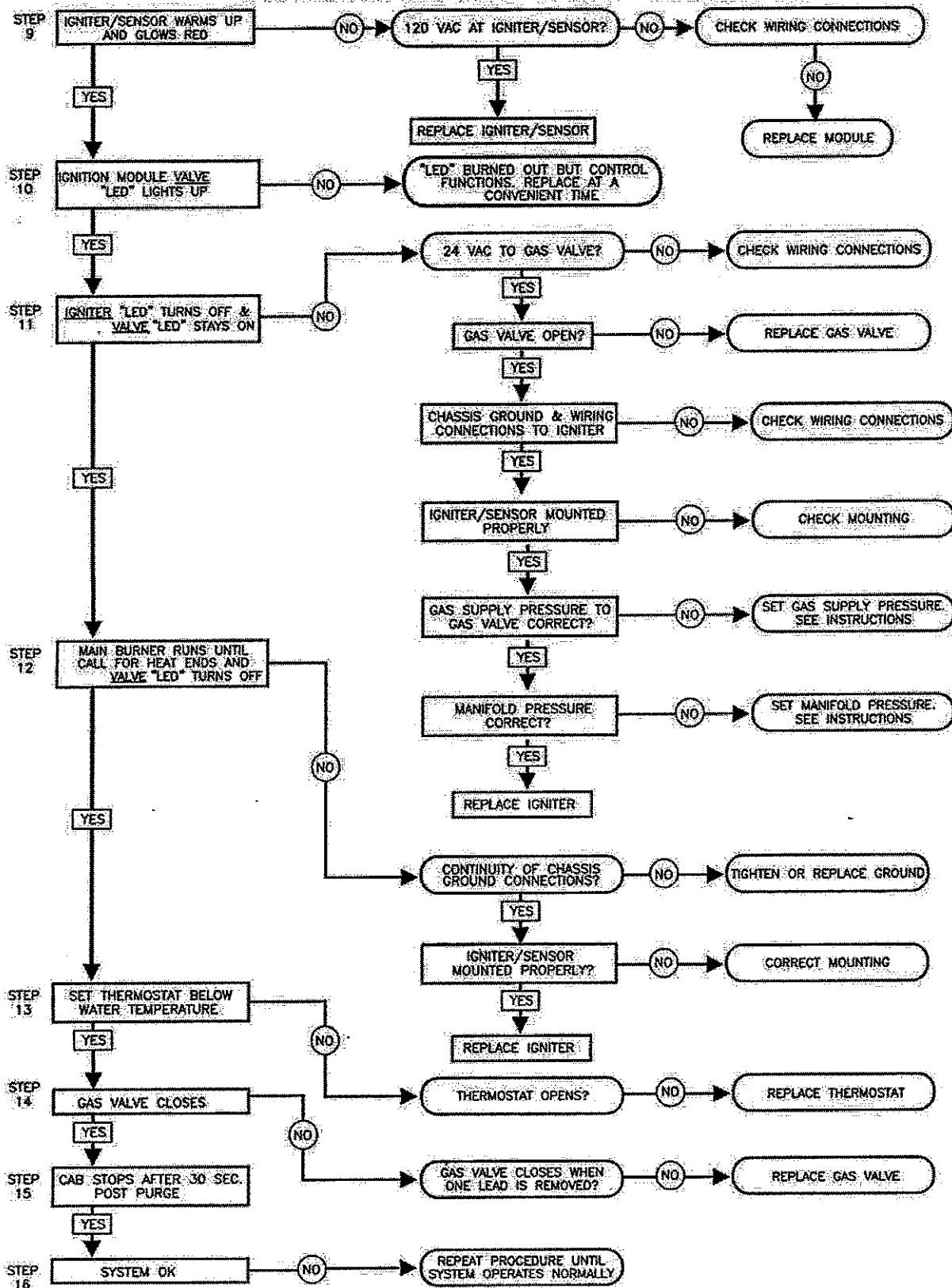
FIG. 42 Top View of Unit

TROUBLESHOOTING CHART

NOTE: REFER TO WIRING DIAGRAM SUPPLIED WITH UNIT



TROUBLESHOOTING CHART CONTINUED



Notes
