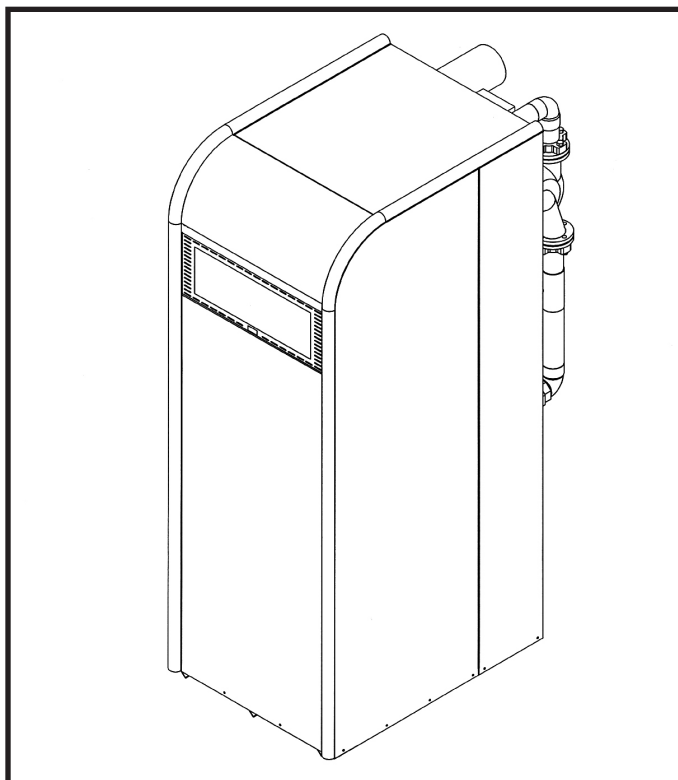


# INSTALLATION AND SERVICE MANUAL



**Intelli-Fin®**  
**Hot Water Heating Boilers**  
**Domestic Hot Water Supply Boilers**  
**1,500,000 — 1,700,000 — 2,000,000 Btu/hr Models**



**FIG. 1 Front View**

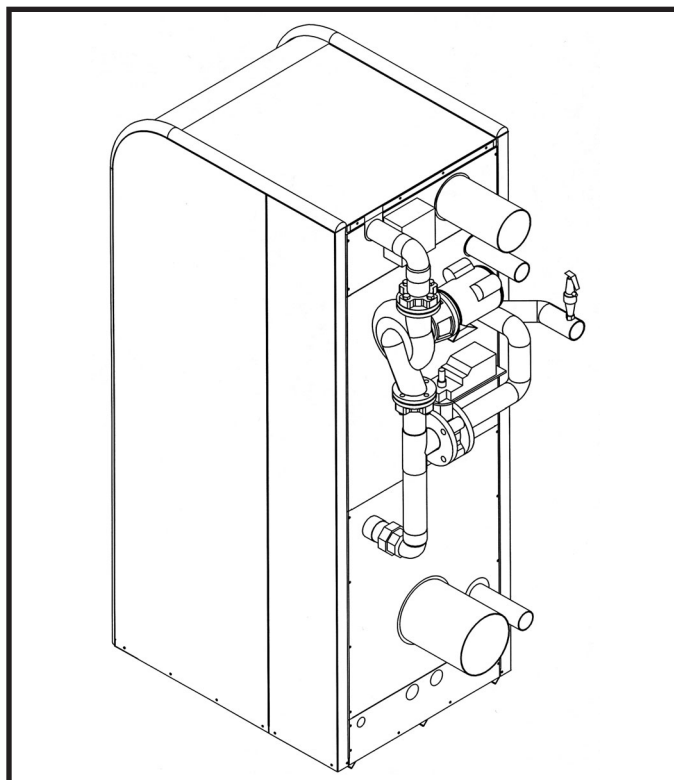
Installation and service must be performed by a qualified service installer, service agency or the gas supplier.

## 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/scale 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).



**FIG. 2 Rear View**

## 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 injury or property damage. Refer to this manual. For assistance or additional information, consult a qualified installer, service agency or the gas supplier.

## TABLE OF CONTENTS

Warranty .....	1	Gas Pressure Switches .....	37
Safety Warnings .....	3	Excel 10 Boiler Interface Controller .....	37
Codes .....	3	Command Display .....	39
<b>Installation Requirements</b> .....	4	Password .....	39
Location .....	4	Changeable Points .....	40
Clearances .....	4	Data Points in Display .....	40
Combustion/Ventilation Air Requirements .....	5	Status Points — Operation .....	42
Construction Air Filter.....	7	Status Points — Alarm .....	43
<b>Venting Systems</b> .....	8	Temperature Adjustment .....	43
Category IV Venting .....	9	Outdoor Reset Function .....	44
Flue Pipe Materials.....	9	Multiple Appliance Installations .....	44
Installation Guidelines .....	9	Sequencing Options .....	45
Vent Length Requirements .....	10	E-Bus Connection .....	45
Vertical Terminations .....	10	Temperature Limit Control.....	47
Drain Tee Installation .....	10	Hot Surface Ignition Control .....	48
Sidewall Terminations .....	12	Hot Surface Igniter.....	48
Direct Vent Systems .....	13	Diagnostic Status LED.....	49
Air Inlet Pipe Materials .....	14	Operation/Diagnostic Lights and Switches .....	50
Air Inlet Pipe Length Requirements .....	14	Burner Assembly .....	50
Vertical Direct Vent .....	15	Combustion Air Blower .....	51
Location Requirements.....	15	Condensate Management System.....	52
Multiple Direct Vent Installations .....	16	Installation and Operation .....	52
Horizontal Direct Vent .....	16	Blocked Drain Switch .....	53
Location Requirements.....	16	<b>Lighting Instructions</b> .....	54
Multiple Direct Vent Installations .....	18	<b>Sequence of Operation</b> .....	56
Intelli-Vent Systems.....	18	<b>Maintenance</b> .....	57
Materials .....	18	Vent System .....	57
Length Requirements .....	18	Flame Patterns .....	57
Vertical Flue - Sidewall Air .....	19	Burner Cleaning.....	58
Sidewall Flue - Rooftop Air .....	20	Heat Exchanger Inspection .....	60
Sidewall Flue - Sidewall Air .....	21	Lubrication .....	61
<b>Gas Supply</b> .....	22	Combustion Air Measurements .....	61
Gas Pressures and Piping .....	22	Freeze Protection .....	62
Manifold Pressure.....	22	<b>Heating Boiler</b> .....	63
Supply Pressure Measurement .....	25	Piping .....	64
Manifold Pressure Measurement .....	26	Piping Length and Diameter .....	64
Water Connections .....	27	Integral Pump Limitations .....	64
Heat Exchangers .....	28	Boiler Pump Operation.....	65
Integral Bypass .....	29	Primary/Secondary Piping .....	65
Valve and Pump .....	29	Minimum Water Temperatures .....	66
Synchronization .....	29	Three Way Valves.....	67
Set-up Maximum Flow.....	30	Boiler Flow Rates.....	67
Bypass Operation .....	31	Placing the Boiler in Operation .....	67
<b>Minimum Water Temperatures</b> .....	31	Boiler Temperature Control .....	69
Flow Switch .....	32	<b>Water Heater/Domestic Hot Water Supply Boiler</b> ....	70
Low Water Cut-Off.....	32	Typical Piping.....	70
Relief Valve.....	32	Set-up Maximum Flow.....	70
Gas Train.....	32	Temperature Rise .....	71
Ratio Gas Valve .....	33	Water Chemistry.....	72
Diaphragm Gas Valve .....	33	Piping Requirements .....	73
Electrical Requirements .....	34	Pump Operation .....	74
Jacket .....	34	Temperature Adjustment .....	75
<b>Components and Controls</b> .....	35	Minimum Inlet Temperatures .....	75
Variable Frequency Drive.....	36	Risk of Scald Warnings .....	76
Low Air Pressure Switch .....	37	Relief Valve .....	76

## 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

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 neighbor's 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.**

## OWNER WARNING⚠

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

## IMPORTANT

Consult and follow local Building and Fire Regulations and other Safety Codes that apply to this installation. Contact the local gas utility company to authorize and inspect all gas and flue connections.

A gas appliance that draws combustion air from the equipment room where it is installed must have a supply of fresh air circulating around it during burner operation for proper gas combustion and proper venting.

## 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 appliance, never violate the following safety rules.

1. Always keep the area around your appliance free of combustible materials, gasoline, and other flammable liquids and vapors.
2. Never cover your appliance, 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 appliance.

## 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-B 149 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, the installation must comply with the CSA International, CAN/CGA-B149 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 appliance 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 airflow. 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 so that the ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service (circulator replacement, control replacement, etc.)
3. Appliances located in a garage or parking structure shall be installed so that all burners and burner ignition devices have a minimum clearance of 18" (46 cm) above the floor. The appliance shall be located or protected so that it is not subject to physical damage by a moving vehicle.
4. The appliance must be installed on a level floor. Combustible floor locations may be used. Maintain required clearances from combustible surfaces.
5. The appliance must not be installed on carpet.

6. The appliance must be installed indoors where it is protected from exposure to wind, rain and weather.
7. This appliance may condense the products of combustion when operating at water temperatures below 130°F (54.4°C). Ensure that the appliance is located near an acceptable drain where the condensate from the heat exchanger and venting system may be properly collected, neutralized and disposed.

### TABLE - A Clearances from Combustible Construction:

Right Side - 0"

Rear - 9" (23 cm) (Minimum 24" (0.61 m) suggested for service to pump and components)

Left Side - 0"

Front - ALCOVE\* (Minimum 24" (0.61 m) suggested for service)

Flue - 1" (25.4 mm)

Hot Water Pipes - 1" (25.4 mm)

\*An ALCOVE is a closet without a door.

## CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

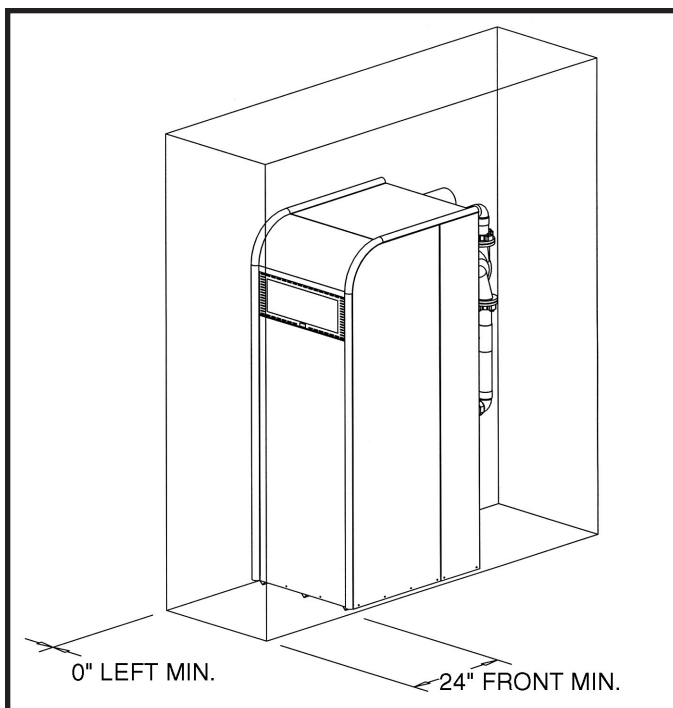


FIG. 3 Clearances from Combustible Construction

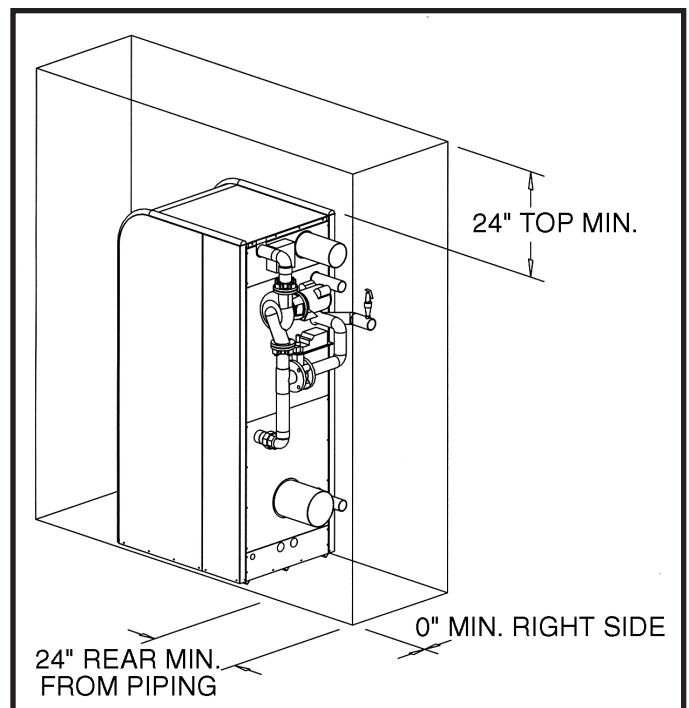


FIG. 4 Clearances from Combustible Construction

## NOTE

Clearances from combustible construction are noted on the appliance rating plate.

Maintain minimum specified clearances for adequate operation. All installations must allow sufficient space for servicing the vent connections, water pipe connections, integral circulating pump, bypass piping and other auxiliary equipment, as well as the appliance. The clearance labels on each appliance note the same service and combustible clearance requirements as shown in the clearances from combustion construction table.

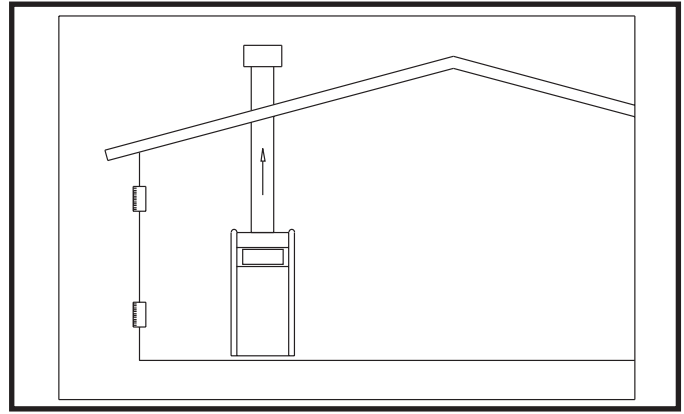
Multiple appliances may be installed in a modular boiler or water heater installation. Multiple appliances may be installed side by side with no clearance between adjacent appliances because this appliance is approved for zero clearance from combustible surfaces and no service access is required from the sides.

Consult the venting section of the manual for specific installation instructions for appropriate type of venting system that you will be using. **Direct Vent** and **Intelli-Vent** venting systems require installation with **Category IV** flue pipe, sealed air inlet pipe and air inlet caps, which must meet the manufacturer's specifications.

## COMBUSTION AND VENTILATION AIR REQUIREMENTS FOR APPLIANCES DRAWING AIR FROM THE EQUIPMENT ROOM

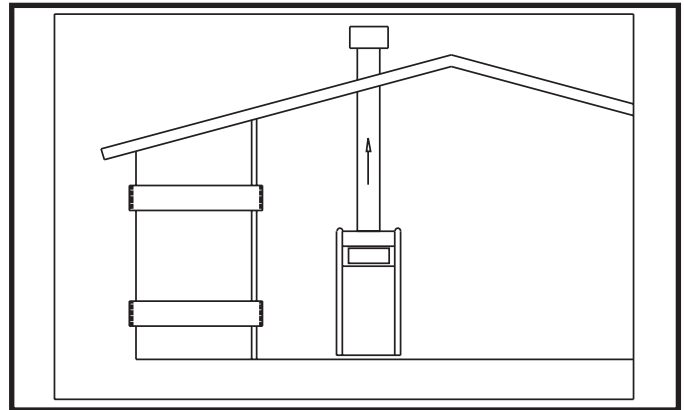
Provisions for combustion and ventilation air must be in accordance with Section 5.3, Air for Combustion and Ventilation, of the latest edition of the National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment, 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 a basic **Category IV** venting system.



**FIG. 5 Combustion 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 input (5.5 cm<sup>2</sup> per kW). This opening must be located within 12" (30cm) of the bottom of the enclosure.
  - b. Ventilation air opening, with a minimum free area of one square inch per 4000 Btu input (5.5 cm<sup>2</sup> per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.



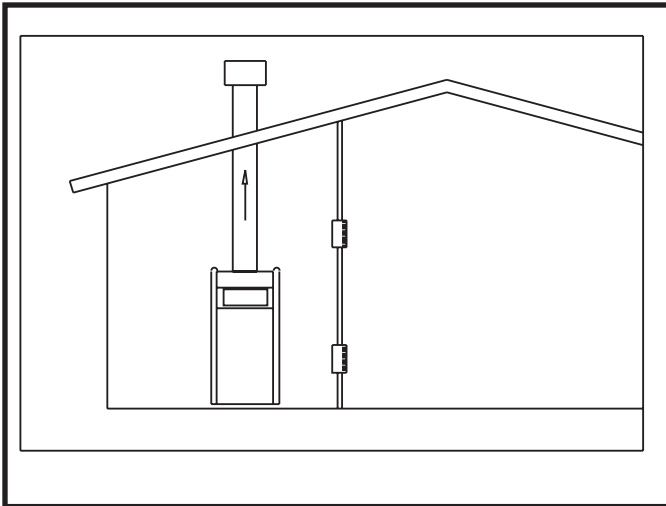
**FIG. 6. Combustion Air Through Ducts**

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 (11 cm<sup>2</sup> per kW) of input.

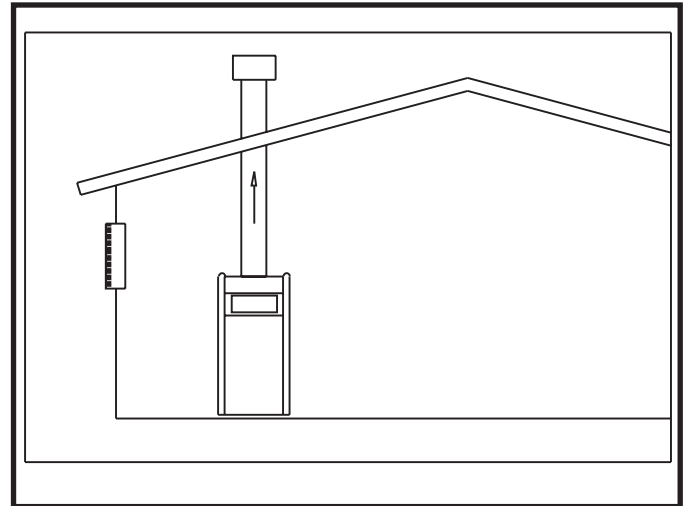
**TABLE - B**  
**Minimum Recommended Combustion**  
**AIR SUPPLY TO MECHANICAL ROOM**

Combustion Air Source			
Btu/hr Input	Outside Air* 2 - Openings	Outside Air* 1 - Opening	Inside Air 2 - Openings
1,500,000	375 in <sup>2</sup> (2419 cm <sup>2</sup> )	500 in <sup>2</sup> (3226 cm <sup>2</sup> )	1,500 in <sup>2</sup> (9,677 cm <sup>2</sup> )
1,700,000	425 in <sup>2</sup> (2742 cm <sup>2</sup> )	567 in <sup>2</sup> (3658 cm <sup>2</sup> )	1,700 in <sup>2</sup> (10,968 cm <sup>2</sup> )
2,000,000	500 in <sup>2</sup> (3226 cm <sup>2</sup> )	667 in <sup>2</sup> (4303 cm <sup>2</sup> )	2,000 in <sup>2</sup> (12,903 cm <sup>2</sup> )

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



**FIG. 7 Combustion Air from Interior Space**



**FIG 8 Combustion Air from Outside - Single Opening**

- If air is taken from another interior space, each of the two opening specified above should have a net free area of one square inch for each 1000 Btu (22 cm<sup>2</sup> per kW) of input, but not less than 100 square inches (645 cm<sup>2</sup>).
- 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 (7 cm<sup>2</sup> per kW). This opening must be located within 12" (30 cm) of the top of the enclosure.

### **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 an appliance that draws combustion air from the equipment room.



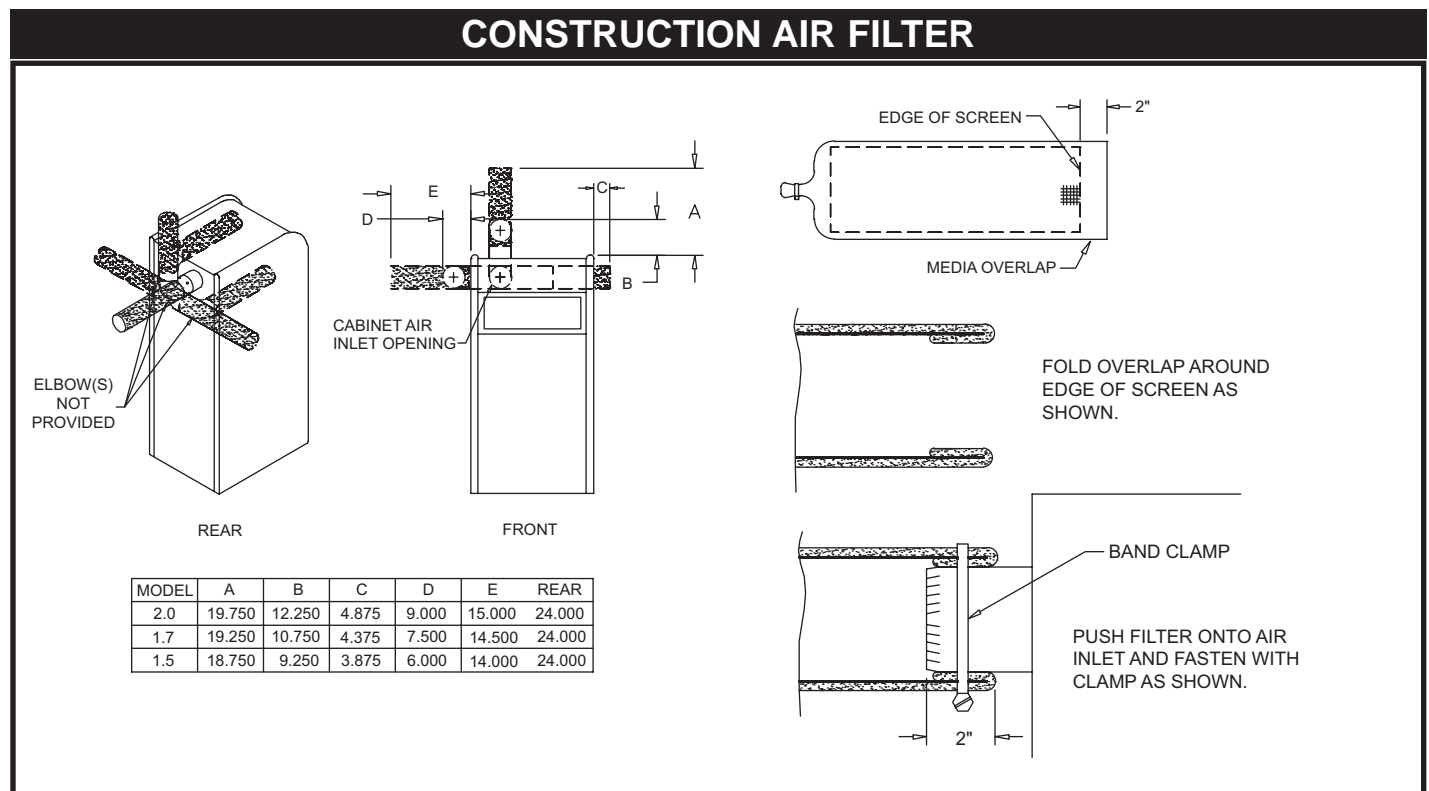
All dimensions based on net free area in square inches. Metal louvers or screens reduce the free area of a combustion air opening a minimum of approximately 25%. Check with louver manufacturers for exact net free area of louvers. Where two openings are provided, one must be within 12" (30 cm) of the 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 the chart above. Single openings shall commence within 12" (30 cm) of the ceiling.

The combustion air supply must be completely free of any chemical fumes that may be corrosive to the boiler. Common chemical fumes that 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 appliance stack. The result is improper combustion and a non-warrantable, premature failure of the appliance.

**EXHAUST FANS:** Any fan or equipment which exhausts air from the equipment 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 equipment room, the installer must make sure that it does not cause drafts that could lead to nuisance operational problems with the appliance.

A construction air filter is installed on the appliance as shipped. The filter assembly is installed on the combustion air inlet located at the rear of the appliance. The filter assembly slips over the air inlet collar and is secured in place with the clamp provided with the filter. If limited space is available at the rear of the appliance, field supplied elbows may be used to mount the filter in the alternate positions shown in the illustration. This filter is **For Temporary Use Only** on an appliance that must be operated for temporary heat or hot water when a building is under construction. The filter will provide a temporary means to remove airborne dust, dirt and particulate matter generated by construction. The filter prevents airborne particulate contaminants from being drawn into the burner with the combustion air. The filter can be cleaned routinely during construction if necessary. Remove the filter to clean. Wash the filter with water. A flow of water from the inside to the outside should remove most particle matter. Allow the filter to dry before reinstalling. Unfiltered combustion air from a construction site can contain contaminants that will collect in the burner reducing the firing rate. A burner that becomes clogged with airborne particulate contaminants must be removed and cleaned to restore proper operation to the burner. Sustained operation of an appliance with a clogged burner may result in nuisance operational problems, bad combustion and non-warrantable component failures. The construction air filter **MUST** be removed from the appliance's air inlet before the appliance is placed in normal operation. Once the construction air filter is removed, ensure that either the equipment room is supplied with combustion air from properly sized combustion and ventilation air openings or a combustion air duct from a **Direct Vent** or **Intelli-Vent** system is connected to the appliance.



The optional **Direct Vent** and **Intelli-Vent** venting systems have specific requirements for a special combustion air duct from the outside that is directly connected to the appliance. See the requirements for this combustion air duct in the venting section for each specialized vent system.

**CONSTRUCTION AIR FILTER KITS  
TABLE - C**

Input Btu/hr	Construction Air Filter Kit
1,500,000	KIT4000
1,700,000	KIT4001
2,000,000	KIT4002

## VENTING

### *Vent System Options*

This appliance has three venting system options. They are: (A) **Category IV Venting** system with vertical roof top termination or sidewall termination of the flue and combustion air supplied from the mechanical room. (B) **Direct Vent** with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Direct Vent system terminates both the flue and air inlet in the same pressure zone. The flue outlet and combustion air intake may terminate on either the sidewall or with a rooftop termination. (C) **Intelli-Vent** with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Intelli-Vent system terminates the flue and the combustion air inlet pipe in different pressure zones. The Intelli-Vent system may terminate the flue on the roof top and combustion air intake on the sidewall, the flue on the sidewall and combustion air from the rooftop or the flue on the sidewall and combustion air from a different sidewall. All appliances are shipped from the factory equipped for **Category IV** venting. The optional **Direct Vent and Intelli-Vent** venting systems will require the installation of specific vent kits and venting materials. The following is a detailed explanation of the installation requirements for each venting system, components used and part numbers of vent kits for each model.

### *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 Standard B149 Installation Codes for Gas Burning Appliances and Equipment or applicable provisions of the local building codes.

Adequate combustion and ventilation air must be supplied to the equipment room in accordance with the latest edition of the

National Fuel Gas Code, ANSI Z223.1, in Canada, the latest edition of CAN/CGA Standard B149 Installation Codes 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 Standard B149 Installation Code for Gas Burning Appliances and Equipment.

Vent connection is made directly to flue outlet opening on the back of the unit. The connection from the appliance vent to the stack must be made as direct as possible.

## 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.

**TABLE - D  
The Category IV Flue Pipe Sizes**

Input Btu/hr	Flue Size
1,500,000	6"
1,700,000	7"
2,000,000	8"



## Category IV Venting

### A CATEGORY IV POSITIVE PRESSURE VENTING SYSTEM

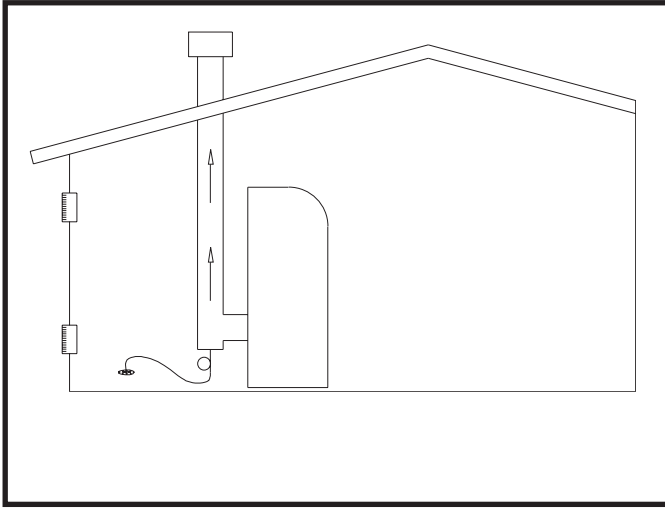


FIG. 10 Basic Category IV Venting - Vertical

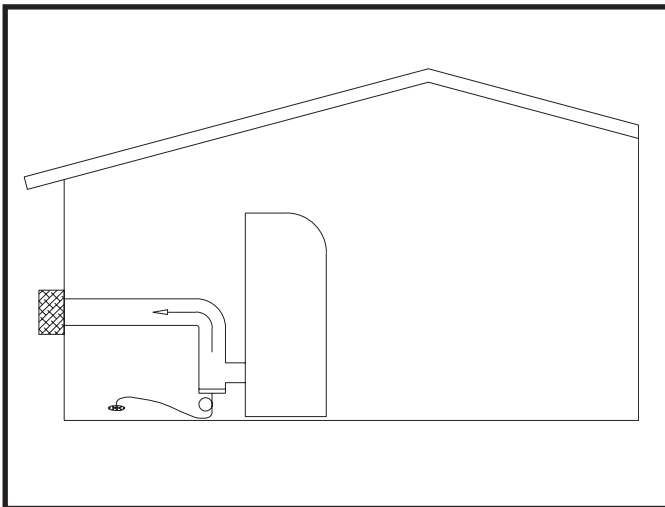


FIG. 11 Basic Category IV Venting - Horizontal

A **Category IV** venting system for the flue products is required on all models of this appliance. A **Category IV** venting system operates with a positive pressure in the vent. This positive pressure is generated by the internal combustion air blower which operates the combustion process and also exhausts the flue products from the building. The **Category IV** flue from this appliance can **NOT** be combined with the vent from any other appliance. The **Category IV** flues from multiple appliances can **NOT** be combined into a common vent. The **Category IV** flue from this appliance must be a dedicated stack. The flue from this **Category IV** appliance must have all vent joints and seams sealed gas-tight. A **Category IV** vent system has specific vent material and installation requirements.

The flue products in the vent system may be cooled below their dew point and form condensate in the flue. The materials used for a **Category IV** vent must be resistant to any corrosive damage from flue gas condensate. The flue from a **Category IV** vent system must have a condensate drain with provisions to properly collect and dispose of any condensate that may occur in the venting system.

### Category IV Flue Pipe Materials

Select venting material from the following specified vent materials:

**Heat-Fab Inc.** Saf-T CI Vent with AL29-4C stainless steel  
(Call 1-800-772-0739 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 Inc.** Corr/Guard Vent with AL29-4C stainless steel  
(Call 1-800-835-2830 for nearest distributor)

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

Or other listed **Category IV** vent systems suitable for a condensing, positive pressure gas fired appliance.

### Venting Guidelines for a Category IV Vent

The connection from the appliance vent to the stack or vent termination outside the building **MUST** be made with listed **Category IV** vent system and must be direct as possible with no reduction in diameter. The **Category IV** vent and accessories, such as firestop spacers, thimbles, caps, etc., **MUST** be installed in accordance with the vent manufacturers instructions. 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.

In a typical installation, each appliance must have a dedicated **Category IV** flue with no other appliance interconnected to any part of the dedicated flue. The flues from multiple Intelli-Fin appliances may only be combined when using an engineered vent system incorporating an induced draft fan to ensure that flue products will be properly exhausted from the building at all times. Failure to use a properly sized induced draft fan on a combined vent installation may result in a hazardous condition where flue gases spill into an occupied living space. Consult the induced draft fan manufacturer to size the induced draft fan and to determine the diameter of the common vent pipe required for a combined vent installation.

Any vent materials specified must be listed by a nationally recognized test agency for use as a **Category IV** vent material.

The venting system must be planned so as to avoid possible contact with concealed plumbing or electrical wiring inside walls, floors or ceilings. Locate the appliance as close as possible to chimney or gas vent.

There shall be no reductions in vent diameter.

Horizontal portions of the venting system shall be supported to prevent sagging. Horizontal runs should slope upwards not less than 1/4 inch per foot (21 mm/m) from the drain tee installed in the flue to the vertical portion of the flue or to the vent terminal on sidewall venting installations. This ensures proper removal of any condensate that may form in the flue. Follow the installation instructions from the vent material manufacturer.

Do not use an existing chimney as a raceway if another appliance or fireplace is vented through the chimney. The weight of the venting system must not rest on the unit. Adequate support of the venting system must be provided in compliance with local codes and other applicable codes. All connections should be secured and sealed per the vent manufacturers specifications.

Vent connectors serving appliances vented by natural draft shall not be connected to any portion of the **Category IV** positive pressure vent system used by this appliance. Connection of a negative draft flue into the positive pressure stack from this appliance may cause flue products to be discharged into an occupied living space causing serious health injury.

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

The installed length of the **Category IV** flue from the appliance to the point of termination, outside of the building, **must not exceed a maximum of 100 equivalent feet (30.5 m) in length.** Subtract 5 feet (1.5 m) of equivalent length for each 90° elbow installed in the vent. Subtract 2 1/2 feet (0.7 m) of equivalent length for each 45° elbow installed in the vent.

The flue may terminate either vertically at the roof top or horizontally on a sidewall. See the information about the specific vent termination location for recommended location and clearances.

### ***General Category IV Vent Termination Clearances***

The vent cap should have a minimum clearance of 4 feet (1.2 m) horizontally from and in no case above or below, unless a 4 foot (1.2 m) horizontal distance is maintained from electric meters, gas meters, regulators and relief equipment.

The venting system shall terminate at least 3 feet (0.9 m) above any forced air inlet within 10 feet (3.05 m).

The venting system shall terminate at least 4 feet (1.2 m) below, 4 feet (1.2 m) horizontally from, or 1 foot (30 cm) above any door, window or gravity air inlet into any building.

Do not terminate the vent in a window well, stairwell, alcove, courtyard or other recessed area. **The vent can not terminate below grade.** The bottom of the vent terminal shall be located at least 12 inches (30 cm) above grade and above normal snow levels.

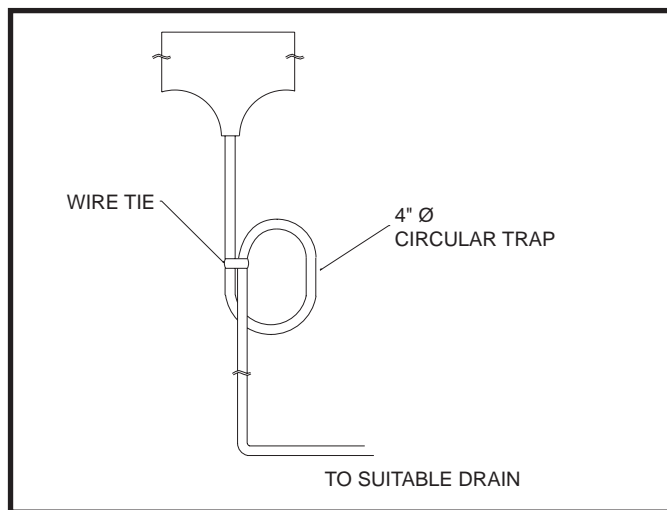
To avoid a blocked flue condition, keep the vent cap clear of snow, ice, leaves, debris, etc.

Flue gases from this appliance may contain large amounts of water vapor that will form a white plume in winter. Plume could obstruct a 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.

The manufacturer shall **NOT** be held liable for any personal injury or property damage due to ice formation or the dislodging of ice from the vent system or the vent termination.

### ***Drain Tee Installation***



**FIG. 12 Drain Tee**

A drain tee **MUST** be installed in the **Category IV** vent pipe to collect and dispose of any condensate that may occur in the vent system. The drain tee should be installed at the point where the flue turns vertical for a roof top termination or as one of the first fittings in a horizontal flue that will terminate on a sidewall. Ensure that horizontal portions of the vent are properly sloped to allow condensate to be evacuated at the drain tee. See the typical vent installation drawings. Plastic drain tubing, sized per the vent manufacturer's instructions, shall be provided as a

drain line from the tee. The drain tubing must have a trap provided by a 4" (10.2 cm)-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 the condensate neutralization system or a suitable drain for disposal of condensate that may occur in the **Category IV** vent system. Refer to the condensate drain installation instructions as supplied by the manufacturer of the vent material. Ensure that the drain from the condensate tee is not exposed to freezing temperatures. See "Freeze Protection" for more information.

## MASONRY CHIMNEY INSTALLATIONS

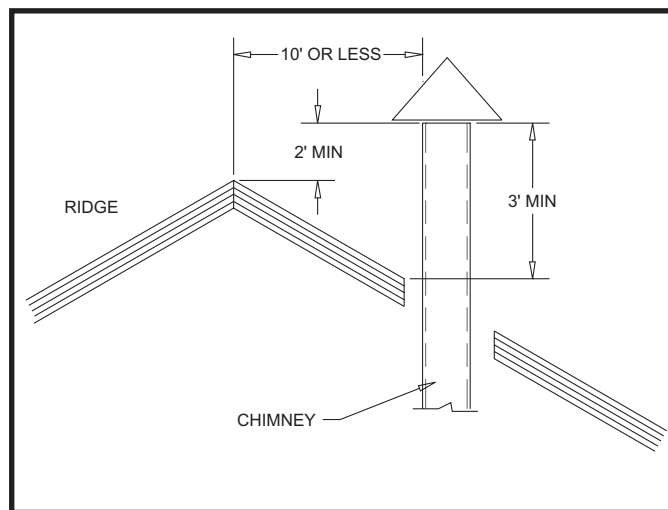
A standard masonry chimney must **NOT** be used to vent the products of combustion from the flue of a **Category IV**, positive pressure appliance. **If a masonry chimney is to be used, the chimney MUST use a sealed, metallic, corrosion resistant liner system to vent flue products from this high efficiency appliance. Sealed, metallic, corrosion resistant liner systems (single wall, double-wall, or flexible or rigid metallic liners) must be rated for use with a high efficiency Category IV, positive pressure vent system.** Corrosion resistant chimney liner systems are typically made from a high grade of corrosion resistant stainless steel such as AL 29-4C. The corrosion resistant liner must be properly sized and fully sealed throughout the entire length if the flue is contained within the masonry chimney. Both the top and the bottom of the masonry chimney must be capped and sealed to provide a dead air space around the sealed corrosion resistant metallic liner. **Consult with local code officials to determine code requirements or the advisability of using a masonry chimney with a sealed corrosion resistant liner system.**

## CAUTION⚠

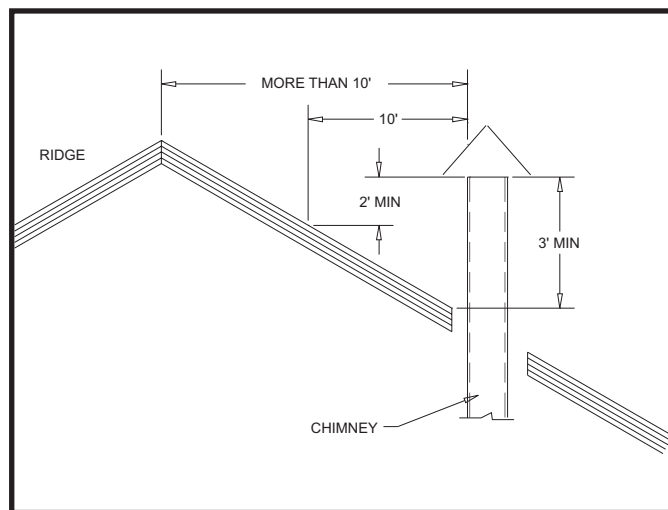
Venting of a high efficiency **Category IV** appliance into a masonry chimney without a sealed stainless steel liner can result in operational and safety problems. Any breaks, leaks or damage to the masonry flue/tile will allow spillage of the positive pressure flue products from the chimney. These flue products can easily escape into an occupied living space causing a health hazard. If there is any doubt about the condition of a masonry chimney, or its acceptability for use after insertion of a corrosion resistant liner system, consult with local code officials.

## VERTICAL VENTING TERMINATIONS

Follow all General **Category IV** Vent Termination Clearances.



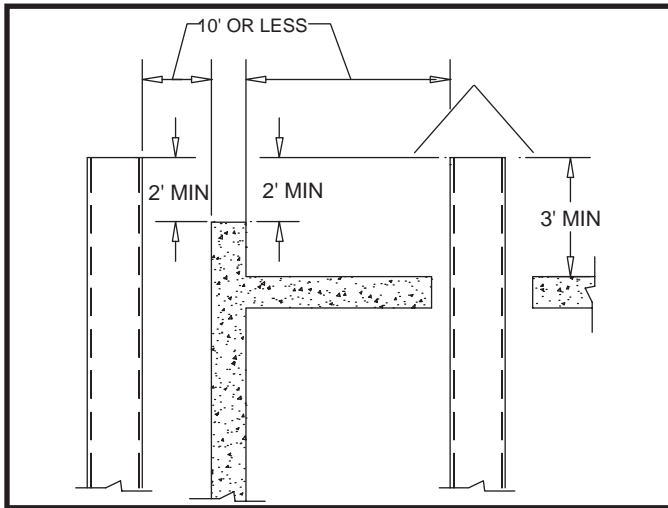
**FIG. 13 Vent Termination from Peaked Roof - 10 Feet or Less from Ridge**



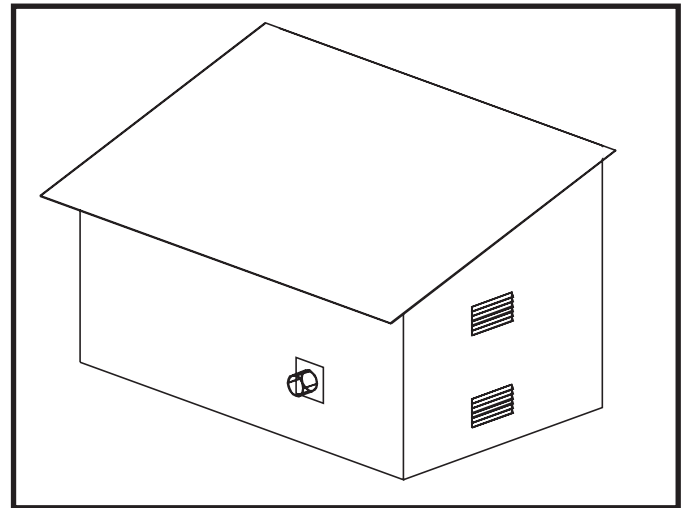
**FIG. 14 Vent Termination from Peaked Roof - 10 Feet or More from Ridge**

The vent terminal should be vertical and exhaust outside the building at least 2 feet (0.61 m) 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 (0.91 m) above the point of exit.

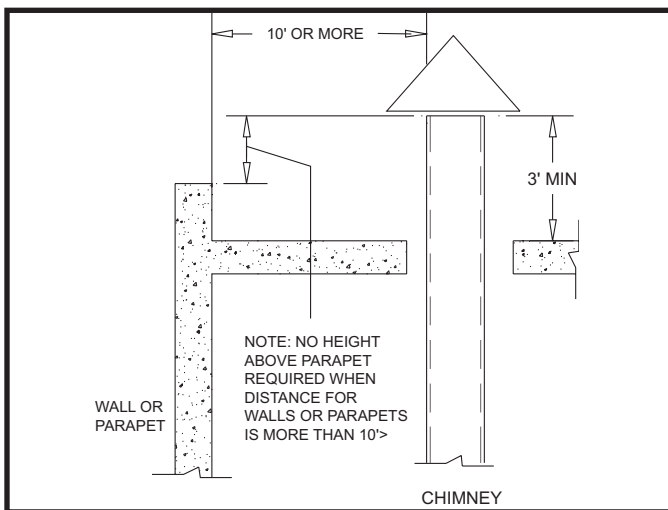


**FIG. 15 Vent Termination from Flat Roof - 10 Feet or Less from Parapet Wall**



**FIG. 17 Sidewall Venting Installation**

The connection from the appliance flue outlet to the sidewall vent cap **MUST** be made with listed type **Category IV** vent materials and accessories. The installer must supply suitable vent pipe material. The sidewall vent cap is available from the appliance manufacturer as a vent kit.

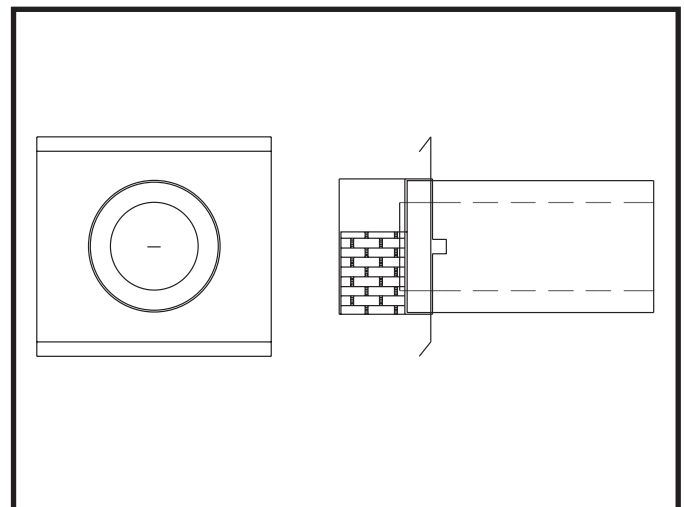


**FIG. 16 Vent Termination from Flat Roof - 10 Feet or More from Parapet Wall**

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

## SIDEWALL VENTING TERMINATIONS

This venting system uses the appliance's internal combustion air blower to force the flue products out of a horizontally-terminated flue. This blower generates a positive pressure in the flue. Combustion air is drawn from the equipment room (see Combustion and Ventilation Air Requirements) unless the appliance is equipped with an optional Direct Vent or Intelli-Vent System.



**FIG. 18 Sidewall Vent Cap**

**TABLE - E  
Sidewall Vent Cap Kits**

Input Btu/hr	Flue Size	Sidewall Vent Cap Kit
1,500,000	6"	SVK3026
1,700,000	7"	SVK3027
2,000,000	8"	SVK3028

The sidewall vent cap kit includes the wall penetration assembly and the discharge screen assembly. All required **Category IV** vent pipe and fittings must be purchased locally.

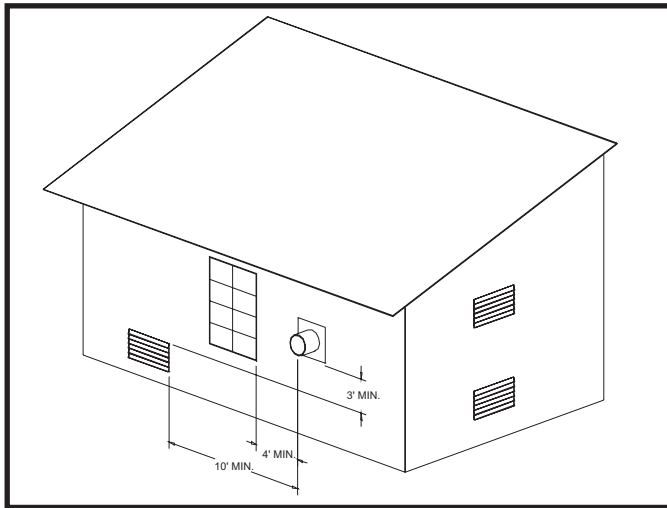
The installed sidewall vent cap assembly may be painted to match the exterior color. The opening through the wall for installation of the sidewall vent cap must provide an air space clearance of 2 inches (5.1 cm) around the flue pipe. The diameter of the opening for installation of the sidewall cap will be 4 inches (10.2 cm) larger (minimum) than the nominal diameter of the installed vent pipe to the sidewall cap.

The sidewall cap is installed from the outside and mounted to the wall with four screws or wall anchors. Seal under the screw heads with caulking. Install the screen assembly using the stainless steel screws provided in the kit. Install the **Category IV** vent pipe from the appliance to the vent cap. The installed vent pipe must protrude at least 2 inches (5.1 cm) into the screen area beyond the thimble portion of the sidewall cap assembly. See detailed instructions packed with the sidewall vent kit.

Follow all requirements in the General **Category IV** Venting sections for venting flue products to the outdoors. See the Combustion and Ventilation Air Requirements section to ensure that adequate combustion and ventilation air is supplied to the equipment room. All other general installation requirements must be followed.

## LOCATION OF A SIDEWALL VENT TERMINATION

Follow all General **Category IV** Vent Termination Clearances.



**FIG. 19 Sidewall Venting Installation with Clearances from Vent Cap**

The vent cap shall terminate at least 3 feet (0.91 m) 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 (0.30 m) above and 2 feet (0.60 m) horizontally from any door, window or gravity air inlet to the building.

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

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

The vent shall not terminate directly above a public walkway due to the normal formation of water vapor in the combustion process. Horizontal terminations must not be located over areas of pedestrian or vehicular traffic.

The vent system shall terminate at least 1 foot (0.30 m) above grade, above normal snow levels and at least 7 feet (2.13 m) above grade when located adjacent to public walkways.

The vent terminal shall not be installed closer than 3 feet (0.91 m) from an inside corner of an L-shaped structure.

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.

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 sidewall vent system must use the sidewall vent cap kit provided by the appliance manufacturer for installation on a sidewall termination.

The sidewall vent cap **MUST** be purchased as a kit from the appliance manufacturer to ensure proper operation. Locally purchased or fabricated sidewall vent caps should not be used.

## DIRECT VENT AND INTELLI-VENT SYSTEMS

**Direct Vent** and **Intelli-Vent** Systems are installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The **Direct Vent** System terminates both the flue and combustion air inlet in the same pressure zone. The **Intelli-Vent** System terminates the flue and combustion air inlet in different pressure zones. The flue outlet and combustion air intake may terminate with either a sidewall or a rooftop termination.

Follow all requirements in the General **Category IV** Venting sections for proper installation and venting of flue products vertically or horizontally to the outdoors. All other general installation requirements must be followed.

The Direct Vent and Intelli-Vent Systems require the installation of an additional pipe to supply combustion air from outdoors directly to the appliance.



In cold climates, the use of type “B” double wall vent pipe or an insulated single wall pipe for combustion air is recommended to help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

Termination point for the flue products must follow the clearance requirements in the Vertical or Horizontal Vent Termination sections of the **Category IV** Venting.

### CAUTION⚠

Appliances that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe connected to the appliance.

**TABLE - F**  
**Direct Vent and Intelli-Vent Flue and Air Inlet Pipe Sizes**

Input Btu/hr	Flue Size	Air Inlet Pipe Size
1,500,000	6"	6"
1,700,000	7"	7"*
2,000,000	8"	8"

\*Piping from the appliance to the air inlet cap may be either 7" or 8". An 8" diameter sidewall air inlet cap is provided in the vent kit.

### *Length of Air Inlet Pipe*

The maximum total length of the sidewall or vertical roof top combustion air inlet pipe as installed from the appliance to the air inlet cap must not exceed 100 equivalent feet (30.5 m) in length. Subtract 5 feet (1.52 m) of equivalent length for each 90° elbow installed in the air inlet pipe system. Subtract 2 1/2 feet (0.7 m) of equivalent length for each 45° elbow installed in the air inlet pipe system.

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

### *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 (6", 7" or 8" I.D.)\*

- Dryer Vent or Sealed Flexible Duct (not recommended for roof top air inlet)
- Galvanized steel vent pipe with joints and seams sealed as specified below.
- Type “B” double wall vent with joints and seams sealed as specified below.

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

### WARNING⚠

Using vent or air intake materials other than those specified, 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 appliance.

### NOTE:

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

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 Combustion Air Supply System

- 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.
- Do not install seams of vent pipe on the bottom of horizontal runs.
- 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.
- 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, Dryer Vent or Flex Duct air inlet pipe should



use a silicone sealant to ensure a proper seal at the appliance connection and the air inlet cap connection. Dryer vent or flex duct should use a screw type clamp to seal the vent to the appliance air inlet and 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.

When a sidewall or vertical roof top 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.

## **DANGER** ⚠

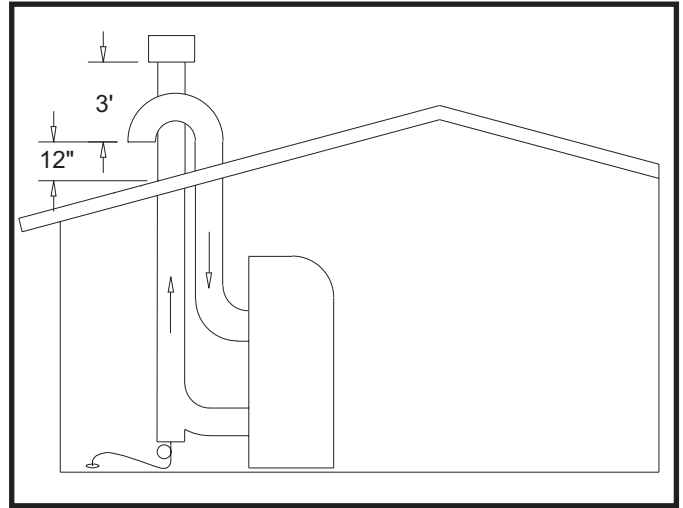
Failure to properly seal all joints and seams as required in the air inlet piping may result in flue gas recirculation, spillage of flue products and carbon monoxide emissions causing severe personal injury or death.

### ***Combined Combustion Air Inlet Points***

The air inlet pipes from multiple appliances 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 8" (20.3 cm) air inlet pipes [50.3 in<sup>2</sup> (324.5 cm<sup>2</sup>) area each] have a total area of 100.6 in<sup>2</sup> (645.2 cm<sup>2</sup>) requires a 12" (30.5 cm) [113.1 in<sup>2</sup> (729.7 cm<sup>2</sup>) 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 100 (30.5 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 and some rooftop terminations. 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.

## **VERTICAL DIRECT VENT SYSTEMS**

A Vertical Direct Vent System is installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Direct Vent system terminates both the flue and air inlet in the same pressure zone. The flue outlet and combustion air intake must both terminate on the rooftop.



**FIG. 20 Vertical Direct Vent Installation with Rooftop Combustion Air Inlet**

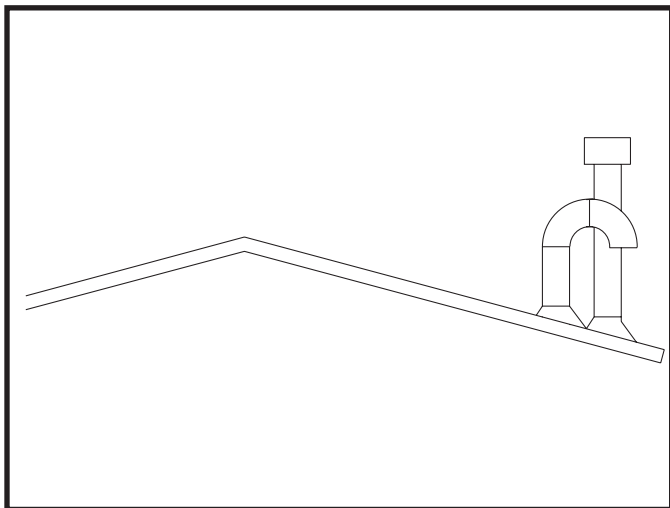
Follow all requirements in the General **Category IV** Venting sections for proper installation and of venting flue products vertically to the outdoors. All other general installation requirements must be followed.

The Direct Vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. The air inlet pipe must use one of the specified materials.

**The maximum installed length of the air inlet pipe from the appliance to the air inlet cap is 100 equivalent feet (30.48 m) in length. The maximum installed length of the flue pipe from the appliance to the termination cap is 100 equivalent feet (30.48 m) in length.** Subtract 5 feet (1.52 m) of equivalent length for each 90° elbow installed in either the flue pipe or the air inlet pipe.

Termination point for the flue products must follow the clearance requirements in the Vertical Vent Termination sections of the **Category IV** Venting.

## VERTICAL COMBUSTION AIR INLET



**FIG. 21 Air Inlet Cap for Rooftop Termination**

The air inlet cap for the vertical roof top air inlet is assembled from components purchased locally. The air inlet cap consists of two 90° elbows installed at the point of termination for the air inlet pipe. The first 90° elbow is installed on the rooftop at the highest vertical point of the air inlet pipe and turned horizontal, the second 90° elbow is installed on the horizontal outlet of the first elbow and turned down. A 90° elbow and a 90° street elbow may be used to make this assembly. If a straight piece of pipe is used between the two elbows, it should not exceed 6" (150 mm) in length. The termination elbow on the air inlet must be located a minimum of 12" (0.30 m) above the roof or above normal levels of snow accumulation.

The point of termination for the combustion air inlet cap **MUST** be at least 3 feet (0.91 m) below the point of flue gas termination (vent cap) if it is located within a 10 foot (3.05 m) radius of the flue outlet. Use care to ensure that the 90° elbow 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 termination point of the combustion air inlet cap must be installed at least one foot (0.30 m) above the rooftop and above normal snow levels.

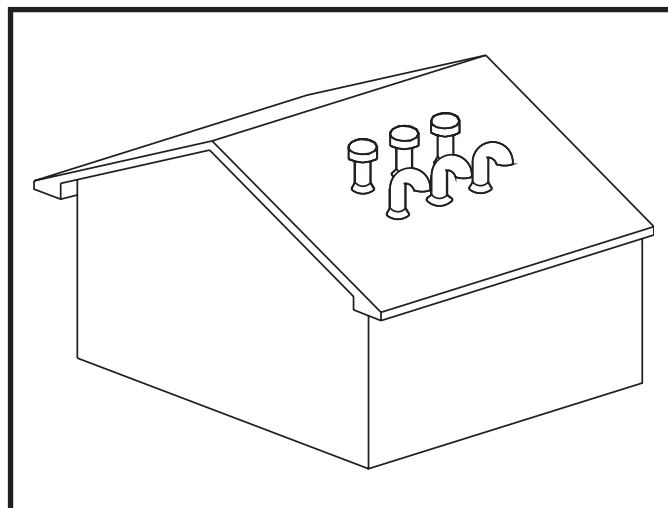
The combustion air cap assembly used **MUST** adequately protect the combustion air inlet from wind and weather.

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

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.

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 that can cause personal injury, death or property damage.

### *Multiple Vertical Direct Vent Installations*



**FIG. 22 Multiple Vertical Direct Vent Installations**

The combustion air inlet caps for multiple appliance installations must maintain the minimum 3 foot (0.91 m) 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 3 feet (0.91 m) 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 **Category IV** venting section must be maintained on multiple appliance installations.

## HORIZONTAL DIRECT VENT

For venting flue products horizontally to the outdoors, follow all requirements in the installation instructions for sidewall venting. Termination point for the flue products must follow the clearance requirements in the Sidewall Vent Termination section of **Category IV** Venting.

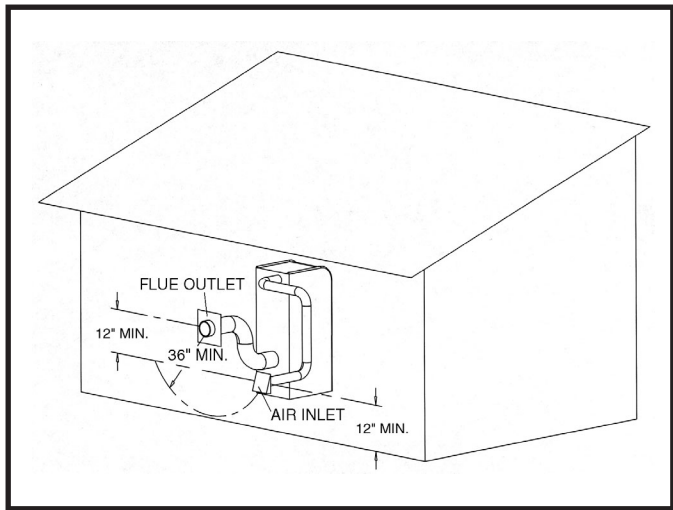
A Horizontal Direct Vent System is installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Direct Vent system terminates both the flue and air inlet in the same pressure zone. The flue outlet and combustion air intake must both terminate on the same sidewall.

Follow all requirements in the General **Category IV** Venting sections for proper installation and of venting flue products to the outdoors with a sidewall termination. All other general installation requirements must be followed.

The Direct Vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. The air inlet pipe must use one of the specified materials.

The maximum installed length of the air inlet pipe from the appliance to the air inlet cap is 100 equivalent feet (30.48 m) in length. The maximum installed length of the flue pipe from the appliance to the termination cap is 100 equivalent feet (30.48 m) in length. Subtract 5 feet (1.52 m) of equivalent length for each 90° elbow installed in either the flue pipe or the air inlet pipe. Subtract 2 1/2 feet (0.7 m) of equivalent length for each 45° elbow installed in either the flue or the air inlet pipe.

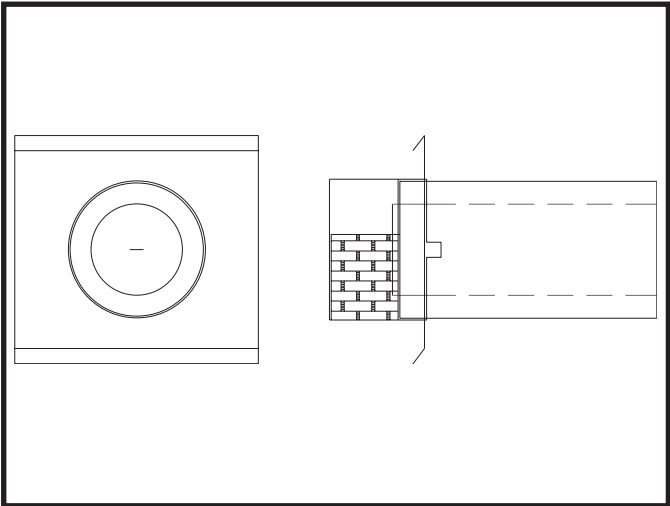
Termination point for the flue products must follow the clearance requirements in the Sidewall Venting Termination sections of the **Category IV** Venting.



**FIG. 23 Horizontal Direct Vent Installations with Sidewall Combustion Air Inlet**

## SIDEWALL COMBUSTION AIR INLET

Horizontal Direct Vent systems installed with sidewall terminations for both combustion air and flue products must purchase the termination caps from the appliance manufacturer. The sidewall air inlet cap and sidewall vent cap for flue products are available as a vent kit.



**FIG. 24 Sidewall Vent Cap**

The part numbers for the required sidewall air inlet cap kit are listed by unit size. The manufacturer, in accordance with CSA requirements, must furnish the sidewall air inlet cap. Each kit includes the special combustion air inlet cap for installation on an exterior sidewall. The sidewall air inlet cap supplied in the kit is sized to provide combustion air for a single appliance only.

TABLE - G			
Input Btu/hr	Flue Cap Size	Air Inlet Cap Size	Sidewall Air Inlet & Flue Cap Kit
1,500,000	6"	6"	HDK3018
1,700,000	7"	8"*	HDK3019
2,000,000	8"	8"	HDK3020

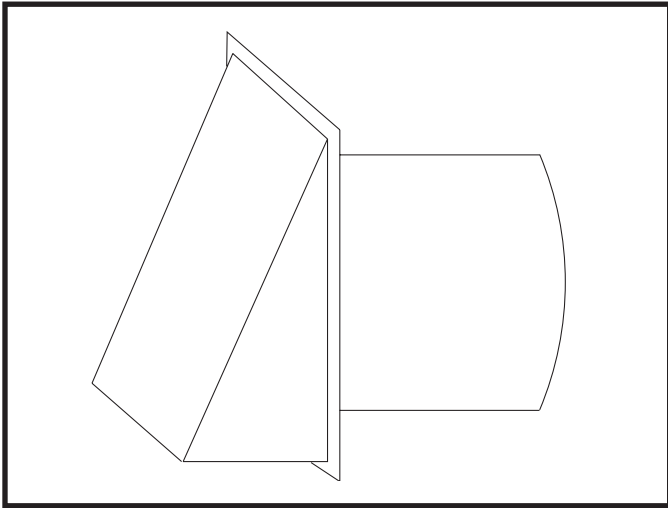
\*Piping from the appliance to the air inlet cap may be either 7" or 8" connecting to an 8" sidewall cap provided in the kit.

### Location of a Sidewall Air Inlet Cap

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 that can cause personal injury, death or property damage.

The termination point of the sidewall air inlet must be installed a minimum of 12 inches (0.30 m) above ground level and above normal levels of snow accumulation.

The point of termination for the sidewall combustion air inlet cap **MUST** be located a minimum of 3 feet (0.92 m) horizontally and 12 inches (0.30 m) below the point of flue gas termination (vent cap) if it is located within a 10 foot (3.05 m) radius of the flue outlet.



**FIG. 25 Air Inlet Cap for Sidewall Termination**

The sidewall combustion air inlet cap **MUST NOT** be installed above the sidewall flue outlet if it is located within a 10 foot (3.05 m) radius of the flue outlet.

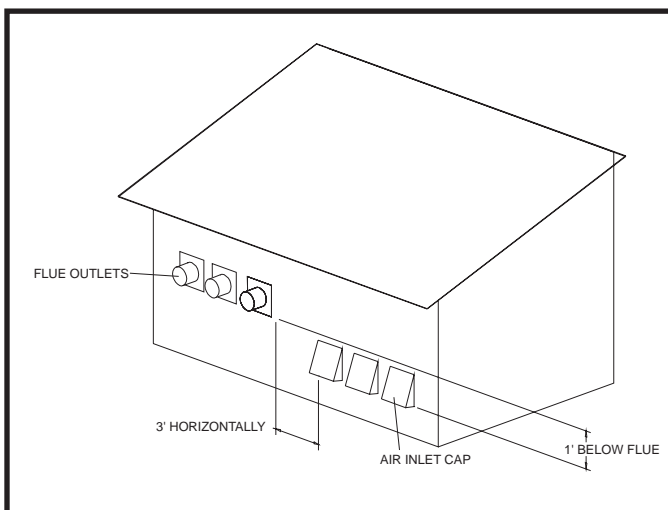
The sidewall combustion air inlet cap must not be installed closer than 10 feet (3.05 m) from an inside corner of an L-shaped structure.

The sidewall combustion air cap assembly used **MUST** adequately protect the combustion air inlet from wind and weather.

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

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

### **Multiple Horizontal Direct Vent Installations**



**FIG. 26 Multiple Horizontal Direct Vent Caps Installed on a Sidewall**

The combustion air inlet caps for multiple appliance installations must maintain the same minimum clearance from the closest vent cap installed within a 10 foot (3.05 m) radius of the point of flue gas termination as specified in single appliance installations. Multiple flue outlet caps may be installed side by side and multiple air inlet caps may be installed side by side but the minimum clearance of 3 feet (0.91 m) horizontal radius and 12 inches (0.30 m) below the closest flue outlet to the air inlet cap must be maintained. All clearance and installation requirements in this section and the applicable portions of the general **Category IV** venting section must be maintained on multiple appliance installations.

## **INTELLI-VENT SYSTEMS**

An Intelli-Vent system is a **Category IV** flue installed with a separate combustion air pipe to the outdoors. The Intelli-Vent system terminates the flue and the combustion air inlet pipe in different pressure zones. The Intelli-Vent system may terminate the flue and combustion air in any one of three configurations.

**These are:**

- (1) The flue on the roof top and combustion air intake on the sidewall;
- (2) The flue on the sidewall and combustion air from the rooftop;
- (3) The flue on the sidewall and the combustion air on a sidewall other than the sidewall where the flue is located.

All appliances are shipped from the factory equipped for **Category IV** venting system. The optional Intelli-Vent systems require the installation of specific venting materials that are purchased locally. Sidewall termination caps for flue products and combustion air must be purchased from the manufacturer. The sidewall caps for combustion air and flue products are available as vent kits. 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.

Follow all requirements in the General **Category IV** Venting sections for proper installation and of venting flue products to the outdoors with either a rooftop or a sidewall termination. All other general installation requirements must be followed.

The Intelli-Vent System requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance. The air inlet pipe must use one of the specified materials.

Combined Air Inlet Points

The air inlet pipes from multiple appliances installed with an Intelli-Vent system can be combined to a single common connection based on the cross sectional area of the common pipe as defined in the Direct-Vent basic information section.

Maximum Length of an Intelli-Vent System

The maximum installed length of the air inlet pipe from the appliance to the air inlet cap is 100 equivalent feet (30.5 m) in length. The maximum installed length of the flue pipe from the appliance to the termination cap is 100 equivalent feet (30.5 m) in length. Subtract 5 feet (1.52 m) of equivalent length for each 90° elbow installed in either the flue pipe or the air inlet pipe. Subtract 2 1/2 feet (0.7 m) of equivalent length for each 45° elbow installed in either the flue pipe or the air inlet pipe.

VERTICAL INTELLI-VENT WITH  
SIDEWALL COMBUSTION AIR

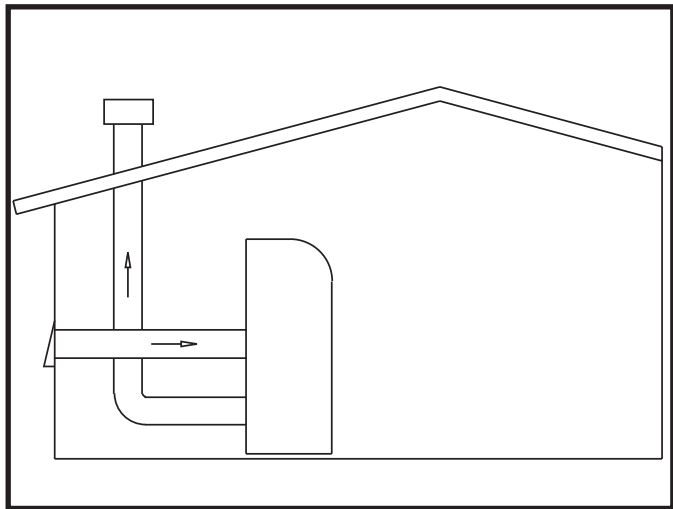


FIG. 27 Vertical Intelli-Vent Installation - Sidewall Combustion Air Inlet

Intelli-Vent systems are installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Vertical Intelli-Vent system terminates the flue at the rooftop and air inlet at the sidewall. The flue outlet and combustion air intake terminates in different pressure zones.

Follow all requirements in the General **Category IV** Venting sections for proper installation and venting of flue products vertically to the outdoors. All other general installation requirements must be followed.

The Intelli-Vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance.

Termination point for the flue products must follow the clearance requirements in the Vertical Vent Termination section of the **Category IV** Venting.

**CAUTION**⚠

Appliances that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe connected to the appliance.

SIDEWALL COMBUSTION  
AIR INLET

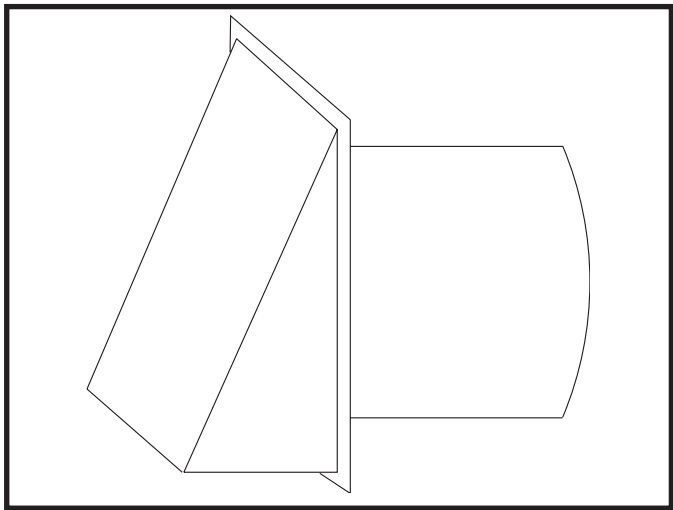


FIG. 28 Air Inlet Cap for Sidewall Termination

The air inlet cap for the sidewall air inlet must be purchased from the appliance manufacturer.

The part numbers for the required sidewall air inlet cap kit are listed by unit size. The appliance manufacturer, in accordance with CSA requirements, must furnish the sidewall air inlet cap. Each kit includes the special combustion air inlet cap for installation on an exterior sidewall.

TABLE - H			
Input Btu/hr	Flue Size	Air Inlet Pipe Size	Sidewall Air Inlet Cap Kit
1,500,000	6"	6"	SAK3000
1,700,000	7"	7"*	SAK3001
2,000,000	8"	8"	SAK3002

\*Piping from the appliance to the air inlet cap may be either 7" or 8" connecting to an 8" sidewall cap provided in the kit.

## Location of a Sidewall Air Inlet Cap

Installation, location and clearance requirements for the sidewall air inlet cap in an Intelli-Vent application are the same as the installation, location and clearance requirements for the sidewall air inlet cap in the Horizontal Direct Vent section of the venting instructions.

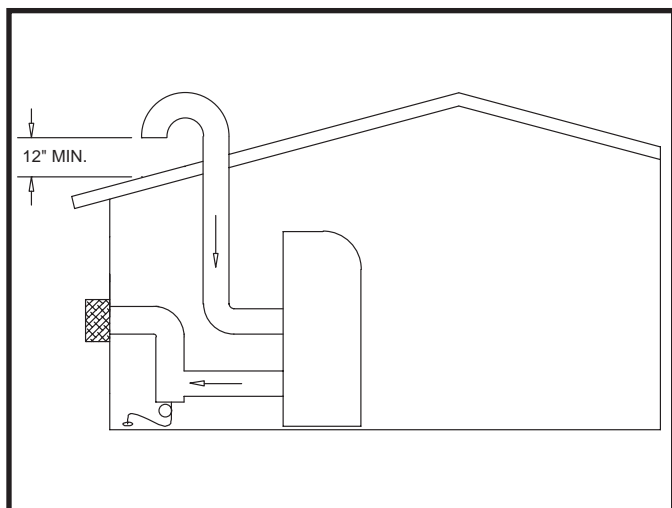
The sidewall combustion air inlet cap and the rooftop flue gas outlet are located in different pressure zones in an Intelli-Vent system.

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

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 that can cause personal injury, death or property damage.

## HORIZONTAL INTELLI-VENT WITH VERTICAL COMBUSTION AIR

Intelli-Vent systems are installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Horizontal Intelli-Vent system terminates the flue at the sidewall and air inlet at the rooftop. The flue outlet and combustion air intake terminate in different pressure zones.



**FIG. 29 Horizontal Intelli-Vent Installation - Rooftop Combustion Air Inlet**

Follow all requirements in the General **Category IV** Venting sections for proper installation and of venting flue products horizontally to the outdoors. All other general installation requirements must be followed.

The Intelli-Vent system requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance.

In cold climates, the use of type “B” double wall vent pipe or an insulated single wall pipe is recommended to prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

Termination point for the flue products must follow the clearance requirements in the Horizontal Sidewall Vent Termination section of the **Category IV** Venting.

### CAUTION ⚠

Appliances that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe connected to the appliance.

The flue and air inlet duct sizes for a Horizontal Intelli-Vent Installation with Rooftop Combustion Air Inlet are listed by unit size. The sidewall vent cap must be purchased from the appliance manufacturer as a vent kit.

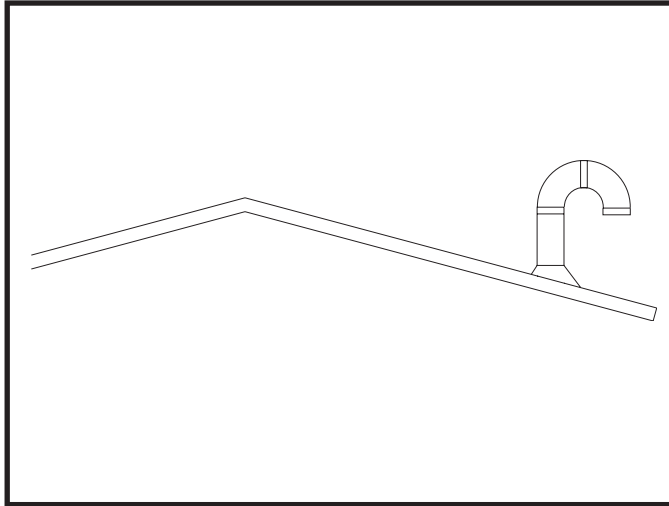
**TABLE - I**

Input Btu/hr	Flue Size	Air Inlet Pipe Size	Sidewall Vent Cap Kit
1,500,000	6"	6"	SAK3026
1,700,000	7"	7"*	SAK3027
2,000,000	8"	8"	SAK3028

\*Piping from the appliance to the air inlet cap may be either 7" or 8" connecting to an 8" sidewall cap provided in the kit.



## VERTICAL COMBUSTION AIR INLET



**FIG. 30 Air Inlet Cap for Rooftop Termination**

The air inlet cap for the vertical roof top air inlet is assembled from components purchased locally. The air inlet cap consists of two 90° elbows installed at the point of termination for the air inlet pipe. The first 90° elbow is installed on the rooftop at the highest vertical point of the air inlet pipe and turned horizontal, the second 90° elbow is installed on the horizontal outlet of the first elbow and turned down. A 90° elbow and a 90° street elbow may be used to make this assembly. If a straight piece of pipe is used between the two elbows, it should not exceed 6 inches (150 mm) in length. The termination elbow on the air inlet must be located a minimum of 12 inches (0.30 m) above the roof or above normal levels of snow accumulation.

### *Location of a Rooftop Air Inlet Cap*

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 that can cause personal injury, death or property damage.

Installation, location and clearance requirements for the rooftop air inlet cap in an Intelli-Vent application are the same as the installation, location and clearance requirements for the rooftop air inlet cap in the Vertical Direct Vent section of the venting instructions.

The rooftop combustion air inlet cap and the sidewall flue gas outlet are located in different pressure zones in an Intelli-Vent system.

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

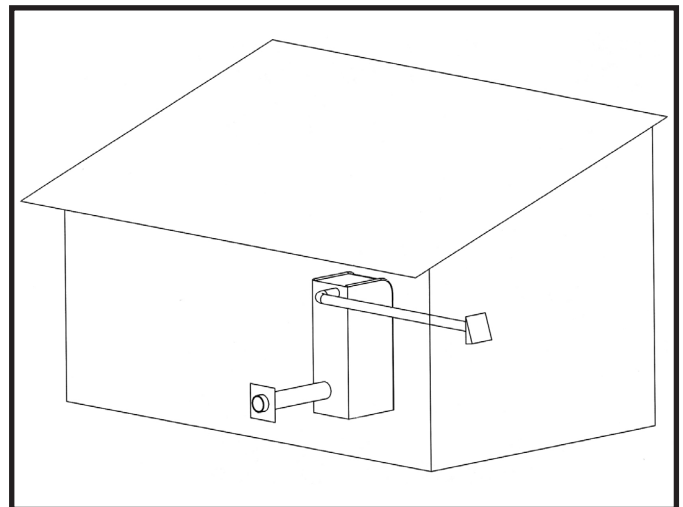
recirculation of flue products in to the combustion air inlet, follow all instructions in this section and related Direct Vent sections.

## HORIZONTAL INTELLI-VENT WITH SIDEWALL COMBUSTION AIR

Intelli-Vent systems are installed with a **Category IV** flue and a separate combustion air pipe to the outdoors. The Horizontal Intelli-Vent system terminates the flue at the sidewall and the combustion air on a sidewall other than the sidewall where the flue is located. The sidewall flue outlet and sidewall combustion air intake must terminate in different pressure zones.

Follow all requirements in the General **Category IV** Venting sections for proper installation and of venting flue products horizontally to the outdoors. All other general installation requirements must be followed.

The Intelli-Vent System requires the installation of an additional pipe to supply combustion air from outdoors directly to the appliance.



**FIG. 31 Horizontal Intelli-Fin Installation with Sidewall Combustion Air in a Different Pressure Zone**

In cold climates, the use of type “B” double wall vent pipe or an insulated single wall pipe is recommended to help prevent moisture in the cool incoming air from condensing and leaking from the inlet pipe.

Termination point for the flue products must follow the clearance requirements in the Horizontal Sidewall Vent Termination section of the **Category IV** Venting.

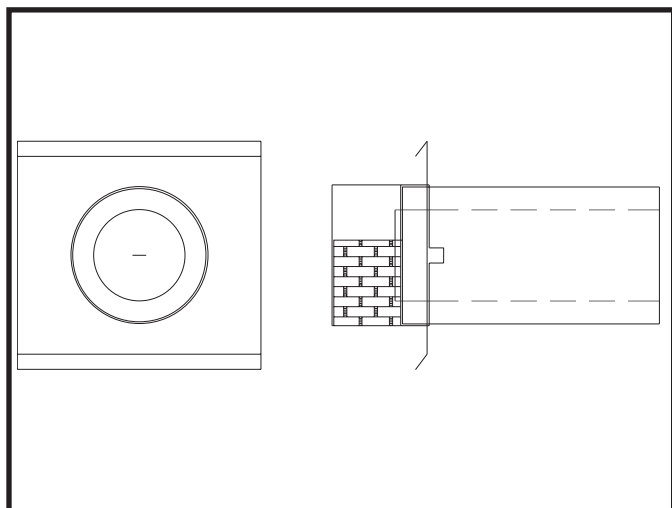
## CAUTION

Appliances that are shut down or will not operate may experience freezing due to convective airflow in the air inlet pipe connected to the appliance.

The flue and air inlet duct sizes for a Horizontal Intelli-Vent Installation with Sidewall Combustion Air Inlet are listed by unit size.

## SIDEWALL COMBUSTION AIR INLET

Intelli-Vent systems installed with sidewall terminations for both combustion air and flue products must purchase the termination caps from the appliance manufacturer. The sidewall air inlet cap and sidewall vent cap for flue products are available as a vent kit.



**FIG. 32 Sidewall Vent Cap**

The part numbers for the required sidewall air inlet and flue cap kit are listed by unit size. The manufacturer, in accordance with CSA requirements, must furnish both the sidewall air inlet and flue cap. Each kit includes the both the special combustion air inlet cap and the sidewall flue cap for installation on an exterior or sidewall. The sidewall air inlet cap supplied in the kit is sized to provide combustion air for a single appliance only.

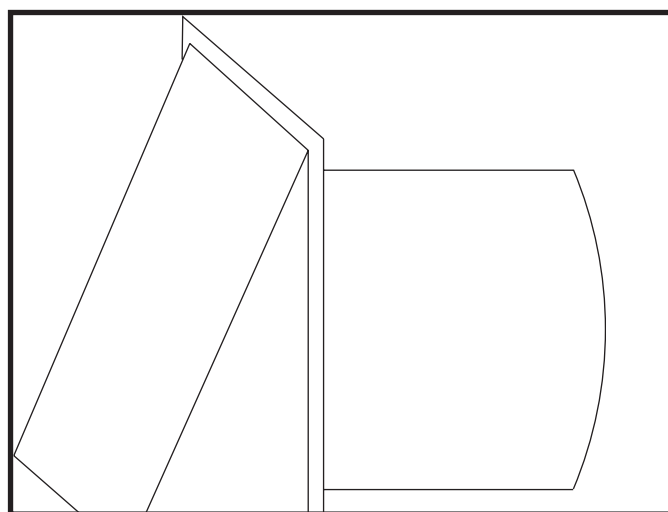
**TABLE - J**

Input Btu/hr	Flue Cap Size	Air Inlet Cap Size	Sidewall Air Inlet & Flue Cap Kit
1,500,000	6"	6"	HDK3018
1,700,000	7"	8"*	HDK3019
2,000,000	8"	8"	HDK3020

\*Piping from the appliance to the air inlet cap may be either 7" or 8" connecting to an 8" sidewall cap provided in the kit.

### *Location of a Sidewall Air Inlet Cap*

Installation, location and clearance requirements for the sidewall air inlet cap in an Intelli-Vent application are the same as the installation, location and clearance requirements for the sidewall air inlet cap in the Horizontal Direct Vent section of the venting instructions.



**FIG. 33 Air Inlet Cap for Sidewall Termination**

The sidewall combustion air inlet cap and the rooftop flue gas outlet are located in different pressure zones in an Intelli-Vent system.

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

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 that can cause personal injury, death or property damage.

## GAS SUPPLY

Verify that the appliance is supplied with type gas specified on rating plate. Consult factory for installations at altitude .

**INLET PRESSURE:** Measured at the inlet pressure tap on the appliance gas manifold. The pressure tap is located upstream of the redundant gas valve and down stream of the field installed gas cock.

**TABLE - K**  
**Inlet Gas Pressure**

	Natural Gas	L. P. Gas
Max. (Inches-Water Column)	10.5" w.c.	13.0" w.c.
Min. (Inches-Water Column)	4.0" w.c.	4.0" w.c.

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

**MANIFOLD PRESSURE:** Manifold pressure is a differential pressure measurement made between the high and low pressure taps at the gas orifice and the pressure in the transition chamber where the gas is supplied to the inlet of the combustion air blower. All manifold gas pressures are noted at full firing rate. The controls on this appliance may fire the burner from 25% up to 100% of rated input, based on system demand. Manifold gas pressure will be reduced as burner input is reduced. All reference gas pressure measurements must be made at 100% of rated burner input. The gas manifold pressure is pre-set at the factory by the ratio gas valve. Adjustment of manifold pressure is not normally required for proper operation. The adjustment point on the ratio gas valve is set at the factory. **DO NOT** attempt to adjust the settings on the ratio gas valve. Improper adjustment of the ratio gas valve may cause incomplete combustion or non-warrantable burner damage.

**TABLE - L**  
**Nominal Manifold Pressure Settings at Full Fire**

Input Btu/hr	Natural Gas	L. P. Gas
1,500,000 - 2,000,000	3.5" w.c.	3.5" 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 (3.5kPa).

- 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 (3.5kPa).
- The appliance and its gas connection must be leak-tested before placing it in operation.

## GAS CONNECTION

- Safe operation of unit requires properly sized gas supply piping. See gas line sizing data.
- Gas pipe size may be larger than appliance connection.
- Installation of a union at the appliance gas line connection is required for ease of service and removal of the gas train.
- Install a manual main gas shutoff valve, outside of the appliance gas connection and before the gas valve, when local codes require.
- A trap (drip leg) **MUST** be provided in the inlet of the gas connection to the appliance.
- The diaphragm gas valve has a bleed port that requires venting to atmosphere, outside the building.
- Optional gas controls may require routing of bleeds and vents to the atmosphere, outside the building when required by local codes.

**TABLE - M**  
**Recommended Gas Pipe Size**  
**Single Appliance Installations**

Btu/hr	Distance from Meter				
	0 - 50 ft.	51 - 100 ft.	101 - 200 ft.	201 - 300 ft.	301 - 500 ft.
1,500,000	2"	2 1/2"	3"	3"	3 1/2"
1,700,000	2 1/2"	2 1/2"	3"	3"	3 1/2"
2,000,000	2 1/2"	3"	3"	3 1/2"	4"

For each elbow or tee, add equivalent straight pipe to total length from TABLE - O.

**TABLE - N**  
**Multiple Appliance Installations Gas Pipe Size Chart**

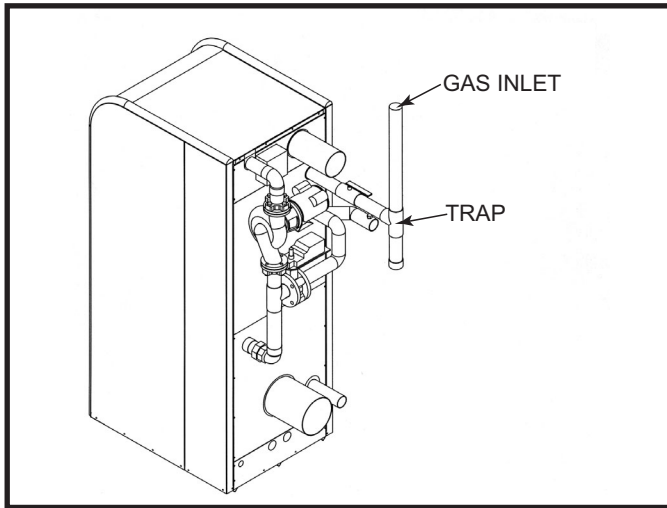
Nominal Iron Pipe Size, Inches	Length of Pipe in Straight Feet													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/4	369	256	205	174	155	141	128	121	113	106	95	86	79	74
1	697	477	384	328	292	267	246	256	210	200	179	164	149	138
1 1/4	1,400	974	789	677	595	543	502	472	441	410	369	333	308	287
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's 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's per Cubic Foot of Gas and 0.60 Specific Gravity)

**TABLE - O**  
**Fittings to Equivalent Straight Pipe**

Diameter Pipe Fitting (inches)							
3/4"	1"	1 1/4"	1 1/2"	2"	3"	4"	5"
Equivalent Length of Straight Pipe (feet)							
2'	2'	3'	4'	5'	10'	14'	20'

## GAS PIPING



**FIG. 34 Gas Line Connection to Unit with Sediment Trap and Manual Main Gas Shut-off Valve**

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

### *Install Piping to Control*

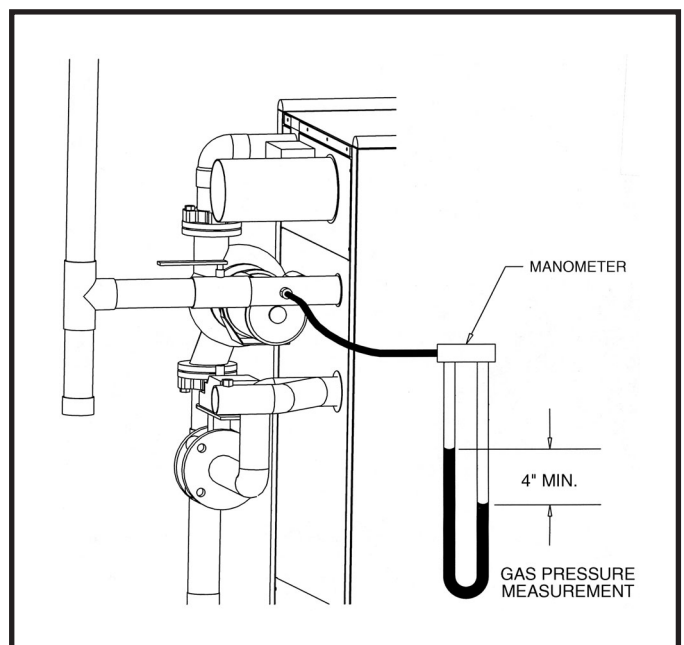
1. The gas line should be a separate line direct from the meter unless the existing gas line is of sufficient capacity. Verify pipe size with your gas supplier.
2. Use new, properly threaded black iron pipe free from chips. If tubing is used, make sure the ends are square, deburred and clean. All tubing bends must be smooth and without deformation. Avoid flexible gas connections. Internal diameter of flexible gas lines may not provide appliance with proper volume of gas.
3. Install a manual main gas shutoff valve at the units gas inlet, outside of the appliance and before the gas valve. Install a union at the appliance gas line connection for ease of service and removal of the gas train.
4. Run pipe or tubing to the units gas inlet. If tubing is used, obtain a tube to pipe coupling to connect the tubing to the units gas inlet.
5. Install a sediment trap in the supply line to the units gas inlet. (See Figure 34).
6. Remove seal over gas inlet to the appliance.

7. Apply a moderate amount of good quality pipe compound (**DO NOT use Teflon tape**) to pipe only, leaving two end threads bare.
8. Connect gas pipe to inlet of appliance. Use wrench to support gas manifold on the appliance.
9. For LP gas, consult your LP gas supplier for expert installation.

## GAS MANIFOLD PRESSURE ADJUSTMENT

The manifold gas pressure on the Intelli-Fin appliance is not field adjustable. The ratio gas valve has been factory set with an internal bias adjustment to ensure a 1:1 air/gas ratio on operation. Tampering with this adjustment will void the warranty on the gas valve assembly and the burner. An Intelli-Fin supplied with a properly sized gas line, properly sized meter and a minimum of 4 inch water column of gas supply pressure while firing at full rate will ensure full burner input. The manifold pressure supplied to the burner is a differential pressure. This pressure is the result of the difference in two gas pressure measurements. A differential manifold gas pressure measurement should not be made until you have measured the gas supply pressure. Gas supply pressure must be a minimum of 4 inch water column with all appliances on the gas line firing at full rate before a manifold pressure measurement is made. Use the following procedure to check gas supply pressure with a manometer connected to the inlet pressure tap on the gas line connection at the rear of the appliance.

## CHECKING GAS SUPPLY PRESSURE



**FIG. 35 Gas Supply Pressure Measurement**

1. Turn the main power switch to "OFF" position.
2. Shut off gas supply at the manual gas cock in the as piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
3. Remove the 1/8" hex plug from the gas pressure test port located on the inlet gas supply connection at the rear of the appliance. Install a fitting in the inlet pressure tapping suitable to connect to a manometer or magnahelic gauge. Range of scale should be 14 inch w.c. or greater to check inlet pressure
4. Turn on gas supply at the field installed manual gas cock, turn on LP gas at tank if required.
5. Turn the power switch to "ON" position and ensure that the Run/Stop switch is in the "Run" position.
6. Adjust the temperature setpoint on the Command Display to call for heat.
7. Observe the gas supply pressure as the burner fires at 100% of rated input. Percent of burner input will be displayed on the Command Display.
8. Ensure inlet pressure is within specified range. Minimum and Maximum gas supply pressures are specified in Gas Supply section of this manual.
9. If gas pressure is out of range, contact the gas utility, gas supplier, qualified installer or service agency to determine necessary steps to provide proper gas pressure to the control.
10. If gas supply pressure is within normal range, proceed to remove gas manometer and replace pressure tap fittings in the gas piping to the appliance.
11. Turn the power switch to "OFF" position.
12. Shut off gas supply at the manual gas cock in the gas piping to the appliance. If fuel supply is LP gas, shut off gas supply at the tank.
13. Remove the manometer and related fittings from gas pressure test port at the inlet gas supply connection to the appliance. Replace 1/8" hex plug in gas pressure test port and tighten.
14. Turn on gas supply at the manual valve, turn on LP gas at tank if required.
15. Turn the power switch to "ON" position.
16. Adjust the temperature setpoint on the Command Display to the desired water temperature so the appliance will call for heat.

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

## IMPORTANT

Upon completion of any testing on the gas system, leak test all gas connections with a soap solution while the main burner is firing. 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 gas piping.

## CHECKING MANIFOLD GAS PRESSURE

There is a pressure test tree located in the top chamber of the appliance. This pressure test point can be accessed by swinging out the front control panel. The pressure test tree is mounted on the front edge of the combustion air blower. It consists of an angle support and four test cocks. There is one cock for positive air and one for negative air, one cock for positive gas and one for negative gas. Manifold pressure measurement will utilize both the positive and negative test points for gas.

1. Open the front controls panel and swing the controls out. Locate the pressure test tree on the front edge of the combustion air blower. The positive and negative gas pressure terminals will be used to check differential gas pressure from the gas manifold and the air box. Each gas pressure connection point will have a small manual cock to attach a hose.
2. Connect a hose from the positive gas and the negative gas to each of the two sides of a manometer. This will allow the two pressure points to be measured at the same time. Open the two gas pressure test point cocks.
3. Set the Command Display to a setpoint which will fire the burner at 100% of rated input.
4. As the appliance comes on and fires, record the inches of water column of displacement on both sides of the manometer. The sum of these two readings as they are effected by the two gas pressures is the differential manifold pressure.
5. The differential manifold gas pressure should be 3.5 inches of water column (+ 0.1" w.c.) when the burner is firing at 100% of rated input.
6. If the differential manifold pressure is not 3.5 inches water column (+ 0.1" w.c.), recheck the gas



supply pressure and adjust to ensure a supply pressure between 4.0 and 10.5 inches water column natural gas (13.0" w.c. for propane) while the appliance is firing at 100% of rated input.

7. This is a reference pressure only and is not field adjustable. An appliance supplied with a minimum of 4 inches water column of gas supply pressure will operate at the correct manifold pressure as the burner input varies with temperature demand.
8. Close the two gas pressure test cocks on the pressure test tree and remove the hoses to the manometer.
9. Close the front control panel.

## IMPORTANT

Upon completion of any testing on the gas system, leak test all gas connections with a soap solution while the main burner is firing. 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 gas piping.

## WATER CONNECTIONS

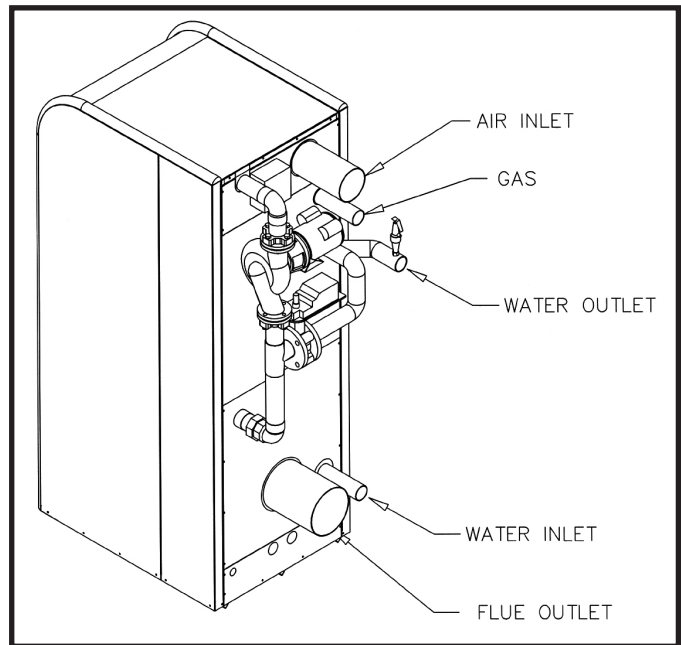


FIG. 37 Water Connections

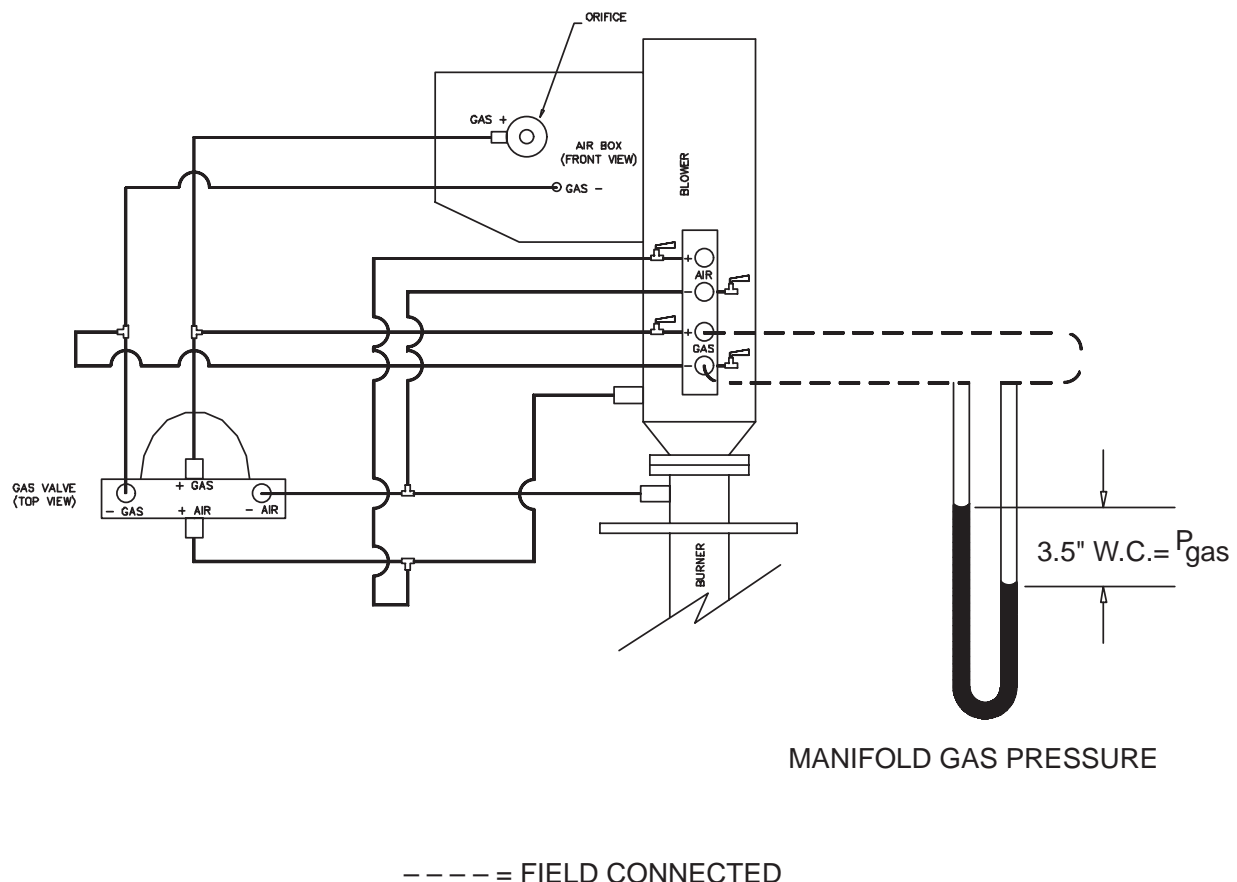


FIG. 36 Manifold Gas Pressure Measurement

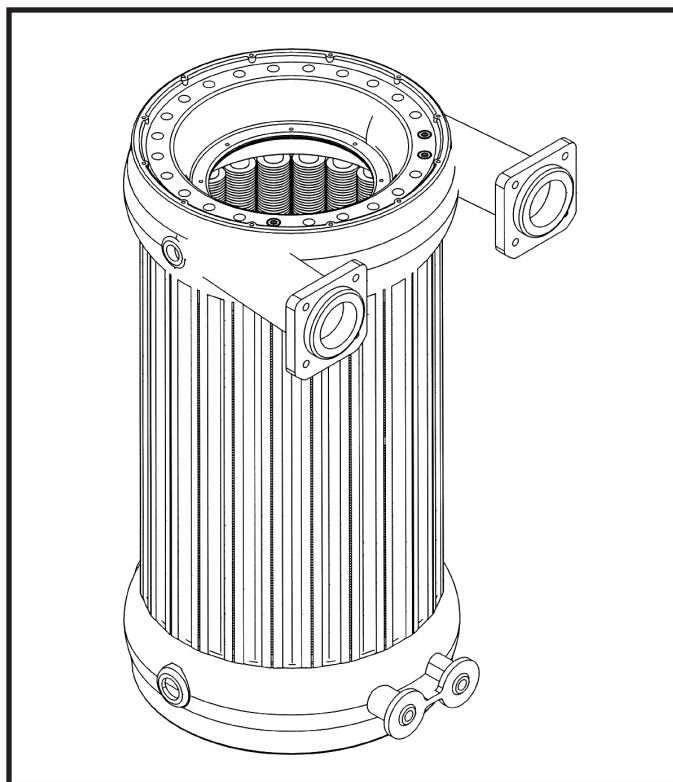
## Inlet and Outlet Connections

For ease of service, install unions on inlet and outlet of the appliance. The connection to the appliance 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.

## Minimum Pipe Size Requirements

Minimum water pipe connections to this appliance are 3 inches (76.2 mm) pipe for single unit installations installed not more than 70 equivalent feet (21.3 m) of pipe from the main system loop or storage tank. The equivalent number of straight feet of pipe for each valve and fitting in the connecting piping must be considered to properly arrive at the total equivalent feet of straight pipe in the field installed piping to the appliance. See the piping requirements in the heating boiler or water heater section of this manual. Consult factory if longer piping distances are required for a specific application.

## PRIMARY HEAT EXCHANGER

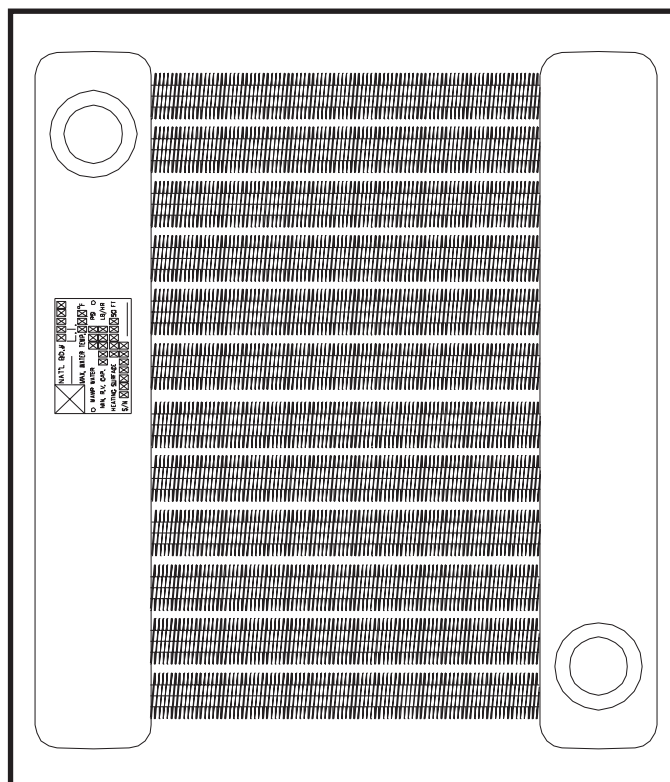


**FIG. 38 Primary Heat Exchanger**

This appliance uses two finned copper tube heat exchangers to maximize the heat transfer process. The primary heat exchanger is mounted in the inner jacket on the front side of the appliance. The primary heat exchanger is composed of two circular glass lined cast iron headers with 24 vertical finned copper tubes. A series of “V” shaped baffles are installed

between the individual tubes to control the movement of the flue products over the finned copper surface and increase heat transfer. Water enters the primary heat exchanger and makes four passes over the area exposed to direct heat from the burner. An internal circulating pump ensures proper water flow over the heat transfer surfaces during burner operation. Water temperatures in the primary heat exchanger are controlled by the operation of the automatic bypass assembly. Operation of the bypass maintains water temperatures above 130°F (54.4°C) in the primary heat exchanger to prevent flue gas condensation on the primary heat exchanger surfaces.

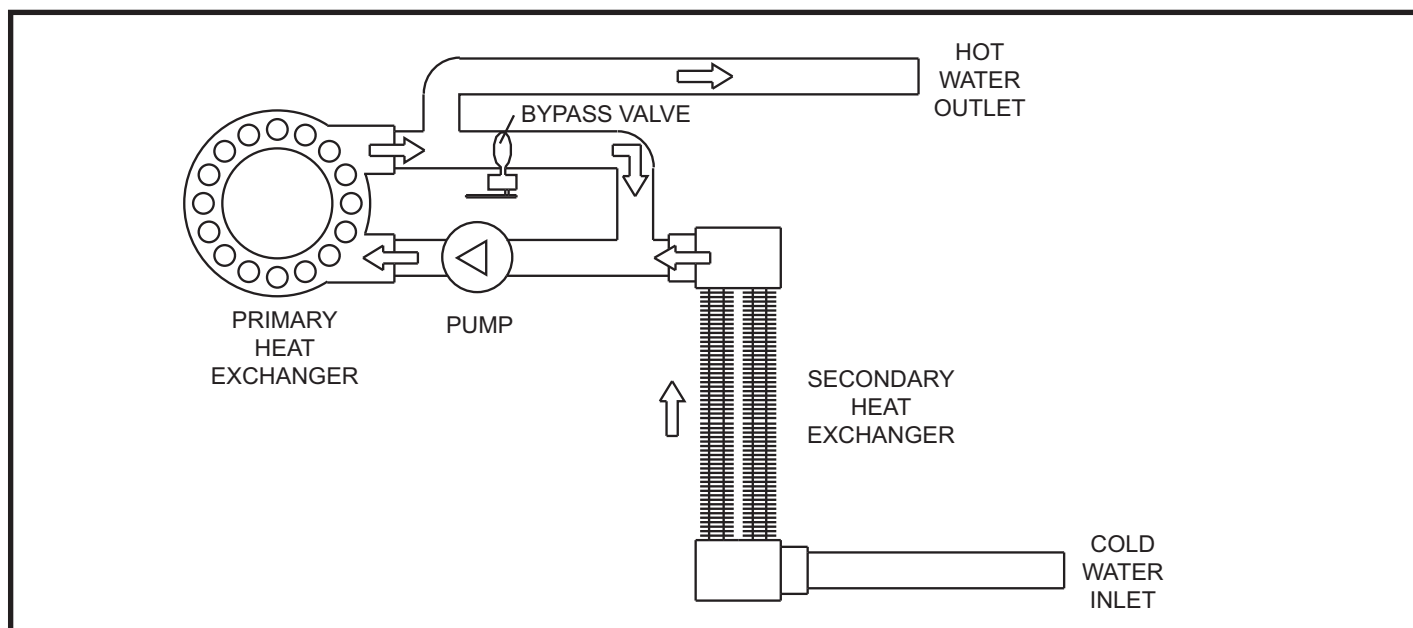
## SECONDARY HEAT EXCHANGER



**FIG. 39 Secondary Heat Exchanger**

A secondary heat exchanger is mounted in an inner jacket chamber at the rear of the appliance. The secondary heat exchanger is constructed from two glass lined cast iron headers and multiple horizontal finned copper tubes. The secondary heat exchanger is mounted in the discharge of the flue products from the primary heat exchanger. This allows additional heat to be absorbed from the flue products exhausted from the combustion process. The return water from the system passes through the secondary heat exchanger before it enters the primary heat exchanger. This allows the coolest return water temperatures to enter the secondary heat exchanger before proceeding to the primary heat exchanger. When return water temperatures are below approximately 130° F (54.4°C), the flue products passing over the secondary heat exchanger may be cooled below their dewpoint resulting in the formation of condensate. The secondary heat exchanger has a special high temperature

## INTEGRAL BYPASS



**FIG. 40 Bypass Piping with Valve Actuator and Pump**

conformal coating to prevent any corrosive damage to the copper tubes or cast iron headers from the low pH condensate. The protective coating is brown in color and covers both the headers and finned tube surfaces. The secondary heat exchanger is designed to maximize heat transfer efficiency by fully condensing flue products. The inner jacket that houses the secondary heat exchanger is designed to collect the flue gas condensate and discharge it from the jacket.

This appliance contains an integral bypass and circulating pump that connects the primary and secondary heat exchangers. A floating-point automatic bypass valve regulates the flow of water through the bypass between the two heat exchangers. The valve is a butterfly type valve with an EPDM seat and a 24 VAC gear driven motorized actuator. The appliance's internal Excel-10 controller senses inlet water temperature to the primary heat exchanger and provides a 24 VAC signal to open or close the valve as required. Operation of the bypass is based on an assumed flue gas dewpoint temperature of 130°F (54.4°C) as referenced in the ANSI standards. The dewpoint of flue gasses becomes the minimum acceptable inlet water temperature for the primary heat exchanger. Sustaining water temperatures in the primary heat exchanger above the dewpoint prevents formation of flue gas condensate on the primary heat exchanger. The Excel 10 establishes a dead band around the 130°F (54.4°C) setting of +1.8°F (2°C). This means the actual temperature can vary positive or negative approximately 2° around the 130°F (54.4°C) minimum desired setting. The variable input rate of the burner from 25% to 100% will also affect the position of the bypass valve as it adjusts to maintain primary heat exchanger (Bypass) temperatures above the 130°F (54.4°C) setting. The inlet temperature to the primary heat exchanger is displayed by the command display and provides the Excel 10 the adjustment point for the bypass valve. The

inlet water temperature to the primary heat exchanger generally should not remain below the minimum dewpoint temperature for more than approximately five minutes. In this case, the inlet temperature to the primary heat exchanger is rarely below 125°F (51.7°C). The actuator on the bypass valve will take between a minimum time of 180 seconds up to a maximum time of 300 seconds to move from a "full closed" position to a "full open" position or vice versa. Operation of the bypass valve actuator assures that water temperature in the primary heat exchanger is maintained high enough to prevent condensate formation on the primary heat exchanger.

### ***BYPASS VALVE - Synchronization***

As the main power is switched on and/or when the run/stop switch is placed in the "RUN" position, the bypass valve will go through a synchronization process to establish a reference point for operation. After the initial synchronization on start-up, the bypass will resynchronize in approximately 2 week intervals of normal operation. This resynchronization will only occur in an off cycle operation of an installed appliance. During the synchronization process the Excel 10 controller will overdrive the valve actuator to a full closed position. This establishes a reference point to assure quicker response to variation in inlet water temperature. The bypass valve operates best when it can start operation from a full closed position. A status point mode of Byp Synch will be indicated in the Command Display as the actuator on the bypass valve is overdriven to the closed position for synchronization.

## BYPASS PIPING ASSEMBLY

The primary and secondary heat exchangers are interconnected with a bypass and pump mounted in 2 1/2 inches (63.5 mm) diameter copper pipe. All access to the piping is from the rear of the appliance. On initial start up, all air must be removed from the bypass piping to ensure proper water flow through the appliance. The bypass piping has an air bleed cock located on the discharge side of the internal pump. This bleed cock should allow any trapped air in the internal piping to be purged from the piping before operation. The bypass piping also contains a flow switch to sense operation of the circulating pump, bulb wells for temperature sensors and a relief valve(s).

## INTEGRAL CIRCULATOR

The appliance has an integral circulating pump mounted in the bypass piping. The pump has a 3/4 H.P. motor wired for 120 volt, single-phase operation as shipped. The on-off operation of the circulating pump is controlled by the Excel 10 controller. The pump will start and run continuously when the power switch is in the "ON" position and the run/stop switch is in the "RUN" position. A flow switch installed in the bypass piping assembly proves water flow.

### *Optional Intermittent Pump Operation*

On-Off operation of the circulating pump is available as an option. Cycling of the integral pump is controlled by the Excel 10 controller. The pump will start on a call for heat and a flow switch installed in the bypass piping assembly proves operation. After the burner cycles off and the call for heat is satisfied, the pump will continue to operate for a timed period to remove any residual heat from the combustion chamber before the pump is turned off. If the ambient temperature at the temperature sensor for the Excel 10 drops below 45° F (7.2° C) the circulator pump will turn on to help prevent freezing of the heat exchanger.

### *BYPASS - Initial Set-up of Maximum Water Flow*

On initial start-up of the Intelli-Fin the maximum water flow to the two internal heat exchangers must be manually set before the automatic operation of the bypass begins.

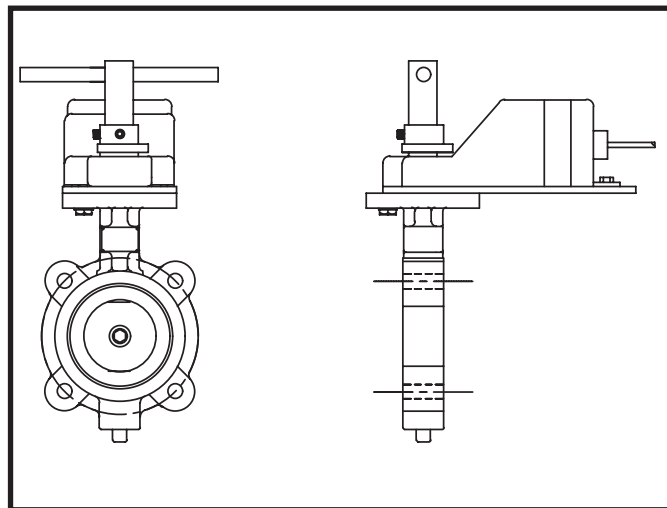


FIG. 41 Bypass Valve and Actuator Assembly

Setting temperature rise on an Intelli-Fin with an automatic bypass is accomplished by disconnecting the power leads to the bypass actuator at the multi-pin connector on the rear of the appliance, declutching the actuator drive and manually closing the bypass valve. **Manual adjustment of the bypass must not be attempted if the 24 VAC power leads are connected to the terminals on the appliance, the appliance is operating or if there is any torque on the bypass valve by the actuator.** Disconnect the 24 VAC power leads to the valve actuator. The declutch button on the actuator must be pushed down and held in the depressed position to disengage the gear driven motor that operates the valve. The declutch button must push in easily without forcing its movement. If the button does not easily move when pushed, the valve is under torque. Forcing the declutch button in will cause non-warrantable damage to the actuator. Torque can be removed by disconnecting the power leads to the valve actuator. With the declutch button fully depressed, move the actuator handle till it is perpendicular to the piping. This fully closes the bypass valve. The position of the handle is the same as the position of the butterfly in the valve seat. With the bypass fully closed, all inlet water flows through the secondary heat exchanger and then through the primary heat exchanger. No water will flow through the bypass at this time. Turn the appliance on and allow the burner to come on and fire at full rate (100% of input as shown on the Command Display). Adjust the field-installed ball valve in the outlet piping from the appliance to achieve the proper temperature rise for your specific model. Adjustment to achieve this temperature rise ensures a maximum of 90 GPM to the bypass and pump when in operation.

**TABLE - P**  
**Temperature Rise At Full Rate Fire**  
**Bypass Manually Fully Closed**

Btu/hr Input	Temperature Rise
1,500,000	31.5°F (17.5°C)
1,700,000	35.7°F (19.8°C)
2,000,000	42.0°F (23.3°C)

**NOTE:**

The Excel 10 controller makes all internal calculations in °C and converts the displayed temperature to °F. This may limit exact temperature adjustment. Setting of temperature rise to the nearest °F is acceptable when setting maximum flow.

Turn off power to the appliance. Reconnect the power leads to the bypass actuator. Turn power on and place the run/stop switch in the run position and allow the the bypass valve to go through the synchronization process before it begins normal operation.

**WARNING** ⚠

Moving the bypass handle while appliance is firing can result in abnormally high water temperature that may cause sudden relief valve discharge.

**BYPASS OPERATION**

1. Main burner ignition is achieved.
2. Integral bypass begins the adjustment process to control inlet water temperature to the primary heat exchanger.
3. The Excel 10-controller senses inlet water temperature to the primary heat exchanger.
4. Inlet water temperature into the primary heat exchanger is displayed as "Bypass Temperature" in one of the 21 points on the Command Display.
5. The floating-point bypass valve begins to adjust position to maintain an inlet temperature to the primary heat exchanger above the dew point of flue products.
6. Minimum inlet water temperature to prevent condensation of flue products is fixed at 130°F

(54.4°C). This control point is programmed into the software in the Excel 10 controller.

7. The Excel 10 provides 24 VAC to operate a high torque motor in the actuator, which adjusts the position of the floating-point bypass valve.
8. The actuator for the bypass valve adjusts in as many as 500 micro-steps to achieve the desired water temperature at the inlet to the primary heat exchanger.
9. With each micro-step of movement in the position of the valve, the Excel 10 checks for a change in water temperature at the inlet to the primary heat exchanger. As long as the inlet water temperature is below 130°F (54.4°C) the bypass is moving toward full open to increase the inlet water temperature. When the inlet water temperature is above 130°F (54.4°C) the bypass is moving toward full closed to sustain the water temperature above the dewpoint of the flue products.
10. Operation of the bypass valve maintains water temperatures above the dew point of flue products at the primary heat exchanger to ensure that condensate formation occurs only on the secondary heat exchanger.

The use of a Floating-Point Bypass Valve means that there is no fixed open or closed position on the valve. If errant hands manually move the bypass adjustment handle, it will take longer to adjust to the proper setting but it will still function properly to maintain water temperatures.

**CAUTION** ⚠

Failure to disconnect power to the actuator before declutching or manually moving the valve handle can cause non-warrantable damage to the actuator.

**MINIMUM WATER TEMPERATURES**

A minimum return water temperature of 50°F (10°C) has been established for each model based on the Btu/hr output at 100% of rated burner input. The temperature setpoint for the Excel-10 controller sensing system temperature or stored water temperature must not be set lower than the specified minimum for each model. Maintaining inlet water temperatures to the appliance equal to or higher than the specified minimum temperature setting ensures proper operation of the bypass and allows all condensate formation to occur on the secondary heat exchanger. An appliance allowed to sustain operation at water temperatures lower than the specified minimum temperature may not provide enough heat from the burner to maintain water



temperatures in primary heat exchanger above the 130°F (54.4°C) dew point of flue products. Operation of the appliance at a temperature below the specified minimum setpoint temperature will result in non-warrantable operational problems from the condensate formation on the primary heat exchanger.

TABLE - Q

Minimum Inlet Water Temperatures

Input Btu/hr	Minimum Return Temperature	Minimum Setpoint
1,500,000	50°F (10°C)	105°F (40.6°C)
1,700,000	50°F (10°C)	90°F (32.2°C)
2,000,000	50°F (10°C)	70°F (23.9°C)

CAUTION⚠

An appliance allowed to operate at return temperatures below the specified minimum settings may experience problems with the operating controls, safety switches, obstruction of the flue gas passages on the primary heat exchanger, incomplete combustion and possible flue gas spillage. Sustained operation at lower than specified water temperatures may cause hazardous conditions that may result in personal injury or non-warrantable damage to the appliance.

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

A water flow switch is factory installed in the internal bypass piping on all heating boilers, hot water supply boilers and water heaters. The flow switch is wired in series with the 24 VAC safety control circuit. This wiring connection installs the flow switch in the 24 VAC safety circuit to prove water flow before main burner ignition. A factory supplied flow switch installed in discharge piping from the top header requires a minimum flow of 26 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. A status point alarm of LowH2OFlow will be indicated in the Command Display on a low water condition as sensed by the flow switch.

LOW WATER CUTOFF  
(If Equipped)

If this boiler is installed above radiation level, a low water cut- off device must be installed at the time of boiler installation. Electronic or float type low water cut-offs are available as a factory supplied option on all models. Low water cut-offs should be inspected every six months, including flushing of float types. A status point alarm of LowH2OFlow will be indicated in the Command Display on a low water condition as sensed by a low water cutoff.

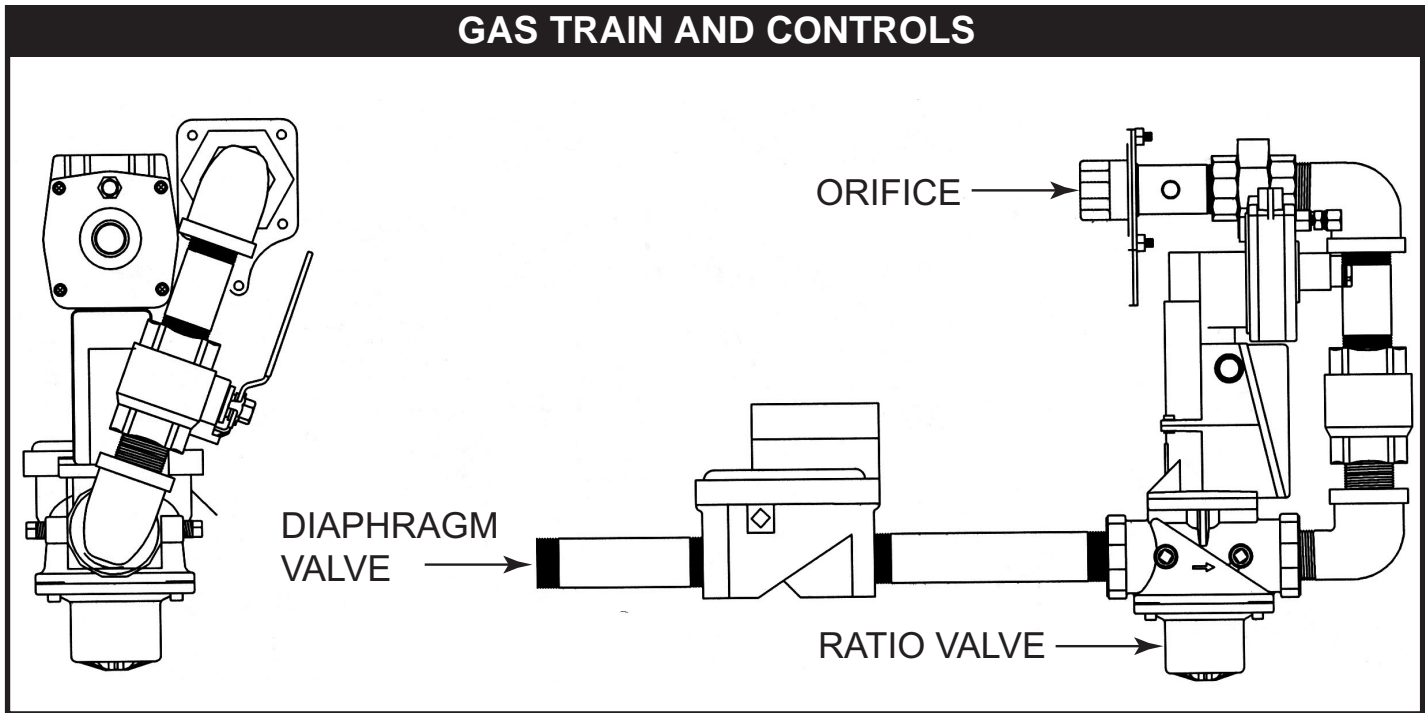


FIG. 42 Gas Train Assembly



## 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.

## NOTE:

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

## RATIO GAS VALVE

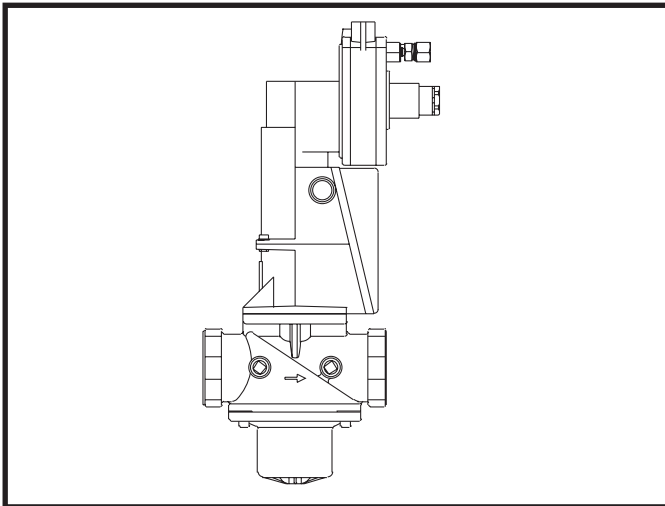


FIG. 43 Ratio Gas Valve

The main gas valve supplying gas to the burner on this appliance utilizes a pressure regulating electro hydraulic actuator providing a slow opening, fast closing safety shut off and air/gas ratio control for the gas combustion process. This gas valve controls the pressure difference across the restriction in the gas supply line as a function of the pressure difference

across the combustion air supply to the burner. The actuator maintains a constant air to gas ratio as the volume of air changes based on the operation of the combustion air blower. The valve is a 1:1 differential pressure air/gas ratio controller. The valve adjusts the same pressure difference on the gas side as it senses on the air side. The valve performs the functions of safety shutoff, constant pressure regulation and air/gas ratio control. Slow opening and safety shutoff is accomplished by operation of an electro hydraulic cylinder. Full closing of the valve seat occurs in less than 0.8 seconds when the valve is de-energized. A visual stroke position indicator is provided on the valve assembly to indicate the position of the valve seat. Operation of the gas valve in combination with the combustion air blower allows the burner input rate to vary from 25% to 100% based on temperature demand. There is no need for an additional upstream constant gas pressure regulator internally to the appliance as long as the gas supply is maintained within the specified minimum and maximum pressures.

The manifold pressure is preset at the factory and adjustment is not usually required if gas supply pressure is maintained within the specified range. If the manifold pressure is to be measured, follow the “Gas Manifold Pressure Measurement Procedure” for proper measurement.

There are no serviceable parts on the ratio gas valve actuator.

## DIAPHRAGM GAS VALVE

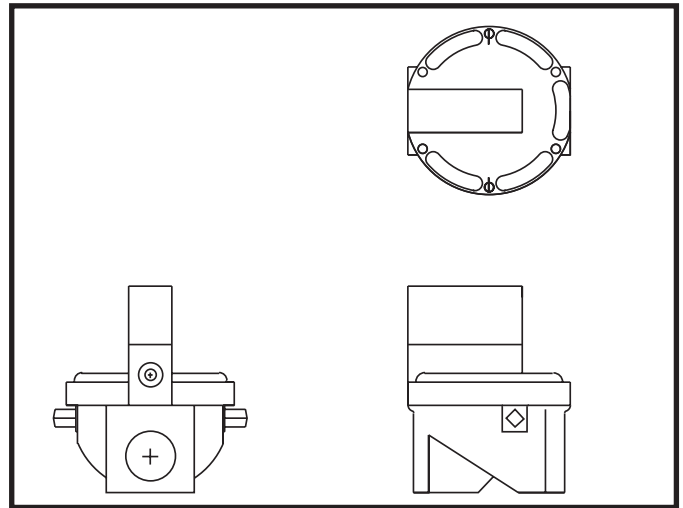


FIG. 44 Diaphragm Gas Valve

A diaphragm type gas valve is also provided in the gas train. As the second valve seat in the gas train, it supplies a redundant safety shutoff valve seat in the gas supply to the burner to ensure safe operation in the remote event of a gas valve failure. The diaphragm gas valve is energized with 24 VAC power at the same time the ratio gas valve is powered in the operational sequence to ignite the burner.

## Venting of Gas Valves and Pressure Switches

The diaphragm type gas valve and optional gas pressure switches are provided with threaded termination points to be vented to the atmosphere, outside the building. The gas pressure regulation function is provided by the ratio gas valve which does not require installation of a vent line. The diaphragm gas valve and optional gas pressure switches are installed in the upper chamber of the appliance. Threaded vent line connections from components requiring an external vent line are provided on the component. These vent line connection points may be accessed by removing the top jacket panels. Local codes may require the routing of these bleeds and vents to the atmosphere, outside the building. Proper routing of vent lines to the atmosphere from the factory supplied termination points is the responsibility of the installing contractor.

## ELECTRICAL CONNECTIONS

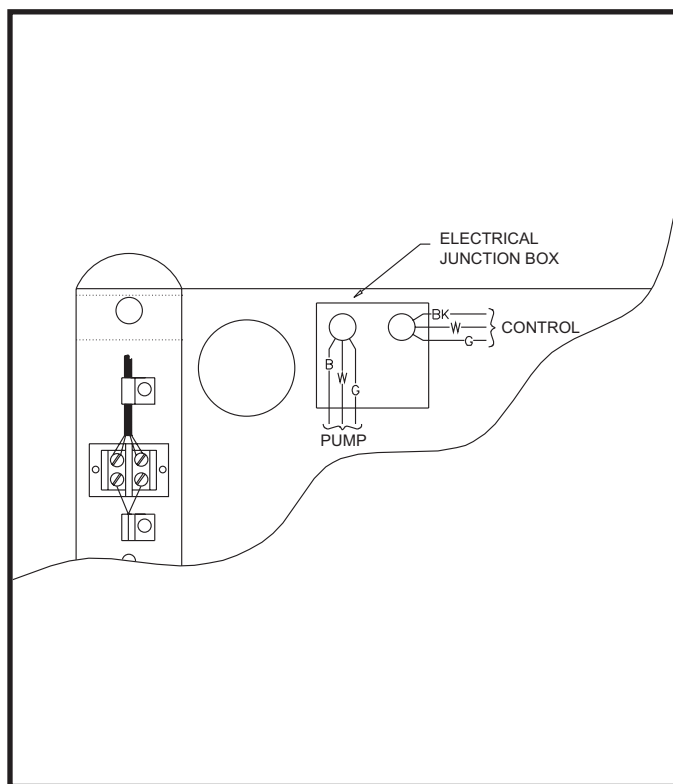


FIG. 45 Electric Power Connections - Controls and Pumps

A 120 VAC, 15 Amp, 1 ph, 60 Hz circuit is required for operation of the integral circulating pump and a 120 VAC, 15 Amp, 1 ph, 60 Hz circuit for the appliance controls are recommended. If a single electrical service is provided to operate both the controls and pump, a 120 VAC, 30 Amp, 1 ph, 60 Hz circuit is recommended. The combustion air blower motor operates on 230 VAC, 3 ph, 60 Hz. This three phase voltage is generated by the variable frequency drive (VFD) and supplied directly to the blower motor. **NOTE: No 230 VAC electrical service is required for operation of the combustion air blower.**

The appliance, 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 appliance 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 appliance is being fired. The Excel 10 temperature controller will energize the integral circulating pump for continuous operation when the main power switch is in the "ON" position and the run stop switch is in the "RUN" position. If the internal water temperature drops below 45°F (7.2°C) the pump will automatically cycle on to help prevent freezing. See Freeze Protection.
4. To avoid serious damage, **DO NOT** energize the appliance until the system is full of water. Ensure that all air is removed from the bypass piping before beginning initial operation. Serious damage may result if the appliance is operated without proper flow.
5. Provide the appliance with proper overload protection.

TABLE - R AMP DRAW DATA 1,000,000 through 2,000,000 Btu/hr Models			
APPROXIMATE TOTAL			
Btu/hr	Blower & Controls	Pump FLA	Amps @ 120 AC
1,500,000	6.7	8.8	15.5
1,700,000	7.2	8.8	16
2,000,000	7.2	8.8	16

## JACKET ASSEMBLY

Inner Jacket - The inner jacket assembly is constructed from a special corrosion resistant stainless steel. This includes both the front primary heat exchanger chamber and the rear secondary heat exchanger chamber. All screws and fasteners used for

assembly of the inner jacket and secondary heat exchanger chamber are also stainless steel. The stainless steel screws are identified by a sealing washer mounted on each screw. **DO NOT mix stainless steel and standard plated fasteners when disassembling and reassembling the inner jacket sheet metal components.** Standard plated fasteners may be damaged by the flue product condensate when used on the inner jacket assemblies.

**Outer Jacket** - The outer jacket assembly is constructed from steel, galvanized on both sides. The galvanized surface is specially prepared and phosphate coated to allow application of a multiple coat enamel paint process. This coating process ensures a long life from the jacket assembly.

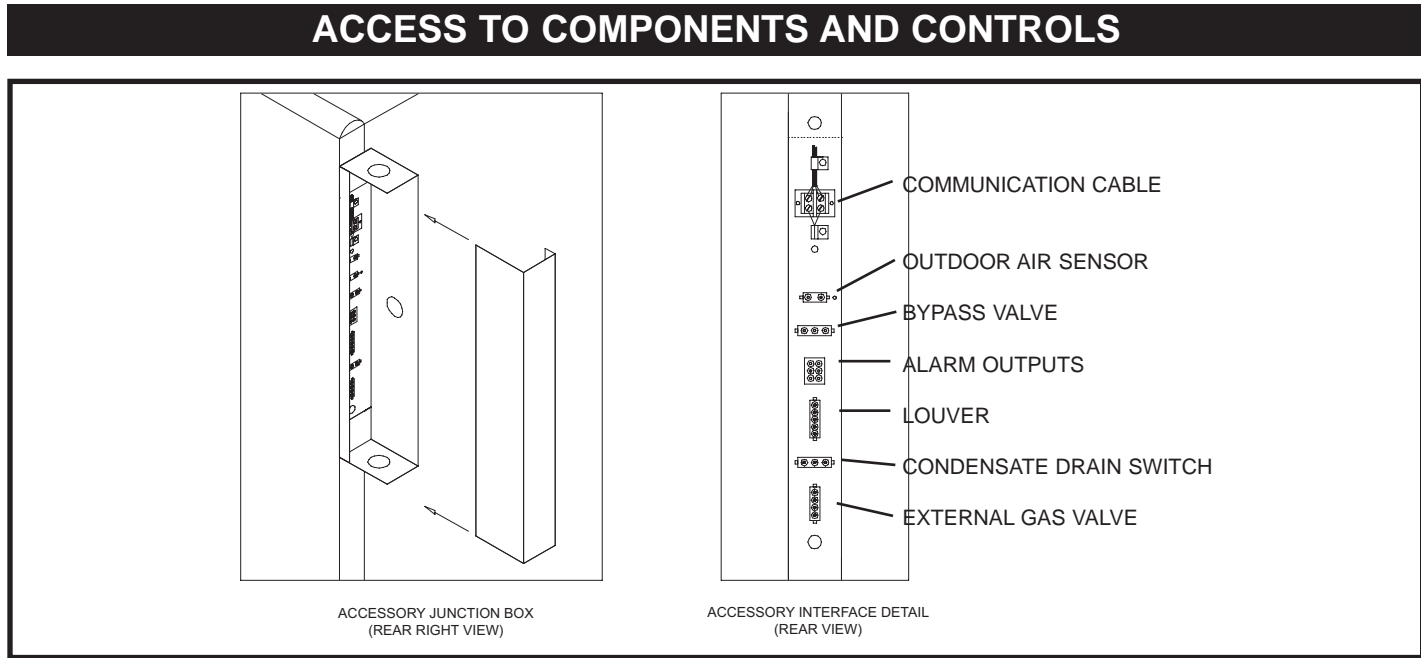


FIG. 46 Component and Auxiliary Controls Connections with Junction Box

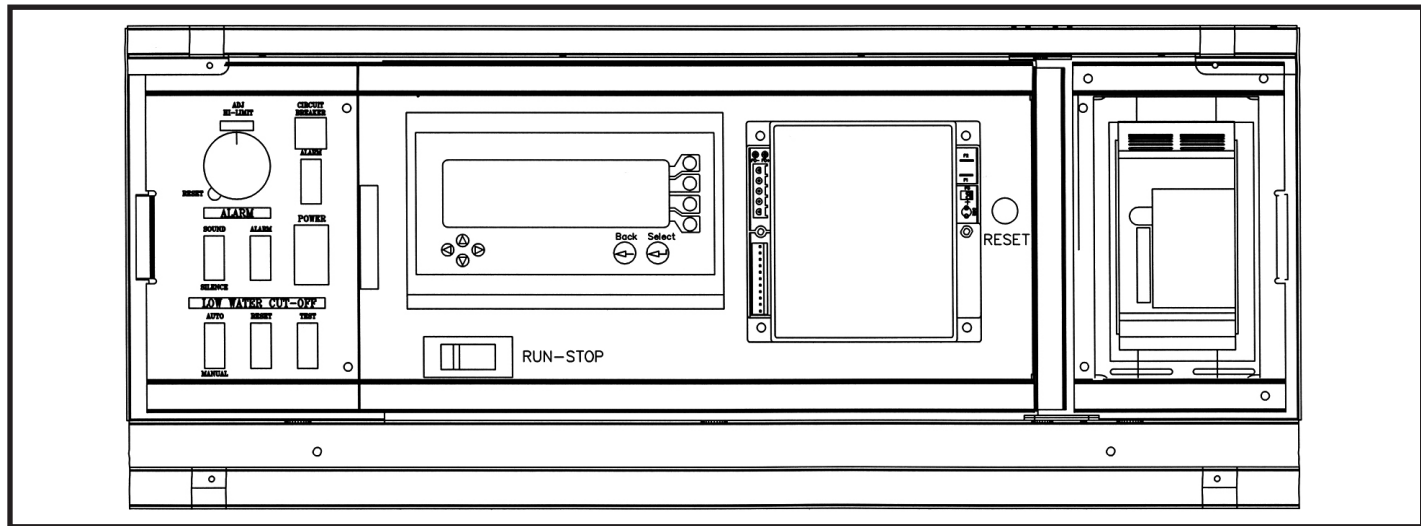
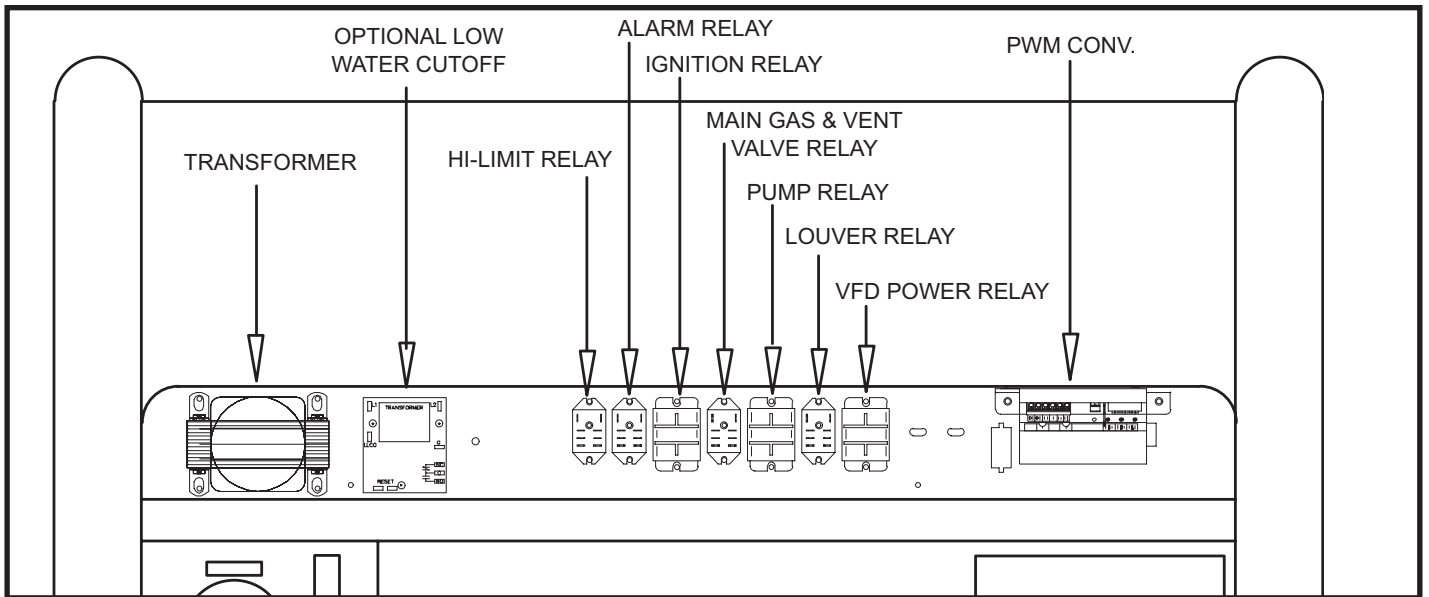
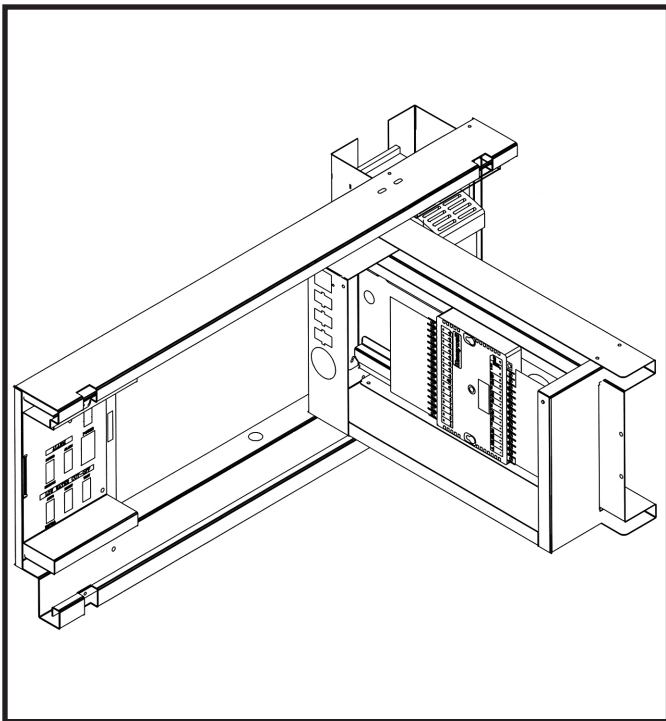


FIG. 47 Front Control Panel Locations



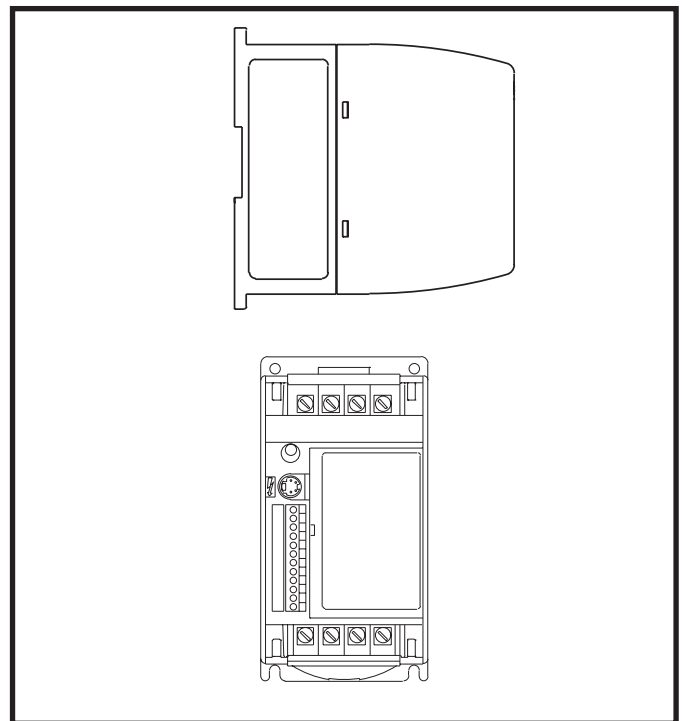
**FIG. 48 Transformer and Relay Locations**



**FIG. 49 Internal Control Panel Location**

A transformer and relay mounting panel is located above the front control panel, underneath the curved exterior front jacket panel. This panel contains a 100 VA transformer to drop 120 VAC to 24 VAC for internal control operation, an optional electronic low water cut-off, a high limit alarm relay, an alarm relay, an ignition relay, gas valve relay, pump relay, louver relay and VFD power relay.

## VARIABLE FREQUENCY DRIVE



**FIG. 50 Variable Frequency Drive**

This appliance uses a variable frequency drive to control operation of the combustion air blower motor. The variable frequency drive is supplied with 120 VAC power. The blower motor operates on 230 VAC 3 phase power. This three phase voltage is generated by the variable frequency drive (VFD) and supplied directly to the blower motor. The variable frequency drive receives a signal from the Excel 10 controller based on water temperature to vary the frequency of the voltage supplied to the blower motor from 15 Hz up to 60 Hz. This varies the

output of the combustion air blower from 25% up to 100% of capacity corresponding to the same variation in burner input. The output from the Excel 10 to the variable frequency drive ensures that combustion air and gas are always supplied in the proper ratio for clean combustion. The variable frequency drive is driven to 100% during the pre-burge portion of the start-up sequence. The variable frequency drive is then provided a signal to operate at 50% for initial burner ignition. After main burner ignition is established, the Excel 10 will use the variable frequency drive to vary the blower speed based on desired water temperature set point, the variation in actual water temperature from the desired setpoint and the various operating characteristics programmed into the control's software.

When removing the variable frequency drive from the appliance, disconnect the power wires to the combustion air blower at the terminals on the variable frequency drive. **DO NOT** disconnect the power wires at the blower motor. Note the marking of the wires for proper reinstallation of the three phase power wires to the VFD. Both the wires and the VFD terminals are marked for proper location of wire terminals. Incorrect installation of the wires may reverse rotation of the blower motor resulting in major operational problems.

## CAUTION ⚠

The voltage output from the variable frequency drive to the combustion air blower is 230 volt 3 phase. Avoid contact with high voltage wiring.

## LOW AIR PRESSURE SWITCH

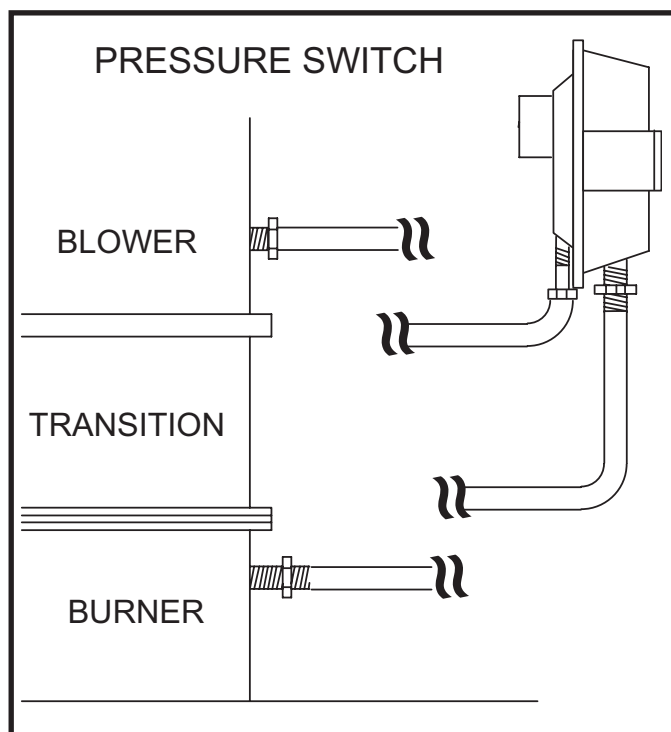


FIG. 51 Low Air Pressure Switch

A differential air pressure switch is used to prove operation of the combustion air blower. The pressure switch sensing points are installed across the point of pressure drop as the air moves into the inlet of the burner. This switch measures the same pressure drop points similar to those used by the ratio gas valve to adjust manifold gas pressure. Correct differential pressure across the sensing points of the pressure switch proves operation of the combustion air blower to the Excel 10 control. The Command Display will exhibit a Status Alarm of LowAirPress and the appliance will shut down operation when the differential pressure switch detects a sustained low air condition.

## HIGH GAS PRESSURE SWITCH LOW GAS PRESSURE SWITCH (Optional)

High and/or low gas pressure switches are available as an option on this appliance. The high gas pressure switch is used to monitor the maximum gas supply pressure supplied to the gas train. If gas pressure exceeds the maximum setting of the pressure switch, the appliance will shut down and a gas pressure fault will be indicated in the Command Display. The low gas pressure switch is to monitor the minimum gas supply pressure supplied to the gas train. If gas pressure falls below the minimum setting of the pressure switch, the appliance will shut down and a gas pressure fault will be indicated on the Command Display. GasPressFail will be shown on the Display for either a high or low gas pressure problem.

## EXCEL 10

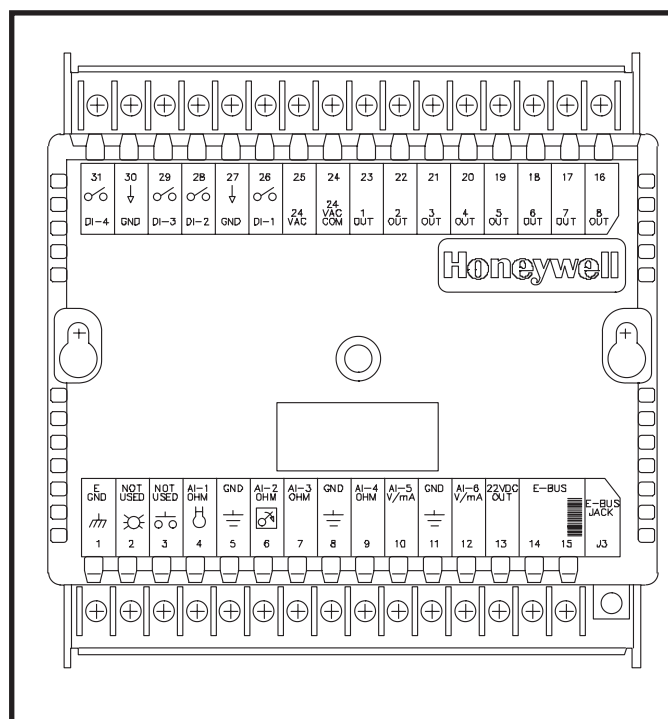


FIG. 52 Excel 10 Control Module

**Excel 10 Boiler Interface Controller** - The boiler interface controller for this appliance is based on the Excel 10 controller platform with unique software customized for operation of the Lochinvar *Intelli-Fin*. The Excel 10 is also compatible with LonWorks<sup>®</sup> building management systems. All of the appliances internal safety, operating and ignition controls interface with the Excel 10 controller. Local communication, programming and a digital display of the appliance functions and operating conditions are accessible through a Command Display. The Command Display is mounted on the front control panel of the appliance as shipped from the manufacturer. If multiple *Intelli-Fin* appliances are to be installed in a single application, see “Multiple Appliance Installations” for information on interfacing, sequencing and display of multiple *Intelli-Fin* appliances.

### NOTE:

A single Command Display is shipped for each job site installation with up to 16 *Intelli-Fin* appliances. A single Command Display is used to display and access the operating conditions of up to 16 *Intelli-Fin* appliances.

The Excel 10 Boiler Interface Control serves as the operating temperature control to regulate the amount of heat added to the water system for both heating boilers and potable water heaters. Custom software programmed into the Excel 10 will determine the proper operating profile for your specific application. Ensure that an *Intelli-Fin* is properly applied. A unit ordered as

a heating boiler must be applied as a heating boiler and a unit ordered as a potable water heater must be applied as a water heater. The Excel 10 Boiler Interface Control provides on/off control of the gas supply to the burner, operation of a VFD to control a variable speed combustion air blower, interface with the ignition control system, on/off control of the integral circulating pump, operation of a floating point bypass valve, control of water temperature set points, and monitoring of all safety functions. The operation and status of these and all related functions are displayed on the Command Display.

The Excel 10 has a single LED located in the middle of the control module. In normal operation of a boiler equipped with an optional outdoor reset function, this LED will blink at the rate of one blink per second. Active alarms will blink this service LED at a faster than normal rate of two blinks per second to indicate an alarm. The alarms which are displayed in this manner are: Network communications failure, sensor failure, hard lockout, water flow failure, low air, blocked drain, low/high gas pressure, flame failure, soft lockout, heat mode failure, high temperature alarm, and boiler not operational. A boiler that is not equipped with the outdoor reset function or a water heater will always blink the LED at the faster rate of approximately two blinks per second. This LED is not to be used as a diagnostic indicator.

The Excel 10 controller is mounted on the backside of the front control panel that mounts the Command Display and the Ignition Control Module. This panel is hinged on the right side so it can be exposed for viewing and service. All connections from the appliance safety and operating controls to the Excel 10 are accomplished with multiple wiring harnesses. Each wiring

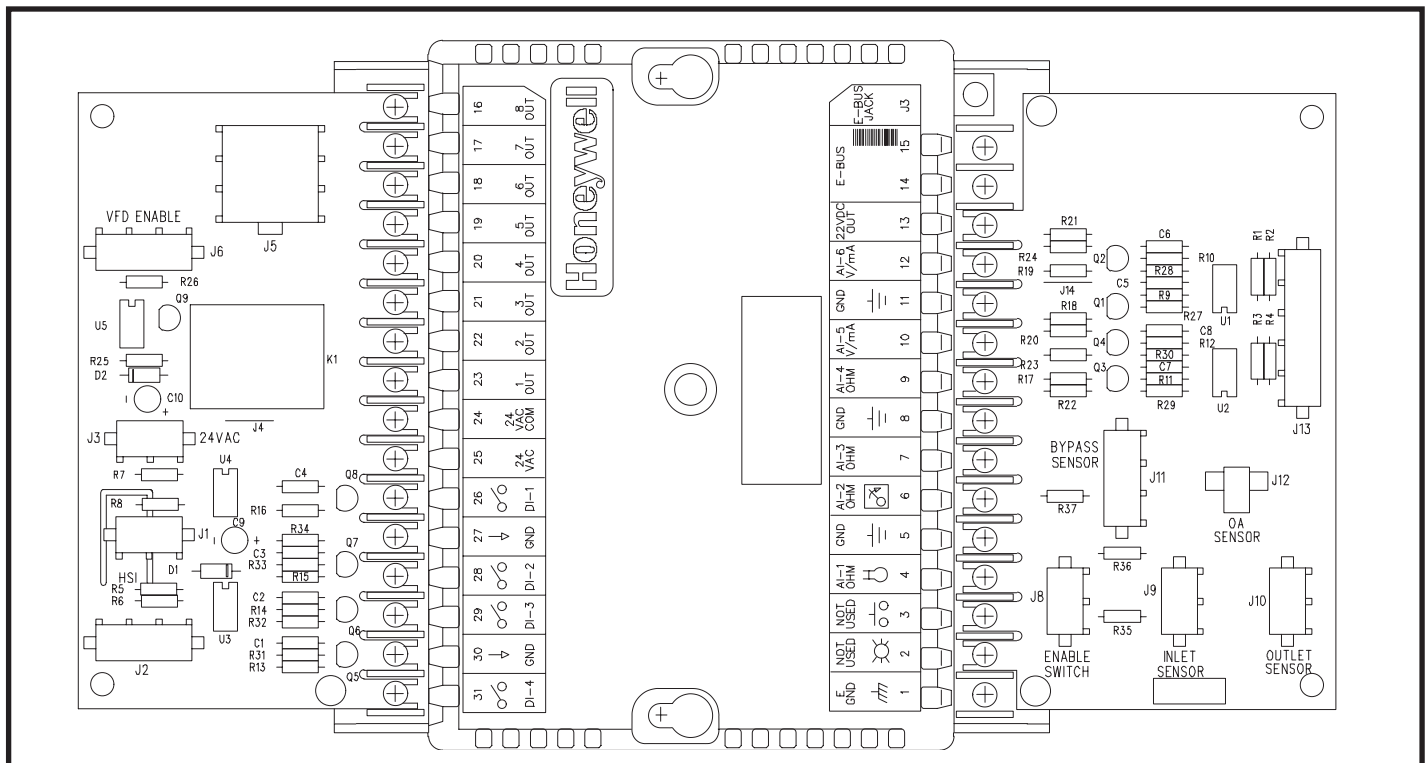


FIG. 53 Excel 10 Control Module with Circuit Boards and Wire Terminal Connections



harness is connected to unique multiple pin terminations to ensure proper connection of all components. The multiple termination points are located on two printed circuit boards mounted on either side of the Excel 10 controller. Use caution when connecting or disconnecting wires at the plug in terminals to prevent damage to the printed circuit boards.

There is a bar code label on the back of the *Intelli-Fin* near the terminal connections. This is the Neuron I.D. label which identifies the exact numerical sequence applied to Excel 10 control installed in the boiler/water heater. This information is required for the local/remote communication network. The numerical sequence is unique to each Excel 10 and must be placed into the network of an energy management system so that the Excel 10 can be recognized by the system. **NOTE: If the Excel 10 is ever replaced, a tear-off label on the new Excel 10 must be placed over this label on the back of the unit for easy reference.**

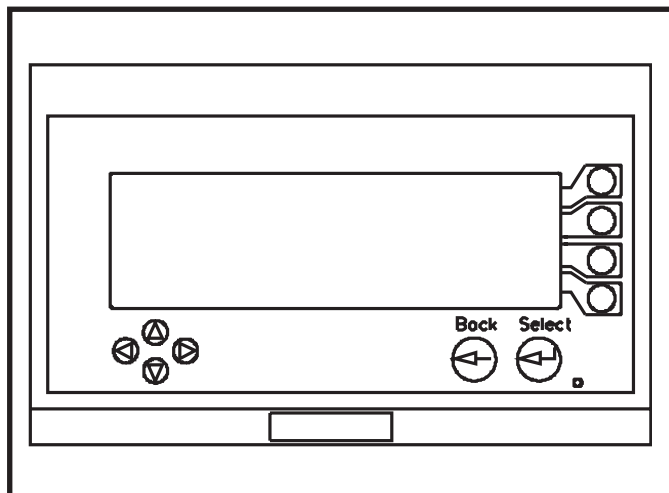
The Excel 10 may have values for the control points specified at the time the control is configured at the factory. If exact control settings are not specified at the time an appliance is ordered, the Excel 10 controller will be pre-programmed with the following default values as shipped from the factory. Special arrangements should be made with the factory during the ordering process to have job site specific values programmed into the control. These values are different for boiler and water heater applications.

**TABLE - S**  
**Default Values**  
**Pre-programmed in the Excel 10**

Point	Boiler	Water Heater
Setpoint Temp	130.0°F	120.0°F
O.A. Lockout	70.0°F	N/A
O.A. Max	60.0°F	N/A
O.A. Min	10.0°F	N/A
Max Setpoint	220.0°F	190.0°F
Min. Setpoint	100.0°F	50.0°F
Operating Sensor	Return/Inlet	Return/Inlet
Heater I.D.	Boiler	Water Heater

## TEMPERATURE ADJUSTMENT

### COMMAND DISPLAY



**FIG. 54 Command Display Panel**

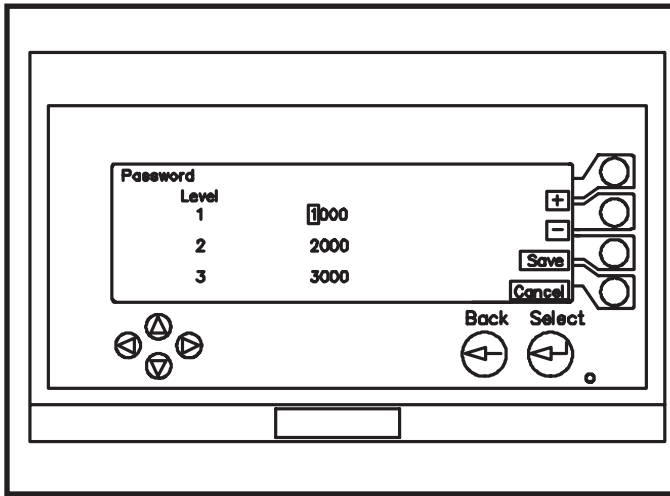
The Command Display provides a communication interface with the Excel 10 via a series of display screens. The front view of the display screen shows the digital display with a cluster of arrow keys on the lower left side. These directional arrow keys move the cursor in the direction of the arrow.

On the lower right side is a back key which moves the display to the previous screen and a select key which highlights a field in the display.

There are also four softkeys along the right side of the display. A notation on the specific screen defines the function of each of these keys. The softkeys may be defined as configure, change, save, cancel, + to increase a value or - to decrease a value on the screen.

## PASSWORD FUNCTION

On initial operation of the *Intelli-Fin* the owner may enter three levels of password with the Command Display to limit access to the changeable operating parameters in the Excel 10. Each password is composed of a four digit number. As shipped from the factory all passwords are zeros. The first level of password allows access to the six changeable points accessible from the Command display. The second level of password allows access to the configuration settings of the Command Display. The third level of password allows the password to be changed.



**FIG. 55 Command Display Password Screen**

The configure button also allows the user to access the password function to enter a password in the Excel 10 from the Command Display. Use of a password will limit the access to the changeable points. When located at the password screen, move the cursor to the first blank space (by using the left or right buttons on the left side of the Command display). Use the “+” or “-” buttons on the right side of the Command Display to either increase (+) or decrease (-) the number to the desired number. Then use the left or right buttons to move the cursor to the next space and repeat this procedure. Once the password has been entered, push the “SAVE” button. Once a password number sequence has been entered into the Command display, they must be correctly reentered to change any of the six adjustable points. If an incorrect password sequence is entered, the password screen will stay in place.

### NOTE:

Once a password is correctly entered, it will not have to be reentered unless five minutes of inactivity on the Command Display has elapsed.

## CONFIGURING THE COMMAND DISPLAY

When the “CONFIGURE” button on the right side of the Command Display is pressed, a password screen will appear. The user must enter the appropriate password and press “SAVE” to access the changeable screen. Pressing this button provides access to a “setup” screen that allows the user to adjust such items as:

## TABLE - T DISPLAY DEFAULT VALUES

	Default	Option
Contrast	50%	0 - 100%
Backlight Mode	AUTO	OFF/ON
Beep on New Alarm	OFF	ON
Beep Rate	4.0s	0 - 60s
Time Format	12	24
Date Format	MM/DD/YY	DD/MM/YY
Engineering Units	English	S.I.

## ACCESSING THE SIX CHANGEABLE POINTS FROM THE COMMAND DISPLAY

When the “CHANGE” button on the right side of the control is pressed, a password screen will appear. The user must enter the appropriate password and press “SAVE” to access the changeable screen. The desired point to change must be highlighted by moving the cursor and then use the “+” or “-” buttons on the right side to change the value to the desired value. Once the desired value is reached, press the “SAVE” button and the new value will be saved and the Command Display will return to the first screen of the 21 points for that boiler/water heater. The password must be entered each time a user wants to change the settings of any of the six changeable points. However, if you go to the screen again within 5 minutes of the last time, it will not require the password again. If the screen is left in the changeable point screen for more than 5 minutes with no activity, it will automatically return to the first screen of the 21 points for the boiler/water heater. Re-entry into this changeable point screen will then require password access again.

### NOTE:

Allow 10 seconds for data shown in the display screens to update when viewing or making adjustments to any of the six adjustable points.

## POINTS FROM INFORMATION VISIBLE FROM THE SCREEN OF THE COMMAND DISPLAY

1. **Calculated Set Point** — The water temperature as adjusted by an optional outdoor reset function used on a heating boiler only. If no outdoor reset

function is used, this displays the same temperature as the setpoint. Outdoor air Reset function not available on a water heater application.

2. **Setpoint Temp** — The desired water temperature as adjusted by the owner/operator. This becomes the lowest boiler operating temperature when an optional outdoor reset function is used. (Changeable Point from the Command Display)
3. **Return/Inlet Temp** — The temperature of the water entering the boiler or water heater, a basic thermometer function to display inlet water temperature.
4. **Supply/Outlet Temp** — The temperature of the water leaving the boiler or water heater, a basic thermometer function to display outlet water temperature.
5. **Temp. Rise** — The difference between inlet and outlet water temperature at the boiler or water heater to show the water temperature rise.
6. **Status** — Displays current status of the control as the appliance is going through its firing sequence and possible faults that could occur and the condition of each. See Status Point Modes and Alarms.
7. **O.A. Lockout** — The maximum outdoor air temperature where the boiler will continue to operate. When the outdoor temperature rises above this setting, no heat should be needed for the building and the boiler will lockout and not fire.
8. **O.A. Max** — The warmest outdoor air temperature where the boiler reset function will begin to function and operate the boiler at the initial setpoint temperature. The boiler setpoint will increase based on a corresponding drop in outdoor temperature below this temperature.
9. **O.A. Min** — The coldest outdoor air temperature where the boiler reset function will reach a maximum boiler water temperature. No additional reset (increase) in boiler temperature will occur past this point as outdoor temperature continues to drop lower. (Changeable Point from the Command Display)
10. **O.A. Temp.** — A display of the outdoor air temperature as sensed by the optional outdoor air reset sensor.
11. **Max. SetPoint** — The maximum water temperature the boiler or water heater may be set to operate at. (Changeable from the Command Display)

12. **Min. SetPoint** — The minimum water temperature the boiler or water heater may be set to operate at. This temperature is established in the configuration process at the factory.
13. **Total Run Time** — The accumulated number of hours that the boiler or water heater burner has been in operation. Time is accumulated in one hour increments and can total up to 99,999 hours before rolling over to restart the accumulation process.
14. **Sequencing Type** — The type of sequencing selected for operation of multiple units, FOFO, FOLO, etc. when ordered as an option. See “Sequencing Options”. (Changeable Point from the Command Display)
15. **Percent Modulation** — The percent of maximum input that the burner is actually firing at. This may vary from 25% up to 100% of rate based on demand.
16. **Auxiliary Relay** — The “ON” or “OFF” status of an additional relay to indicate a specified function of the unit.
17. **Percent Bypass** — The percent that the bypass valve is open to allow heated discharge water to be recirculated into the inlet of the primary heat exchanger in order to control condensate formation on the primary heat exchanger. 0% indicates that the valve is fully closed and 100% indicates that the valve is fully open. The percentage will vary with valve operation.
18. **Bypass Temp.** — A display of the water temperature in the inlet to the primary heat exchanger after being mixed with hot discharge water from the bypass piping when the bypass valve is open.
19. **Operating Sensor** — A display which indicates the location of the operating sensor in the unit. The operating sensor may be in the Return/Inlet or Supply/Outlet of the boiler or water heater. (Changeable Point from the Command Display)
20. **Heater Pump** — The “ON” or “OFF” status of the integral circulating pump for the boiler or water heater.
21. **Heater I.D.** — An indication of whether the unit is a boiler or water heater. (Changeable Point from the Command Display).

HEAT SOURCE		
AUX. SEQUENCER	HEATING	
BOILER #01	HSI OK	
BOILER #02	BURNER ON	
BOILER #03	LOWAIR PRES	
BOILER #04	LOWH2OFLOW	
BOILER #05	STANDBY	
V MORE V	CONFIGURE	

SCREEN #1

FIG. 56a Command Display Data Screen

BOILER #12		
CALCULATEDSETPOINT	150.1 F	
SETPOINT TEMP.	150.1 F	
RETURN/INLET TEMP.	145.1 F	
SUPPLY/OUTLET TEMP.	150.5 F	
TEMP. RISE	5.4 DDF	
STATUS	STANDBY	
V MORE V	CHANGE	
CONFIGURE		

SCREEN #4

FIG. 56d Command Display Data Screen

HEAT SOURCE		
BOILER #06	STANDBY	
BOILER #07	STANDBY	
BOILER #08	STANDBY	
BOILER #09	STANDBY	
BOILER #10	FLAME FAIL	
BOILER #11	STANDBY	
V MORE V	CONFIGURE	

SCREEN #2

FIG. 56b Command Display Data Screen

BOILER #12		
O.A. LOCKOUT	70.0 F	
O.A. MAX.	60.0 F	
O.A. MIN.	10.1 F	
O.A. TEMP.	65.0 F	
MAX. SETPOINT	220.0 F	
MIN. SETPOINT	50.0 F	
V MORE V	CHANGE	
CONFIGURE		

SCREEN #5

FIG. 56e Command Display Data Screen

HEAT SOURCE		
BOILER #12	STANDBY	
BOILER #13	STANDBY	
BOILER #14	H2OFLOW OK	
BOILER #15	AIRPRES OK	
BOILER #16	OFF LINE	
V MORE V	CONFIGURE	

SCREEN #3

FIG. 56c Command Display Data Screen

BOILER #12		
TOTAL RUN TIME	987.00 HR	
SEQUENCING TYPE	EFF OPT RT	
PERCENT MODULATION	0.00 %	
AUXILIARY RELAY	OFF	
PERCENT BYPASS	50.00 %	
BYPASS TEMP.	150.2 F	
V MORE V	CHANGE	
CONFIGURE		

SCREEN #6

FIG. 56f Command Display Data Screen

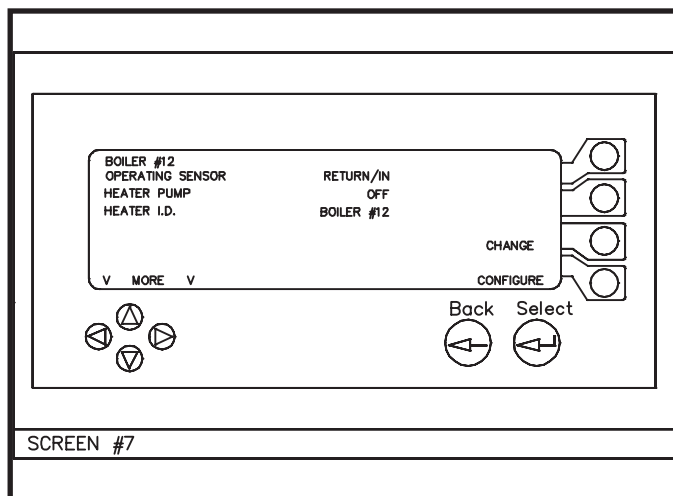


FIG. 56g Command Display Data Screen

## STATUS POINTS

In the screen display for a specific boiler or water heater, there will be a Status indication. The status point details the operational mode of the appliance or in the event of a control sensed failure, a status point alarm. The status point alarm mode indicates the reason for the control sensed shut down of the appliance.

## POWER-UP AND NAVIGATION BETWEEN THE SCREENS OF THE COMMAND DISPLAY

The first screen is viewable on the Command Display as it is powered up. This Command Display screen gives the current software version running on the Excel 10. This screen goes away after 60 seconds. The amount of time until this screen changes is displayed on the bottom left of the screen in a numeric count. After the 60 seconds expires or when the user presses any key during this interval, the next screen is displayed. This feature is used for performing factory tests.

After power-up, the Command Display starts acquiring data from the Excel 10. The following screens display the status of the bytes of data received from the Excel 10. After receiving all the data bytes, the Command Display shows the Heat Source(s) and the presence of an Optional Sequencer, if equipped. Note that the Heat Source names can vary but typically they may be Boiler #01 up to Boiler #16 or WtrHtr #01 up to WtrHtr #16, based on the application. At the time an order is placed, the owner may specify a unique name for each appliance if desired. Pressing the *Configure softkey* will take you to the System Configure screen with two active *softkeys*. The *Setup softkey* will take you to a screen which allows you to setup the display in the screen. The *Password softkey* will take you to the password screen to set the three levels of password required to access the various functions of the Excel 10. Pressing the *Back key* will return you to the Heat Source display. The *up* and *down arrow keys* can be used to scroll the cursor up and down to the various heat sources (boilers or water heaters) at this location. To the right of each heat source is displayed the operational status of the individual appliance. Pressing the

**TABLE - U**  
**Status Point Operational Modes:**

<b>Self Test:</b>	Excel 10 self test period, approximately 5 seconds during power up of Excel 10.
<b>Standby:</b>	There is no call for heat and the boiler is waiting for a call for heat.
<b>H2OFlow OK:</b>	Checking operation of flow switch to verify water flow from the pump.
<b>Air Press OK:</b>	Low air switch verifies operation of combustion air blower.
<b>Drain OK:</b>	Verifies that the condensate drain flow to the optional Condensate Management System is not blocked.
<b>GasPress OK:</b>	Verifies gas pressure at optional switch(es) - high and/or low.
<b>PrePurge:</b>	Pre purge operation of combustion air blower.
<b>HSI OK:</b>	Hot Surface Igniter On.
<b>Burner ON:</b>	Burner On.
<b>Heating:</b>	Temperature is beginning to rise.
<b>PostPurge:</b>	Post purge combustion blower operation after a call for heat sequence.

Select key when the cursor is on a specific heat source displays the parameters for this Boiler or Water Heater. Pressing the *Change softkey* takes you to a screen displaying the six adjustable points for the Boiler or Water Heater. Use the *up* and *down arrow keys* to move the cursor to each point. Use the *+* and *- softkeys* to adjust the setting pressing *Select softkey* to enter the revised setting into memory. Pressing the *Back button* will return you to screen displaying the parameters for this Boiler or Water Heater. Pressing the *Back button* will return you to screen displaying the Heat Source(s) and the presence of an Optional Sequencer, if equipped.

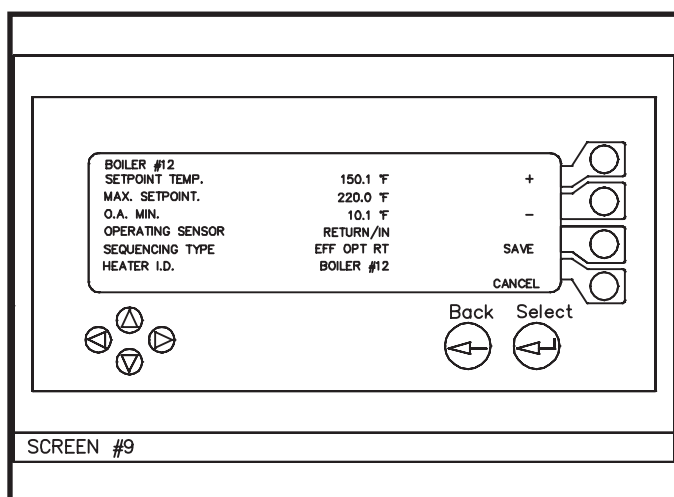


FIG. 57 Command Display Data Screen

## OUTDOOR RESET FUNCTION SELECTIONS (Optional on Heating Boilers Only)

As an option, the Excel 10 control may be equipped with an outdoor reset function. This function uses a sensor to measure the outdoor temperature and automatically adjust the boiler setpoint temperature to compensate for colder outdoor temperatures. O.A. Min, Max, SetPoint and Setpoint Temp are changeable points from

the Command Display. The additional values required by the Excel 10 to properly operate the reset function should be specified at the time a boiler is ordered. If specific settings are not available the default values will be programmed into the Excel 10 at the factory. The operating parameters for the reset function are:

**O.A. Lockout** — The maximum outdoor air temperature where the boiler will continue to operate. When the outdoor temperature rises above this setting, no heat should be needed for the building and the boiler will lockout and not fire. Default setting if not specified is 70.0°F (21.1°C). This setting should be specified at the time the boiler is ordered.

**O.A. Max** — The warmest outdoor air temperature where the boiler reset function will begin to function and operate the boiler at the initial setpoint temperature. The boiler setpoint will increase based on a corresponding drop in outdoor temperature below this temperature. Default setting if not specified is 60.0°F (15.6°C).

**O.A. Min** — The coldest outdoor air temperature where the boiler reset function will reach a maximum boiler water temperature (Max. SetPoint). No additional reset (increase) in boiler temperature will occur past this point as outdoor temperature continues to drop lower. Default setting if not specified is 10.0°F (-12.2°C). This setting is a Changeable Point from the Command Display.

**O.A. Temp.** — A display of the outdoor air temperature as sensed by the outdoor air sensor.

**Max. SetPoint** — The maximum water temperature that the boiler or water heater may be set to operate at. Default setting if not specified is 220.0°F (104.4°C)F. This setting is a Changeable Point from the Command Display.

**Setpoint Temp** — This is the lowest boiler operating temperature that the boiler will maintain when the outside air temperature is at the O.A. Max. This setting is a Changeable Point from the Command Display.

### TABLE - V Status Point Alarm Modes:

<b>Low H2O Flow:</b>	<b>Low water or flow condition exists.</b>
<b>Low Air Press:</b>	<b>Low air condition exists.</b>
<b>Block Drain:</b>	<b>Blocked condensate drain exists.</b>
<b>Block Flue:</b>	<b>Blocked flue or louver proving switch failed to prove.</b>
<b>Gas Press Fail:</b>	<b>Low or high gas pressure condition exists.</b>
<b>Flame Fail:</b>	<b>Hard lockout on a flame failure signaled from the ignition control.</b>
<b>Soft Lockout:</b>	<b>Wait period for the ignition control to recover from soft lockout conditions.</b>
<b>Over Temp:</b>	<b>Indicates that a higher than programmed temperature has been reached.</b>



**Calculated Set Point** — The water temperature as adjusted by the optional outdoor air reset function used on a heating boiler only. If no outdoor reset function is used, this displays the same temperature as the setpoint. Outdoor Air Reset function not available on a water heater application.

These functions are shown in the screens of the Command Display. Where noted, these settings are changeable from the Command Display to configure boiler operation to the building heat load and weather conditions in a specific geographic area.

## MULTIPLE APPLIANCE INSTALLATIONS

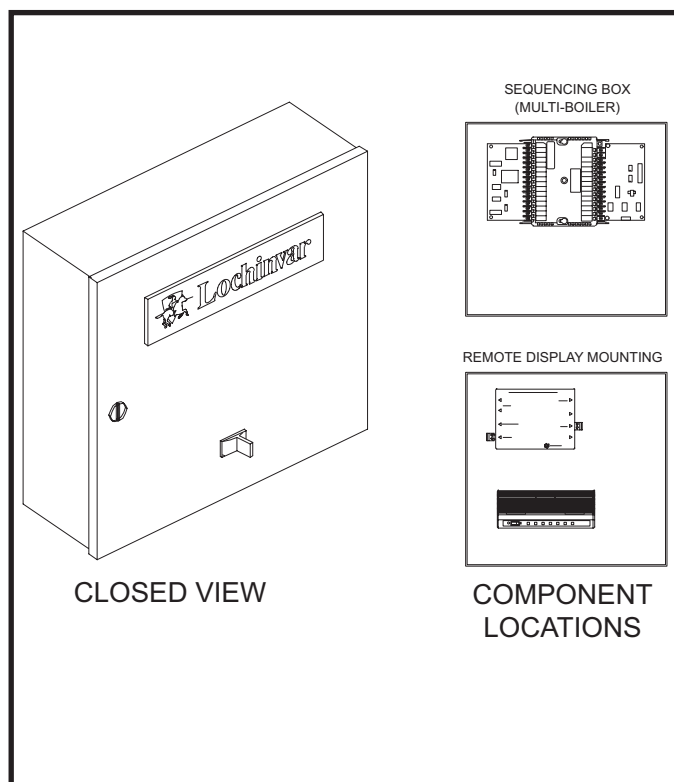


FIG. 58 Sequencer Control Panel

## SEQUENCING OPTIONS

The sequencer is supplied as a separate control enclosure that is connected to the multiple appliances via an E-bus connector on the rear of the appliance. The sequencer comes mounted in an enclosure that requires a field installed 24 VAC power source. An optional enclosure with a sub base and 24 VAC power supply is available to allow remote mounting of a Command Display adjacent to the sequencer. Multiple sequencing options are available. The specific software programming required to sequence multiple boilers must be specified at the time the appliances are ordered. The sequencing options are used to control how multiple boilers or water heaters are cycled to meet system demand. The sequencing options are programmed into an Excel 10 controller at the factory based on the number of selectable sequencing

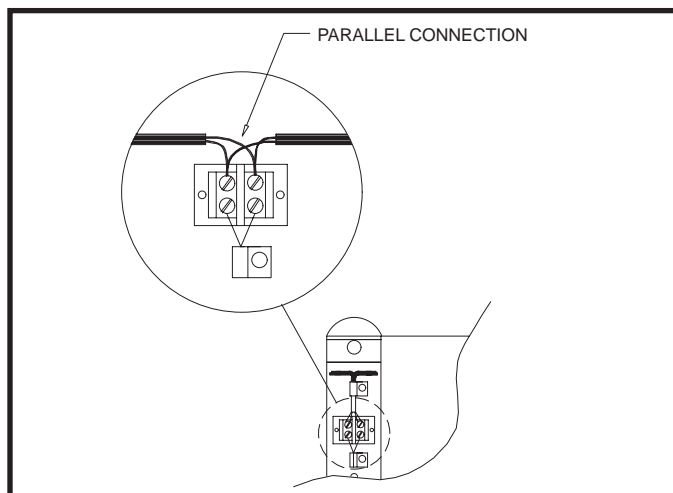
algorithms ordered. The desired method of sequencing multiple boilers or water heaters may be selected from the screen of the Command Display. There are up to five sequencing options that are selectable from the Command Display, based on the sequencing package purchased.

### NOTE:

Separate sequencers are required to control multiple Boilers and Water Heaters.

1. **First On - First Off** — This is a lead/lag control functionality. The sequencing of the boilers or water heaters is based on the total loop load with added units being brought on when the units that are running are at 100% and the loop load is not being met. Boilers or water heaters are turned off when the loop load falls and the first boiler or water heater on is at minimum load.
2. **First On - Last Off** — This is simple first on/ last off without rotation of the lead boiler or water heater.
3. **Efficiency Optimized** — The lead/lag will be based on first on/first off lead/lag. The overall efficiency will be optimized to run the boilers or water heaters at their highest efficiency. Highest efficiency occurs at the minimum loading for each boiler or water heater. Therefore, this option will add boilers or water heaters when the load reaches a point where the next boiler or water heater can run at minimum load.
4. **Efficiency Optimized with Time Equalization** — This is the same as “Efficiency Optimized” but the lead/lag is based on boiler or water heater run times. The boilers or water heaters will be sequenced to equalize run times to within approximately a 24 hour time period. If no opportunity is given to cycle, the control will not interrupt action to equalize runtime.
5. **None** — This is the default for any boiler or water heater control which has not purchased one of the Sequencing Option Packages.

## INTERFACING MULTIPLE APPLIANCES



**FIG. 59 E-Bus Connection to Controls**

Connection between multiple *Intelli-Fin* appliances is accomplished via an E-Bus connection. An E-Bus terminal is provided on the rear of each appliance. The minimum specification for the communication wire is for a Level IV, 22 AWG (0.034 mm<sup>2</sup>) plenum or non-plenum rated (as applicable), unshielded, twisted pair, solid conductor wire. Use plenum rated wire where required. See “Wire Requirements” for a listing of manufacturers who supply communication wire

meeting this specification. The twisted pair wire is used to make daisy chain connections between the E-Bus terminals on multiple appliances. The E-Bus connection uses a Free Topology Transceiver (FTT) to support a polarity-insensitive free topology wiring scheme for star, loop and/or bus wiring. The maximum number of nodes per segment is 60. The maximum number of nodes in a two-segment FTT network is 120, when using a repeater between the two segments. Consult factory for additional information on interface wiring of multiple *Intelli-Fin* appliances connection to an EMS.

FTT networks are flexible and convenient to install and maintain. However, it is imperative to plan the network layout and to create and maintain accurate documentation. Careful planning and up to date documentation facilitates compliance verification and future FTT network expansion. It also minimizes unknown or inaccurate wire run lengths, node to node (device to device) distances, node counts, total wire length, inaccurate repeater locations, and misplaced or missing terminations.

*Wire to the terminal blocks as follows:*

### NOTE:

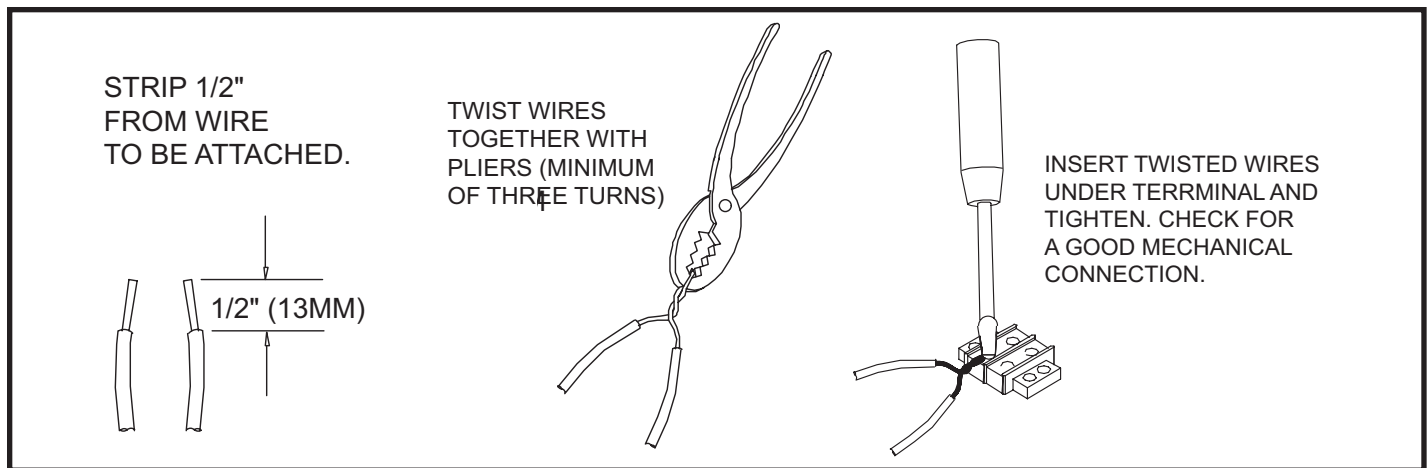
When attaching two or more wires to the same terminal, twist wires together (see Fig. 60). Deviation from this rule can result in improper electrical contact.

**TABLE - W**  
**Daisy-Chain Doubly Terminated FTT Network Bus Topology Specifications**

Wire/Cable Type	Maximum FTT network Bus length for segment(s) in feet (meters)	Maximum node-to-node length for segment(s) in feet (meters)
Level IV 22 AWG unshielded, twisted pair, solid conductor communications wire (use plenum rated wire where required)	4593 (1400)	3773 (1150)

**TABLE - X**  
**Singly Terminated FTT Network Bus Topology Specifications**

Wire/Cable Type	Maximum FTT network Bus length for segment(s) in feet (meters)	Maximum node-to-node length for segment(s) in feet (meters)
Level IV 22 AWG unshielded, twisted pair, solid conductor communications wire (use plenum rated wire where required)	1640 (500)	1312 (400)



**FIG. 60 Wire Termination for E-Bus Connection**

1. Strip 1/2 in. (13 mm) insulation from the conductor.
2. Insert the wire in the required terminal location and tighten the screw to complete the termination.
3. If two or more wires are being inserted into one terminal location, twist the wires together a minimum of three turns before inserting them.
4. Cut the twisted end of the wires to 3/16 in. (5 mm) before inserting them into the terminal and tightening the screw.
5. Pull on each wire in all terminals to check for good mechanical connection.

#### Wire Requirements

The minimum type and grade of wire required to “network” the Intelli-Fin to other units or LonMark® devices is a Level IV, 22 AWG (0.034 mm<sup>2</sup>) plenum or non-plenum rated (as applicable), unshielded, twisted pair, solid conductor communication wire. The following manufacturers supply communication wire that meets or exceeds this specification for E-Bus connections.

Anixter	(847) 677-2600 www.anixter.com
Belden Wire and Cable Co.	(800) 235-3361 www.belden.com
BICC General (BICC Cable, Brand-Rex, General Cable, Carol Cable)	(800) 424-5666 www.biccgeneral.com
ConnectAir International	(800) 247-1978 www.connect-air.com
Eastman Wire & Cable	(800) 257-7940 www.eastmanwire.com
Honeywell Inc.	(800) 345-6770 www.honeywell.com

Lucent Technologies

(305) 569-3600

www.lucent.com/netsys/  
systemax

Windy City Wire

(800) 379-1191

www.smartwire.com

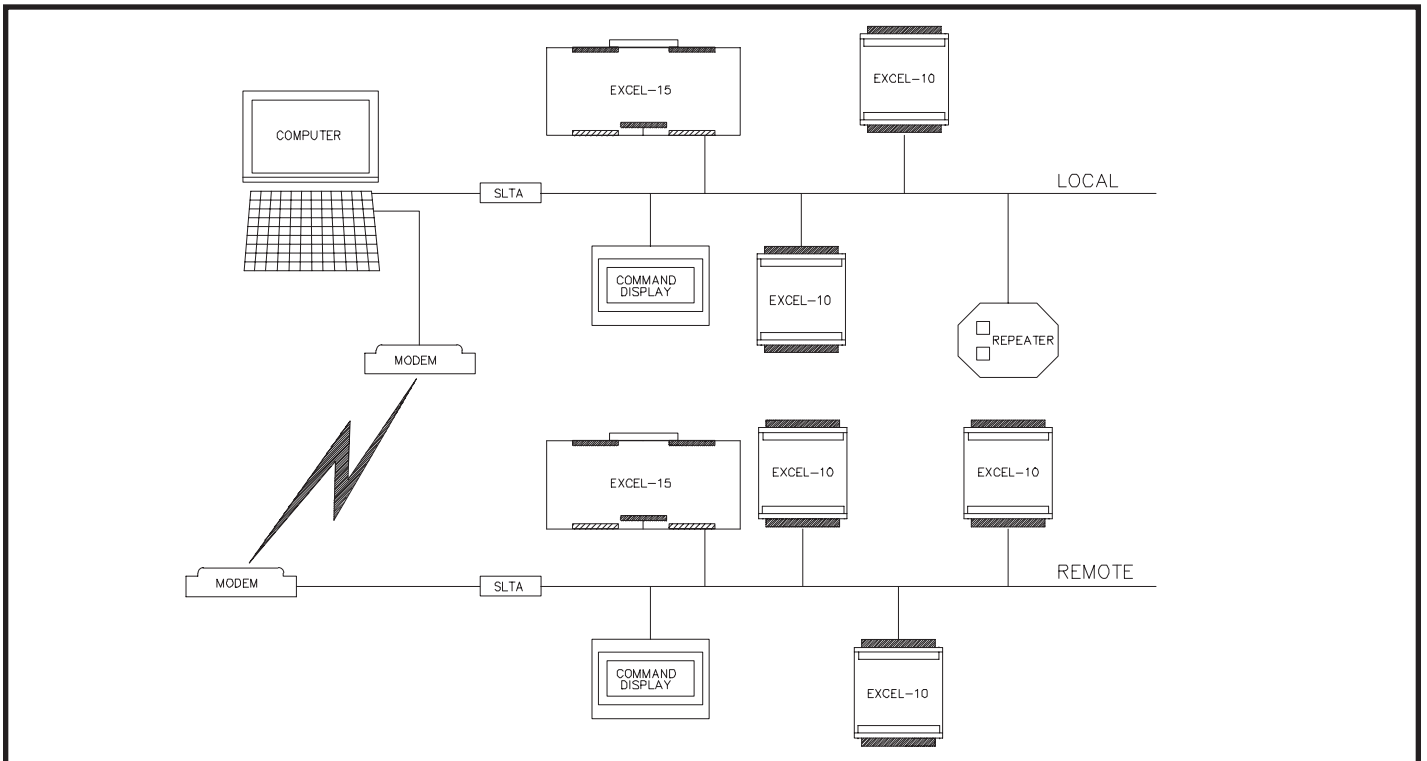
#### NOTE:

The minimum specification for Level IV, 22 AW (0.034 mm<sup>2</sup>) unshielded, twisted pair, solid conductor communication cable must be plenum-rated when the wire is routed through air ducts or plenum areas. Non-plenum rated communication cable is for general use when the wire is not being routed through air ducts or plenum areas.

#### ADDITIONAL COMPONENTS USED TO INTERFACE MULTIPLE APPLIANCES

**Serial LonTalk® Adapter (SLTA)** — A serial LonTalk® adapter is required to provide communication between the E-Bus and either a PC serial port or an approved modem using the SLTA-10 EIA-232 port. The SLTA interfaces with LonSpec™ software. There are specific null modem cable requirements for proper connection to a modem. The SLTA has a DB-9 female connection. Direct connection to a PC can be made with a DB-9 to DB-9 cable or a DB-9 to DB-25 cable, based on the available PC connection.

**FTT Repeater** — A repeater is available to increase the network wiring length in an E-Bus network. The repeater is designed to be installed in a standard field supplied 4 by 4 junction box.

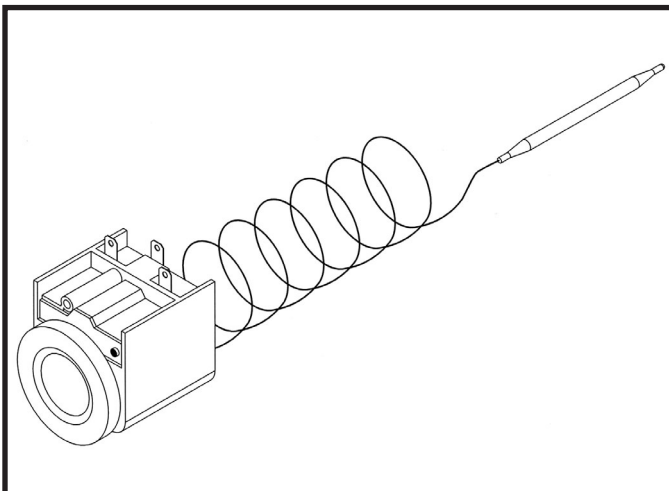


**FIG. 61 Typical Building Management System Diagram**

**Excel 15** — The Excel 15 Building Manager is a LonMark® compliant device that provides network management functions for the E-Bus in a Light Commercial Building Solutions System. The Excel 15 is compatible with the E-Bus and uses the free topology transceiver (FTT). Individual Excel 15 Controllers and Communicating Subbases distributed on the E-Bus perform specific HVAC equipment control. The Excel 15 monitors and controls both local and remote controller points. If E-Bus communications are interrupted, the Excel 15 is capable of stand-alone operation.

A Manual Reset High Limit control is located on the left front side of the control panel, beside the Command Display. Additional switches, alarm indicating lights and optional low water cut-off control switches are also located on this panel. The setting of this control knob limits maximum discharge water temperature. A red reset button, located beside the knob, must be pushed whenever water temperature has exceeded the set point of manual reset limit. The temperature of the water in the heat exchanger must drop a minimum of 15°F (8.3°C) below the setting of the manual reset high limit control before the reset function can be activated.

## HIGH WATER TEMPERATURE LIMIT CONTROL



**FIG. 62 High Water Temperature Control**

A red indicating light is illuminated when the water temperature exceeds the setting of the high limit control. A status point alarm of Over Temp will be displayed in the Command Display when water temperature exceeds the Setpoint Temperature programmed into the Excel 10 control on operation of the high water temperature limit control.

### NOTE:

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

## HOT SURFACE IGNITION SYSTEM

### IGNITION CONTROL MODULE

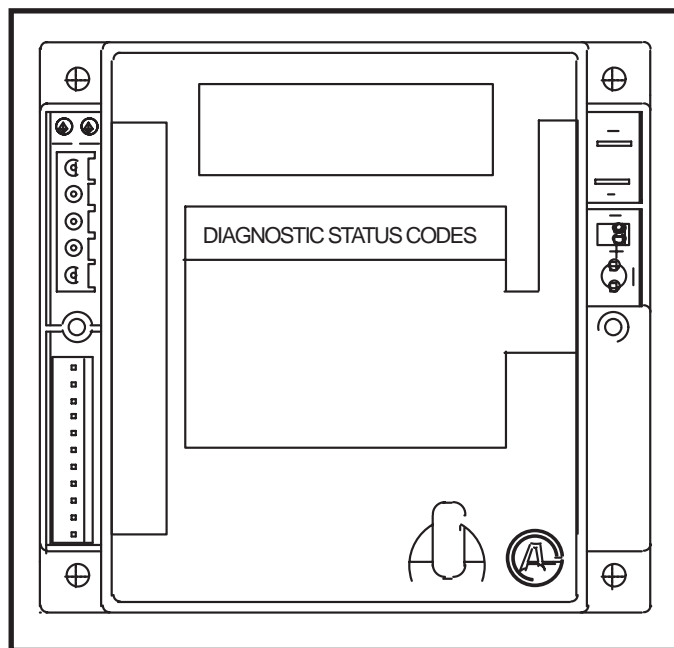


FIG. 63 Hot Surface Ignition Control Module

This appliance uses a proven hot surface ignition control system. The operation of the electronic control module for the hot surface igniter proves the presence of an ignition source much like a proven standing pilot before the gas valves are energized. The ignition control module starts and proves the operation of the combustion air blower, proves the presence of the proper ignition temperatures from the hot surface igniter, energizes the main gas valves, proves the presence of main burner flame, provides for soft lockouts on control sensed faults, provides a hard lockout on flame failure and controls the pre and post purge timings of the combustion air blower. A status point alarm of FlameFail will be displayed in the Command Display on a hard lockout for flame failure.

### Service Parts

This appliance uses a proven electronic ignition control module and a hot surface igniter. The electronic 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 hot surface igniter or ignition module **MUST** be replaced with a new OEM unit only. An OEM specification igniter and ignition control module for this specific unit is available from your local distributor. **DO NOT** use general purpose field replacement ignition modules or igniters. Each appliance has one ignition module and one hot surface igniter.

### Ignition Module Lockout Functions

The ignition module may lockout in either a hard lockout condition requiring pushing of the reset button to recycle the control or a soft lockout condition which may recycle in a fixed time period to check for correction of the fault condition. A typical hard lockout fault is a flame failure condition. Pushing the reset button for the ignition control is the only way to reset an ignition module that is in a hard lockout condition. The reset button is located on the inside front control panel. The reset button is active after the post purge cycle when there is hard lockout condition as indicated by the Status LED. Turning main power "OFF" and then "ON" or cycling the thermostat will not reset a hard lockout condition. Wait five seconds after turning on main power before pushing the reset button when the ignition module is in a hard lockout. The ignition module will go into a soft lockout in conditions of low air, low voltage or low hot surface igniter current. A soft lockout condition will operate the combustion air blower for the post purge cycle and then the ignition module will pause for a fixed time period. The timed length of the pause is based on the type of fault sensed by the control module. At the end of this timed pause, the ignition module will attempt a new trial for ignition sequence. If the soft lockout fault condition has subsided or has been corrected at the end of the timed pause, main burner ignition should be achieved with the resumption of the normal trial for ignition sequence. If the control sensed fault is not corrected, the ignition module will continue in the soft lockout condition. If the electronic thermostat opens during the soft lockout period, the ignition module will exit soft lockout and wait for a new call for heat from the thermostat. A soft lockout condition may also be reset by manually cycling the electronic thermostat or turning the main power switch "OFF" and then "ON" after the control sensed fault has been corrected. SoftLockout will be shown in the screen of the Command Display when the ignition control module has gone into a soft lockout condition.

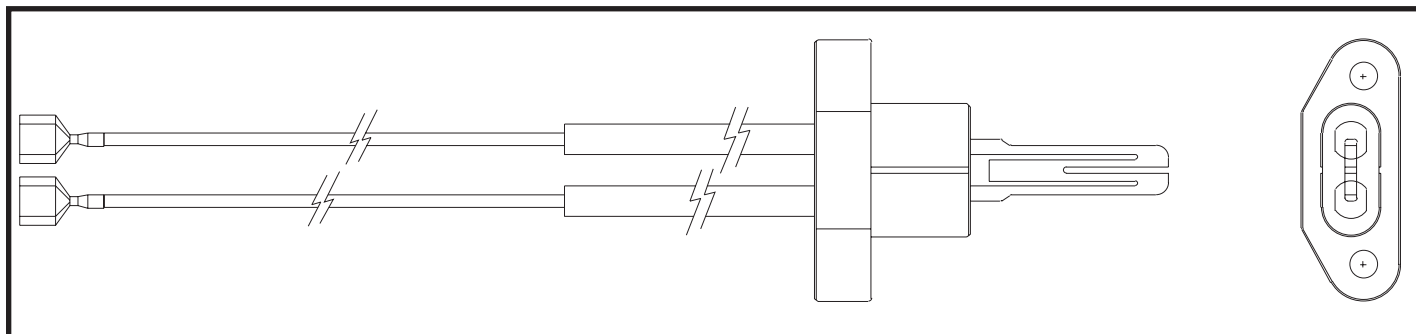


FIG. 64 Hot Surface Igniter



## Diagnostic Status Indication

The ignition module has an LED that indicates the status of the ignition safety circuits. The flashing operation of this LED indicates the diagnostic status of the ignition control module. The following listing gives the flashing diagnostic status codes as signaled by the ignition module.

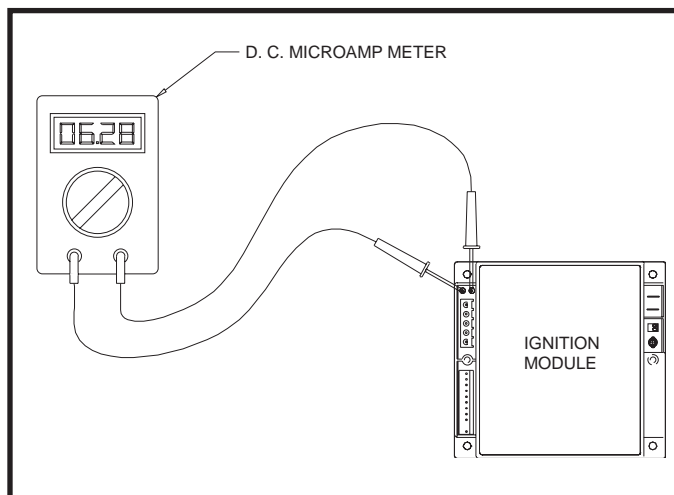


FIG. 65 Flame Current Measurement on the HSI Module

## TABLE - Y Ignition and Control Timings

### Proven Pilot Hot Surface Ignition System

#### Pre-purge Time

15 Seconds

#### Hot Surface Igniter Heat-up Time

25 - 35 Seconds

#### Main Burner Flame Establishing Period

4 Seconds

#### Failure Response Time

0.8 Seconds at  $< 0.5 \mu\text{A}$  flame current

#### Post-purge Time

30 Seconds

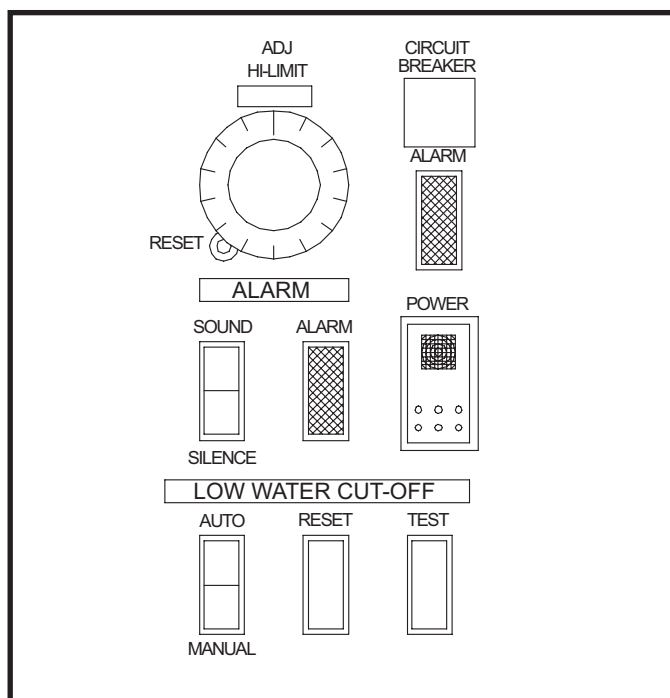
## TABLE - Z Ignition Module Status LED Diagnostic Codes

### Code Sequence

### Condition

<b>Constant ON</b>	System OK, no faults present.
<b>Constant OFF</b>	Possible control fault, check power; LED may be defective, do not replace control if all operational sequences function properly - see Trouble Shooting Guide.
<b>One Flash</b>	Low air, check air pressure switch and hoses to pressure sensing points, blower start-up/proving blower, venting and sealing of pressurized chamber. Note: Brief Flashing normal on blower startup.
<b>Two Flashes</b>	Flame without call for heat, check for a gas valve stuck in the open position, air, venting, burners and the combustion process. Blower will remain on.
<b>Three Flashes</b>	Lockout due to flame failure, push reset button on inner control panel after correcting ignition problem. Initial heater start up without properly bleeding air from the gas line may require multiple reset functions to achieve proper ignition.
<b>Four Flashes</b>	Igniter failure, igniter will not maintain minimum 2.7 amp current draw, caused by low voltage, bad wiring/continuity, high resistance or igniter failure.
<b>Five Flashes</b>	Power supply problem, check for low supply voltage or transformer output less than 18 VAC.
<b>Six Flashes</b>	Replace ignition module, internal fault.

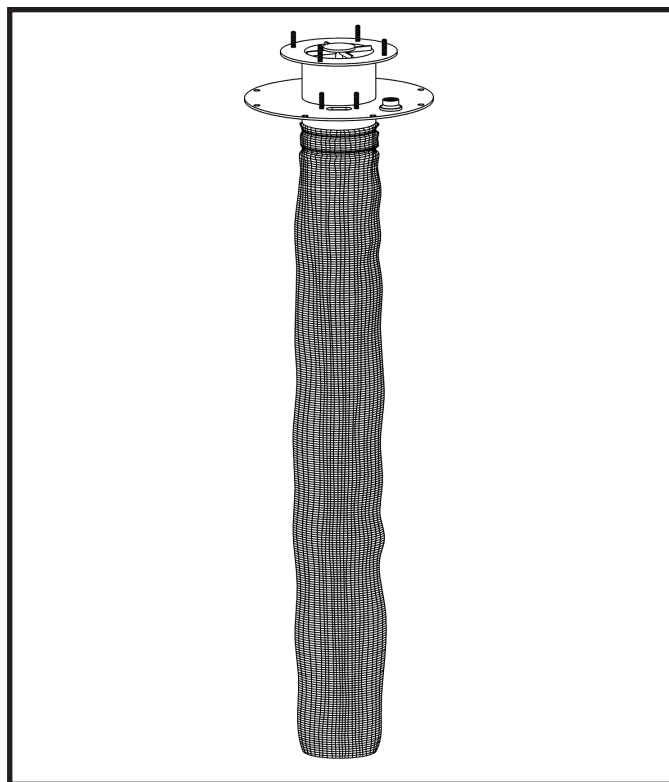
## OPERATION/DIAGNOSTIC LIGHTS, RESETS AND SWITCHES



**FIG. 66 Exterior Control Panel**

The control panel has a lighted ON/OFF power switch and 11 indicating lights and switches to show operation, control sensed malfunctions and diagnostics.

## BURNER



**FIG. 67 Burner Assembly**

**TABLE - AA**  
**Diagnostic Lights and Switches**

Indicator	Function
<b>Power</b>	Lighted ON/OFF Main Power Switch
<b>Alarm Silence</b>	Rocker Switch to Silence an Optional Audible Alarm.
<b>Alarm Light</b>	Amber Indicating Light for an Alarm Condition.
<b>High Limit Light</b>	Red Indicating Light for Water Temperature Exceeding Maximum Setting of High Limit Control.
<b>High Limit Knob</b>	Adjustable Rotary Knob to Set Maximum Water Temperature
<b>High Limit Reset</b>	Red Push Button to Reset High Limit when High Limit Setting is Exceeded.
<b>Circuit Breaker</b>	Reset Button for a 5 Amp breaker on the 24 VAC Control Circuit.
<b>Low Water Cut-Off</b>	
<b>Auto/Manual Switch</b>	Rocker Switch to select either a Manual Reset or Auto Reset function of the Low Water Cut-Off.
<b>Test Switch</b>	Black Momentary Rocker Switch interrupts the sensing circuit of the Low Water Cut-Off to prove operation.
<b>Reset Switch</b>	Red Momentary Rocker Switch to Reset the Low Water Cut-Off after a test or Low Water Condition when operating in the Manual Reset Mode.
<b>Command Display</b>	
<b>Run/Stop Switch</b>	“RUN” allows normal operation - “STOP” shuts down operation, but allows communication with a network.
<b>Ignition Control</b>	
<b>Flame Failure Reset</b>	Red Push Button to reset the Hot Surface Ignition Control when a hard lockout condition from a Flame Failure has occurred.

This appliance uses a single cylindrical burner installed vertically into the cavity located in the center of the primary heat exchanger. There is a unique burner for each one of the three models.

Burners may **NOT** be changed between different Btu/hr input models. The burner consists of a round mounting flange welded to a mixing tube. The top side of the mixing tube provides the transition which mounts the discharge from the combustion air blower into the burner. The bottom side of the mixing tube is attached to a stainless steel perforated sleeve. This stainless steel sleeve is covered with a loose fitting, woven alloy material that forms the burner port surface. The woven burner port material is called Alcromesh which is a unique alloy of iron, chrome, aluminum and several rare earth metals. This alloy is designed to operate stress free as a burner port surface. The Alcromesh burner port surface can sustain operation from a blue flame down to infrared conditions as the burner input varies. Internally, the burner has a cone and distribution baffles to balance the air/gas mixture over the surface of the burner. The burner mounting flange provides a flame view port and the mounting point for the hot surface igniter. The hot surface igniter is removable from the burner mounting flange without removing the burner assembly from the heat exchanger.

### NOTE:

An index mark is provided on the burner flange to ensure proper orientation when removing and reinstalling the burner. A properly indexed burner will ensure correct location of the combustion air blower and adequate clearances from other components in the top jacket chamber.

The burner is designed to operate from 100% of rated input down to 25% of rated input in normal operation. Burner

operation at input rates of less than 50% may include operation in the infrared state. At input rates firing above 50%, there may be some slight infrared visible on the tips of the woven burner port material. This is normal burner operation.

## COMBUSTION AIR BLOWER

This appliance uses a sealed air blower to provide combustion air for the burner and operate the **Category IV** venting system. The blower assembly consists of a sealed housing and blower wheel constructed from cast aluminum. The blower is operated by a fully enclosed 230 VAC, 3 Phase electric motor. This motor has a 3/4 HP rating on the 1,500,000 Btu/hr model and a 1 HP rating on the 1,700,000 and 2,000,000 Btu/hr models. The blower housing and motor assembly is fully sealed and **CAN NOT** be field serviced.

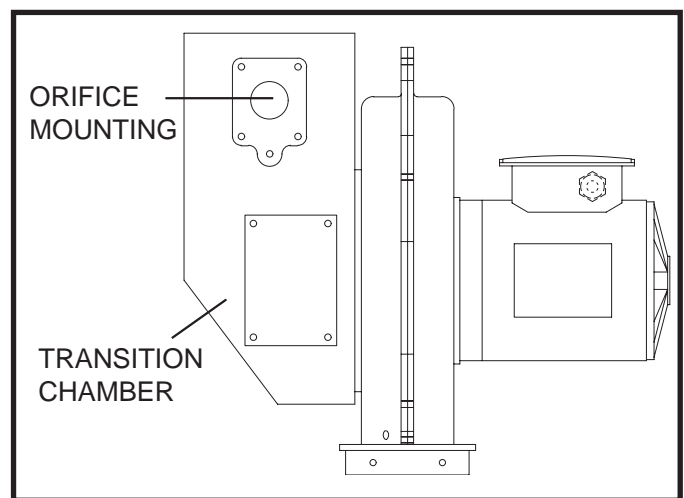


FIG. 69 Combustion Air Blower and Transition Chamber

A sealed transition chamber is mounted on the inlet to the combustion air blower. This chamber contains the gas orifice

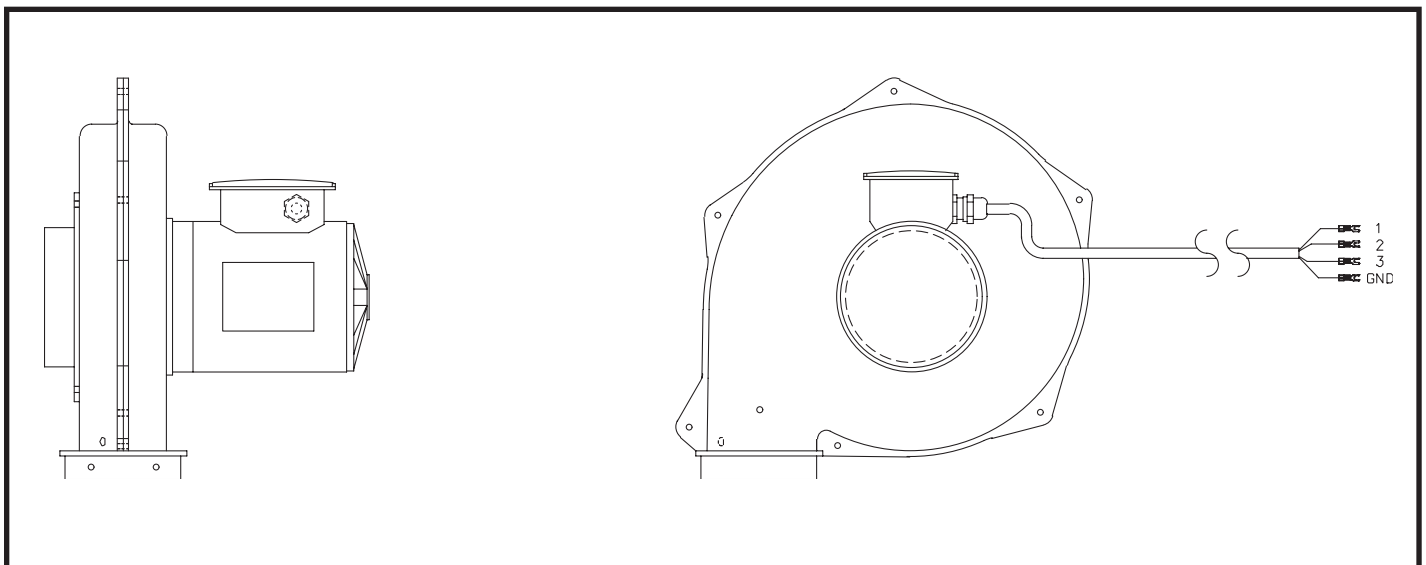
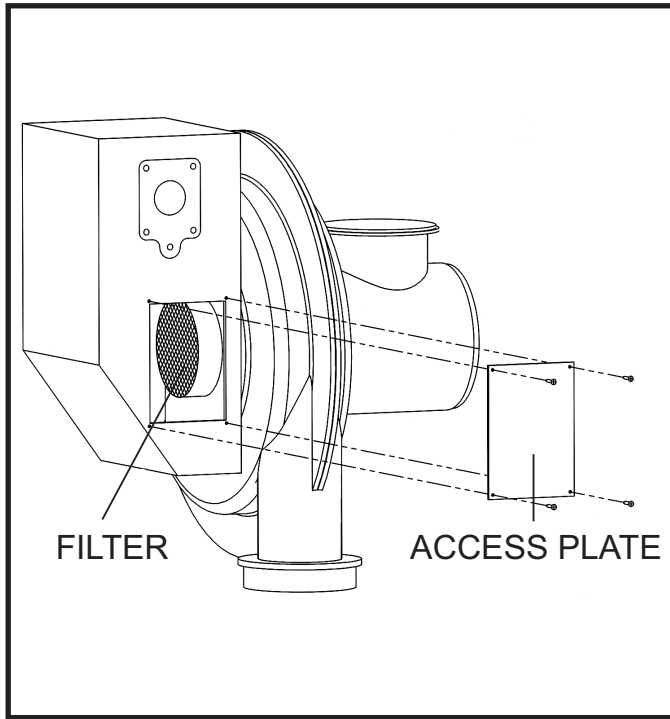


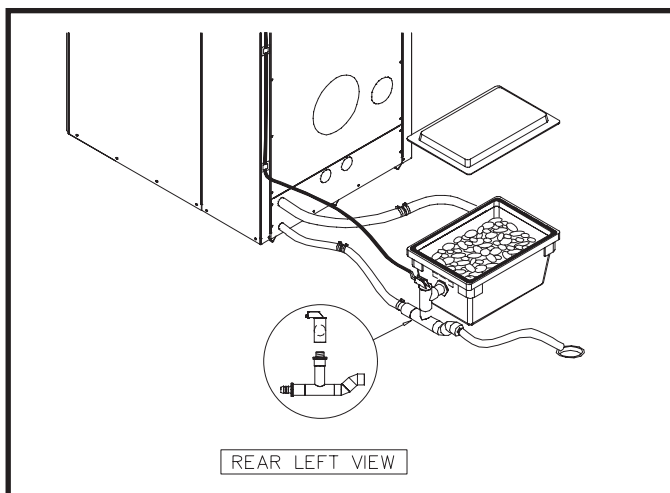
FIG. 68 Combustion Air Blower

and a sensing point for operation of the ratio gas valve. Inside the transition chamber, at the inlet to the combustion air blower there is a filter to prevent particulate matter and small foreign objects from entering the blower and burner. This filter should be checked and cleaned on a six month interval or more often in a contaminated environment. An for inspection port is provided on the side of the transition chamber to allow access to the internal filter for inspection and cleaning. If cleaning is required, remove the filter through the inspection port and clean with soapy water or compressed air.



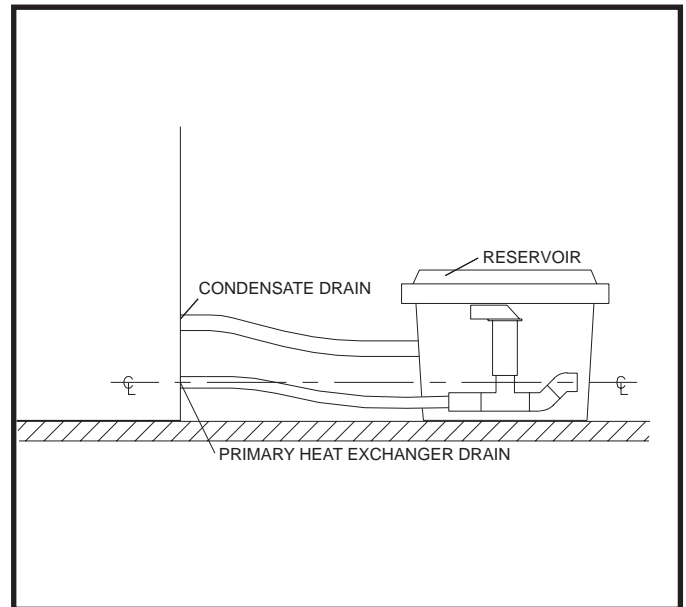
**FIG. 70 Cleaning the Internal Combustion Air Blower Inlet Filter**

## CONDENSATE MANAGEMENT SYSTEM (Optional)



**FIG. 71 Location and Connection of Neutralization Reservoir**

This high efficiency appliance may operate as a condensing appliance for extended periods of time based on return water temperatures. Condensate occurs when the products of combustion are cooled below their dew point in the heat transfer process. The liquid condensate formed from this high efficiency heat transfer process is mildly acidic. The condensate will typically have a pH ranging from 4.0 to 5.0 as it is discharged from the condensate drain on the rear of the appliance. The internal jacket area where the condensate is collected (secondary heat exchanger) is constructed from a special corrosion resistant stainless steel. All materials external to the appliance in contact with the condensate must be corrosion resistant. This is typically accomplished by using PVC plastic pipe and synthetic tubing. Condensate must be able to flow freely from the appliance. All condensate flow is accomplished by gravity requiring a minimum downward slope of 1/4" per foot (21mm/m) to ensure proper flow to the condensate management system and/or a suitable drain. The neutralizer reservoir **MUST** always be mounted on the same level or lower than the bottom of the appliance cabinet. All condensate piping and connections must be easily accessible for routine maintenance and inspection. Sufficient lengths of tubing, clamps and barbed connectors are supplied in the kit to allow the neutralizer reservoir to be positioned to the right, left or rear of the appliance.



**FIG. 72 Condensate Drain Location on rear of the Appliance**

Operation of the appliance in a full condensing mode for extended periods of time may produce flue gas condensate in amounts up to the following volume:

**TABLE - BB**  
**Approximate Maximum**  
**Condensate Volumes**

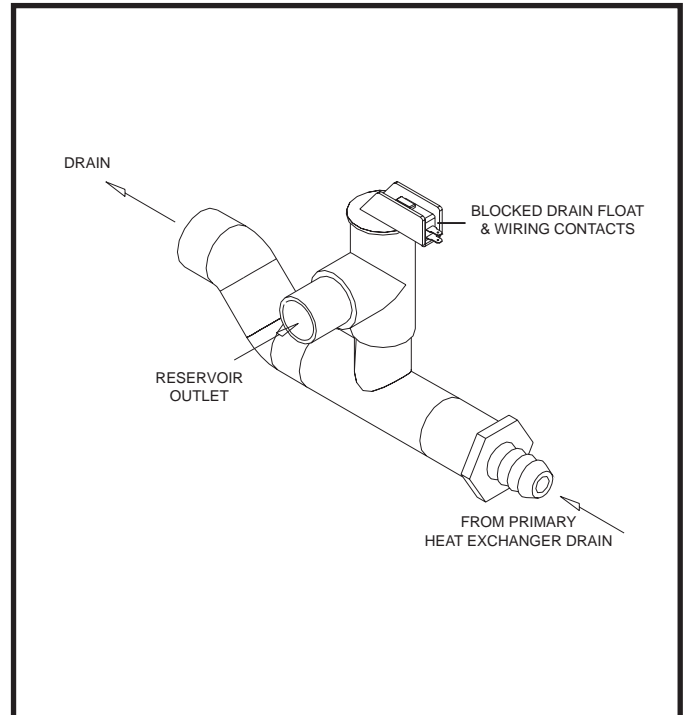
Model/Input Btu/hr	Gallons Per Hour
1,500,000	7.3
1,700,000	8.3
2,000,000	9.7

Many codes will require the acidic condensate to be neutralized before it can be placed in a drain system. The optional condensate management system consists of a neutralizer kit to control the pH of the liquid discharged to a drain system. The neutralizer in the condensate management system consists of an industrial grade, non corrosive plastic reservoir for collection of the condensate. The reservoir is charged with a reagent grade calcium carbonate. The initial calcium carbonate fill is shipped installed in the reservoir. The top to the reservoir is sealed and held in place with two straps. It is not necessary to open the reservoir before placing the neutralizer in service. The reagent grade calcium carbonate should fill approximately 3/4 of the reservoir in an even layer over the bottom. The condensate outlet from the appliance must be piped to the reservoir inlet. An elbow and barb are provided for connection to the appliance condensate drain hose (large hose). The drain from the condensate drain tee in the venting system may also be routed to the reservoir inlet for disposal of any condensate formed in the flue. This would be accomplished by adding a field installed tee to the hose assembly. Ensure that a trap is provided in the drain line from the flue to prevent flue gases from escaping with the condensate.

The condensate collects in the reservoir where it is in direct contact with the calcium carbonate. As the reservoir fills, it provides an extended residence time to neutralize the condensate. The neutralized condensate exits from the reservoir outlet. The drain tee assembly must be installed in the reservoir outlet. The upper half of the drain assembly (large tee) and the lower half must be screwed together before mounting on the reservoir. The tee assembly is screwed in to the reservoir outlet and the top of the large tee is positioned vertically. Before installing the blocked drain float, prime the installed drain tee assembly with 8 ounces (250 ml) of water to prevent flue gas spillage from the drain. The blocked drain float assembly snaps into the top of the large tee. The blocked drain wiring harness should be routed up the back of the appliance and plugged into the blocked drain connection. Mounting tabs for the harness conduit are provided in the kit. The lower half of the drain assembly screws into the bottom of the tee. The drain assembly allows the drain from the primary heat exchanger (small hose) to be connected to the reservoir outlet. Hose, barbs and clamps are provided in the kit. The outlet from the lower half of the drain tee assembly has two 45° elbows at the point of discharge from the assembly. The hose to the floor drain attaches at this point. Use standard 1/2" PVC, CPVC or suitable hose to run to floor drain.

When the condensate level in the reservoir rises to the drain, the pH is controlled to a range of 6.5 to 7 before exiting the system. (A pH of 7 is neutral. As the pH number increases in numerical value, the relative acidity of the discharge decreases.) The neutralized condensate may then be discharged into a suitable drain system without fear of damage to the drain system. Ensure that the top remains on the reservoir keeping it sealed to prevent any contamination to the treatment process.

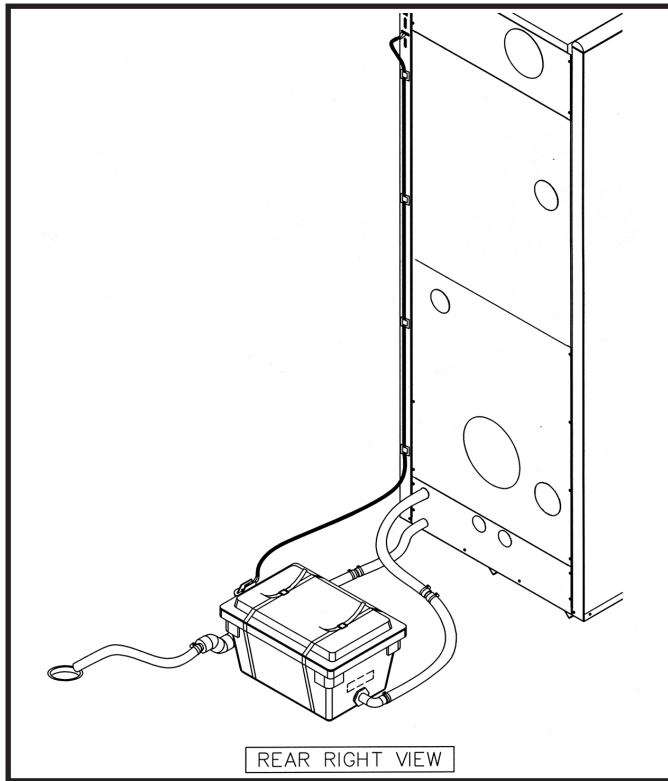
### Blocked Drain Switch



**FIG. 73 Blocked Drain Switch and Interconnection**

The piping to the condensate reservoir is equipped with a blocked drain switch. The wiring harness from the blocked drain switch is plugged into the "DRAIN" terminals on the back side of the appliance. The drain terminal connection is located on top left side of the rear jacket, inside the junction box cover, as part of a series of control connection points. Remove the jumper plug before connecting the blocked drain switch wiring harness. If the drain that allows the neutralized condensate to exit from the reservoir becomes blocked or obstructed and the normal flow of condensate to the drain stops, the blocked drain switch will shut down operation of the appliance. A status point alarm of **BlockDrain** will be displayed on the Command Display on operation of the condensate management system blocked drain switch.





**FIG. 74 Installed Condensate Neutralization System**

### ***Condensate Testing***

The initial fill of reagent grade calcium carbonate should sustain neutralization for 3 months of operation. An appliance operating at higher temperatures will produce condensate at lower levels allowing the calcium carbonate to remain effective as a neutralizer for a maximum of 6 months. The pH of the neutralized condensate discharged from the reservoir should be checked at 30 day intervals. A pH meter or indicating test strips may be used to monitor the relative acidity of the condensate. When the pH of the condensate discharged from the reservoir can not be maintained above a pH of 6.0, the calcium carbonate must be recharged. Recharge packages of reagent grade calcium carbonate are available from your distributor.

### ***Replenishing the Neutralizer***

All of the depleted calcium carbonate must be removed from the reservoir and properly disposed. Rinse and clean the reservoir thoroughly before adding the new charge to the system. Ensure that the piping to and from the reservoir is clear with no obstructions. Add the new reagent grade calcium carbonate in an even layer over the bottom of the reservoir. Replace the top on the reservoir, replace the two straps to secure the top and return the appliance to service. Check the related piping for leaks on the initial firing after the system is recharged.

## **LIGHTING INSTRUCTIONS**


### **FOR YOUR SAFETY, READ BEFORE OPERATING**

### **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.

- A. 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.
- B. 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.
  - Do not try to light any appliance.
  - Do not touch any electric switch; do not use any phone in your building.
  - Immediately call your gas supplier from a neighbors phone.
  - Follow the gas supplier's instructions.
  - If you cannot reach your gas supplier, call the fire department.
- C. Use only your hand to turn the gas control handle. Never use tools. If the handle will not turn by hand, don't try to repair it, call a qualified service technician. Force or attempted repair may result in a fire or explosion.
- D. Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the boiler. 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.

## LIGHTING INSTRUCTIONS

1. **STOP!** Read the safety information.
2. Set the Temperature Setpoint function of the Command Display to the lowest setting.
3. Turn Off all electrical power to the appliance.
4. This appliance is equipped with an ignition device, which automatically lights the burner.  
**DO NOT** try to light the burner by hand.
5. Turn the main manual gas cock handle clockwise  to the "OFF" position.

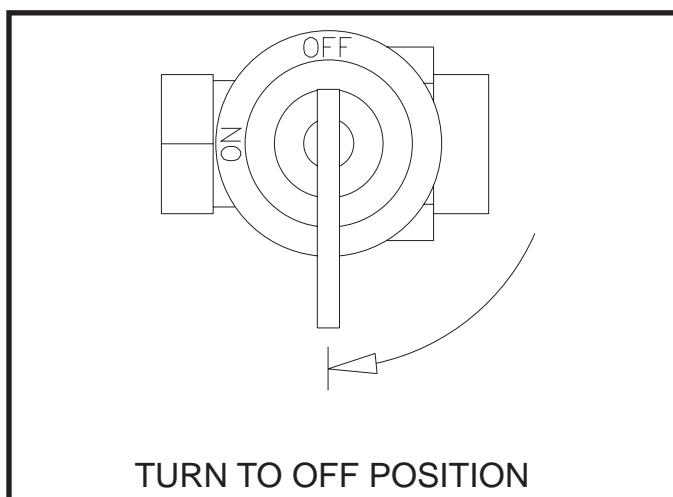



FIG. 75 Gas Cock with Handle in "OFF" position

6. Wait five (5) minutes to clear out any gas. If you smell gas, **STOP!** Follow "B" in the safety information. If you don't smell gas go on to the next step.
7. Turn the main manual gas cock handle counterclockwise  to the "ON" position.

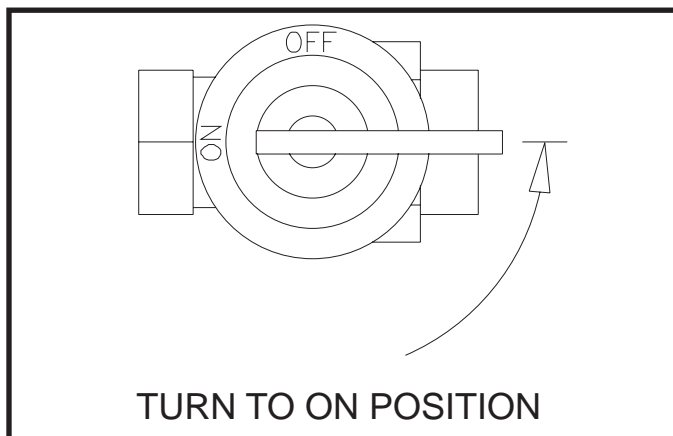



FIG. 76 Gas Cock with Handle in "ON" position

8. Turn on all electric power to the appliance.
9. Set the Temperature Setpoint function of the Command Display to the desired setting.
10. 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. Set the Temperature Setpoint function of the Command Display to the lowest setting.
2. Turn off all electric power to the appliance if service is to be performed.
3. Turn the main manual gas cock handle clockwise  to the "OFF" position.

## WARNING

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

## IGNITION SYSTEM CHECKOUT

1. Set run/stop switch to "STOP" position.
2. Set the Temperature Setpoint function on the Command Display and high limit controls to the highest setting.
3. Turn electric power on.
4. Set run/stop switch to "RUN" position.
5. Allow bypass to synchronize and safety switches to prove.
6. The igniter will cycle on trial for ignition.
7. The ignition module will lock out and indicate a flame failure through the appropriate flash code.
8. Readjust Temperature Setpoint of the Command Display and high limit to normal settings.
9. Turn on gas supply.
10. Push the reset button to the right of the ignition module on the front control panel to reset ignition module.

11. If ignition system fails to operate properly, repair work must be performed by a qualified serviceman or installer.

## SEQUENCE OF OPERATION

1. The power switch is placed in the "ON" position and the run/stop switch is in the "RUN" position.
2. 120 VAC Power is supplied to the control junction box and to the integral Pump.
3. 120 VAC Power is supplied to the control Transformer, Ignition Module and Excel 10.
4. The bypass valve will synchronize on initial startup only.
5. 24 VAC is supplied to all low voltage controls.
6. Integral pump starts and is proven by a Flow Switch.
7. Command Display Set Point (Operating Temperature) is set to call for heat.
8. Excel 10 Controller initiates a start-up sequence by checking the Temperature Sensors and input signals from the safety controls.
9. Excel 10 enables the Ignition Module.
10. Ignition Module enables the Variable Frequency Drive.
11. Excel 10 Controller drives the Variable Frequency Drive.
12. The Variable Frequency Drive supplies the Combustion Air Blower with 230 VAC 3 phase power.
13. Combustion Air Blower starts operation and drives to 100% speed for prepurge.
14. Blower makes the low air switch contacts to enable the Ignition Module.
15. Blower cycles down to 50% speed and the Ignition Module initiates the heat-up sequence of the Hot Surface Igniter.
16. Hot Surface Igniter proves 1800°F (982°F) Ignition Temperature by current draw through the Ignition Module.

17. The Ignition Module supplies voltage to the Variable Ratio Gas Valve and the Redundant Gas Valve.
18. Relay contacts prove operation of the Igniter, Gas Valves and Safety Switches to the Excel 10.
19. Variable Ratio Gas Valve senses the pressure from the Combustion Air Blower and supplies gas to the orifice and into the Blower inlet to pre-mix.
20. The Gas/Air mixture is forced into the Burner and out of the Burner Ports under pressure.
21. Hot Surface Igniter lights the Gas/Air mixture and then serves as a flame sensor to prove Main Burner Flame by rectification.
22. Burner is now in a soft start firing at 50% of rated input.
23. Excel 10 Controller signals the Variable Frequency Drive to adjust blower speed based on desired water temperature Set Point.
24. Burner input rate is variable down to 25% of rate or up to 100% of rate as required to satisfy the Set Point programmed into the Command Display.
25. Excel 10 Controller senses Inlet Water Temperature to the Primary Heat Exchanger and provides a signal to adjust the floating point Bypass Valve (based on return/inlet control choice).
26. Bypass Valve adjusts position to maintain an inlet temperature to the Primary Heat Exchanger above the dew point of flue products.
27. Operation of the Bypass Valve maintains water temperatures above the dew point of flue products to ensure that condensate formation occurs only in the Secondary Heat Exchanger.

## Heat Transfer Process

28. Burner Input continues to increase until water temperature reaches the Set Point temperature.
29. Burner Input may stabilize at a fixed rate where demand equals input.
30. Burner Input will decrease rate when water temperature exceeds temperature Set Point and demand.
31. Heated products of combustion pass over the Primary Heat Exchanger transferring heat to the water.

32. Rate of flue product movement is controlled by "V" Baffles on the heat exchanger to maximize heat transfer.
33. Heated products of combustion then pass over the Secondary Heat Exchanger to absorb additional heat.
34. Flue products pass into the flue collector and are exhausted from the unit.

### End of Sequence

35. Set Point temperature is satisfied.
36. Power to the gas valves is turned off.
37. Combustion Air Blower ramps up to 100% speed and runs for a 30 second post purge timing and turns off.
38. Excel 10 is now in a standby mode waiting for the next "Call for Heat".

## 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

**A. 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. Flush the condensate drain hose with water to clean. 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.

**B. VISUALLY CHECK MAIN BURNER FLAMES** at each start up after long shutdown periods or at least every six months. A burner viewport is located on the burner mounting flange.

### WARNING

The area around the burner viewport is hot and direct contact should result in burns.

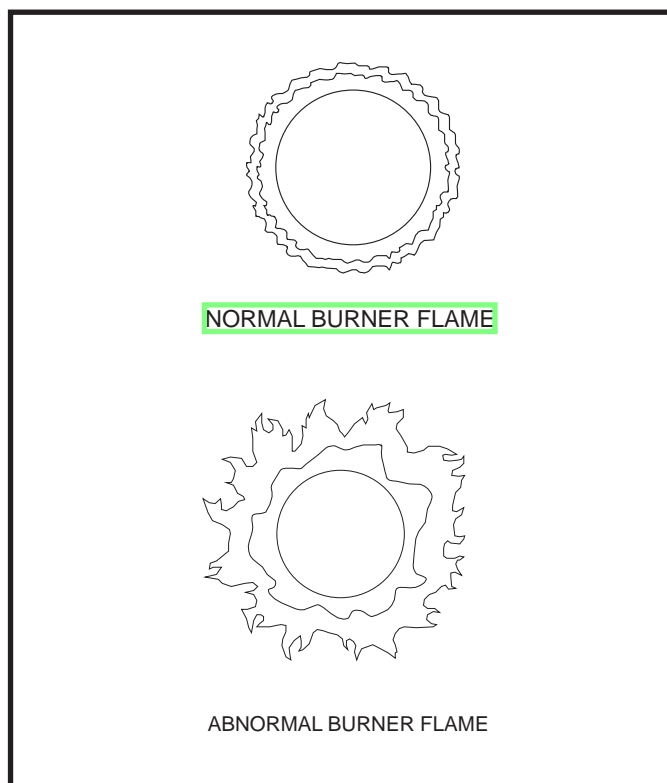


FIG. 77 Flame Pattern

1. Normal Flame: A normal flame at 100% of burner input is blue, with slight yellow tips a well defined flame and no flame lifting.
2. Yellow Tip: Yellow tipping can be caused by blockage or partial obstruction of air flow to the burner.
3. Yellow Flames: Yellow flames can be caused by blockage of primary air flow to the burner or excessive gas input. This condition MUST be corrected immediately.
4. Lifting Flames: Lifting flames can be caused by over firing the burner, excessive primary air or high draft.

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

### C. FLUE GAS PASSAGEWAYS CLEANING PROCEDURES:

Any sign of soot around the inner jacket, outer jacket, flue pipe connections, burner or in the areas between the fins on the copper heat exchanger 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.

## NOTE:

All gaskets/sealant on disassembled components or jacket panels must be replaced with new gaskets/sealant on re-assembly. Gasket and sealant kits are available from your distributor.

## CAUTION

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

### D. BURNER MAINTENANCE

The burner should be removed for inspection and cleaning on an annual basis. An appliance installed in a dust or dirt contaminated atmosphere will require inspection and cleaning on a more frequent schedule. An appliance installed in a contaminated environment may require cleaning of the burner on a 3 to 6 month schedule or more often, based on severity of the contamination. The fan assisted combustion process may force airborne dust and dirt contaminants, contained in the combustion air, into the burner. With sustained operation, non-combustible contaminants may reduce burner port area, reduce burner input or cause non-warrantable damage the burner.

Use extreme care when operating an appliance for temporary heat during new construction. Airborne contaminants such as dust, dirt, concrete dust or dry wall dust can be drawn into the burner with the combustion air and block the burner port area. An external combustion air filter is provided with the appliance. The combustion air filter is for **Temporary Use Only and MUST be removed when the appliance is placed in normal service.** An additional filter is located inside the transition chamber, at the inlet to the combustion air blower, to also prevent particulate matter and small foreign objects from entering the blower and burner. This internal filter should be checked and cleaned on a six month interval or more often in a contaminated environment. See the Combustion Air Bower section of this manual for cleaning instructions. The burner of an appliance used for temporary heat without a combustion air filter installed will probably require a thorough cleaning before the unit is placed into normal service.

## BURNER REMOVAL AND CLEANING

*Access to the burner will require the following steps:*

- a. Turn off main electrical power to the appliance.
- b. Turn off main manual gas shutoff to the appliance.

- c. Remove the outer control panel cover. Open the control panel and remove the screws from the lower front edge of the radiused front outer jacket panel. Lift the edge of the radiused panel and locate the internal screws attaching the back edge of the radiused panel. Reach through the control panel opening with a 5/16" nut driver and loosen the 2 internal screws holding the rear edge of the radiused panel. Pull the panel slightly forward and remove it. Remove the screws along the front and rear edge of the top outer jacket panel to remove the jacket top. This allows access to the components in the top of the appliance.
- d. Disconnect the gas supply connection to the internal gas train at the field installed union.
- e. Remove the air inlet pipe connection to the boiler/water heater.
- f. Remove the insulation blanket\* on top of the heat exchanger. *Note: Take care not to tear insulation blanket on removal.*
- g. Disconnect the blower motor power wires at the connection to the VFD.
- h. Disconnect the power wires to the gas valves, flow switch and pressure switches (if equipped). Multiple pin connectors are used at all of these components for ease of service.
- i. Remove the sensing tubes from the air ratio gas valve to the combustion air blower.
- j. Remove the 6 nuts holding the blower assembly to the blower and remove the blower assembly.
- k. Disconnect the power wire to the hot surface igniter.
- l. Remove the hot surface igniter. The hot surface igniter is fragile. Use care to prevent impact damage to the silicon carbide igniter surface when removing the igniter.
- m. Remove the 8 nuts holding the burner to the heat exchanger.
- n. The burner can now be lifted vertically out of the heat exchanger cavity.
- o. Use care to prevent damage to the woven burner port surface on removal.

\* Insulation jacket is tucked under the control panel assembly and can not be "removed" without removing the control panel.

## NOTE:

When the combustion air blower is removed for any reason, the inlet to the burner must be covered to prevent foreign objects from falling into the burner. A foreign object such as a nut, bolt, wire or other metallic items will cause a rapid non-warrantable failure of the burner on operation.

## NOTE:

Use care when removing and handling the burner. Sharp objects or impact may damage or tear the woven burner flame surface.

### *Burner Cleaning Procedure*

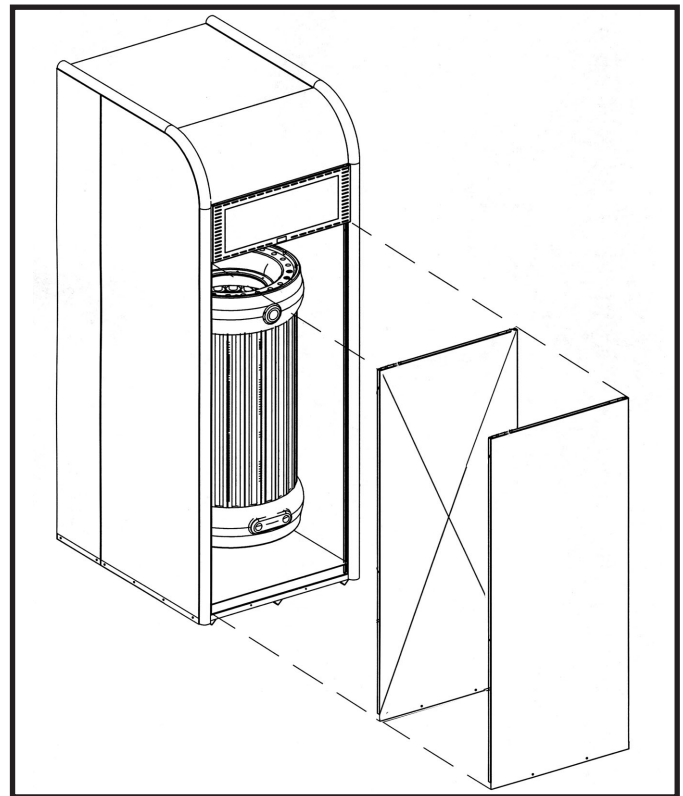
Remove any visible dust or dirt blockage from the surface of the burner with a vacuum. Compressed air may also be blown across the burner surface to clean the “pores” of the woven burner port material.

The burner may best be cleaned by immersing the burner port area in a solution of dishwashing detergent and hot water. Do not use chlorine based solvents or cleaning agents on the burner. Allow the burner to remain in the solution for a short period of time to remove dust, dirt and oil or grease laden contaminants. Rinse the burner thoroughly with clean water to remove any residue from the detergent cleaner. The burner should be air dried quickly after removal from the cleaning solution and rinsing to prevent any oxidation or rusting of the ferrous components in the burner port material.

### **E. CHANGING THE HOT SURFACE IGNITER**

1. Turn off main electrical power to the appliance.
2. Turn off main manual gas shutoff to the appliance.
3. Carefully pull back the insulation flaps to expose the burner mounting flange.
4. Locate the Hot Surface Igniter.
5. Disconnect the two power leads to the hot surface igniter.
6. Loosen and remove the two wing nuts that mount the igniter.
7. Lift the igniter vertically out of the burner mounting flange. Use care, do not hit or break the silicon carbide igniter.

8. Check the replacement igniter for cracks or damage before installing.
9. Ensure that the fiber gasket used to seal the base of the igniter to the burner flange is reinstalled to seal the base of the replacement igniter.
10. Carefully insert the igniter into the mounting point on the burner flange and position on the mounting studs.
11. Reinstall the two wing nuts and tighten by hand only. Over tightening the wing nuts may break the ceramic mounting flange.
12. Ensure that the igniter gasket is properly installed and seals the point of contact between the igniter and burner mounting flange.
13. Reconnect the power leads to the igniter.
14. Replace the insulation blanket flaps.
15. Turn on main gas supply.
16. Turn on main power.
17. Test fire the appliance to ensure proper operation.



**FIG. 78 Location of Primary Heat Exchanger**



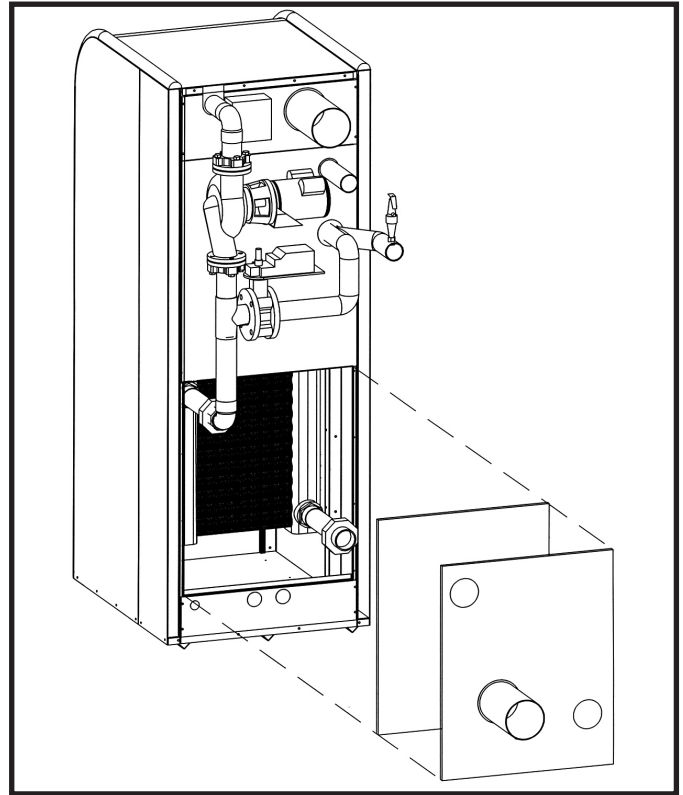
## NOTE:

All gaskets/sealant on disassembled components or jacket panels must be replaced with new gaskets/sealant on re-assembly. Gasket and sealant kits are available from your distributor.

### F. PRIMARY HEAT EXCHANGER INSPECTION

1. Turn off all power to the appliance.
2. Turn off main gas to appliance.
3. Remove the front outer jacket door.
4. Remove the front inner jacket door.
5. Check the heat exchanger surface for soot. If soot is present, heat exchanger must be cleaned and problem corrected.
6. Remove burner as described in Burner Maintenance procedure.
7. Check “V” baffles on the exchanger. Remove and clean if necessary.
8. Remove soot from heat exchanger with a stiff bristle brush. Use a vacuum to remove loose soot from surfaces and inner chamber.
9. The heat exchanger can be removed by disconnecting all water piping to the bypass and secondary heat exchanger, removing the screws holding the heat exchanger to the top of the inter jacket, and sliding the heat exchanger towards the front of the appliance. Once the heat exchanger is removed, a garden hose can be used to wash the tubes to ensure that all soot is removed from the heat exchanger surfaces. **NOTE:** Do not wet the insulation blankets on the inside of the outer jacket panels.
10. Ensure that any soot present on the burner is removed. See Burner Cleaning Procedure.
11. Carefully reinstall the heat exchanger and “V” baffles if removed from the appliance.
12. Reinstall inner jacket panels, burner, manifolds, wires and hoses. Use new gasket material to ensure a proper air seal.
13. Reassemble all gas and water piping. Test for gas leaks.
14. Reassemble outer jacket panels.
15. Cycle unit and check for proper operation.

### G. SECONDARY HEAT EXCHANGER INSPECTION



**FIG. 79 Location of Secondary Heat Exchanger**

1. Turn off all power to the appliance.
2. Turn off main gas to appliance.
3. Break the union, pump flange and bypass valve flange to remove the pump and external portion of the bypass assembly.
4. Remove the inner jacket door.
5. Check the heat exchanger surface for soot or fouling. If soot is present, heat exchanger must be cleaned and problem corrected.
6. Check “V” baffles on the exchanger. Remove and clean if necessary.
7. Remove soot from heat exchanger with a soft bristle brush. Use care not to damage coating on the exterior of the secondary heat exchanger. Use a vacuum to remove loose soot from surfaces and inner chamber.
8. The heat exchanger can be removed by disconnecting all water piping to the bypass and secondary heat exchanger and sliding the heat exchanger towards the rear of the appliance. Once the heat exchanger is removed, a garden hose can

be used to wash the tubes to ensure that all surface deposits are removed from the exterior of the heat exchanger surfaces.

9. Carefully reinstall the heat exchanger if removed from the appliance.
10. Reinstall inner rear jacket panels, bypass piping and condensate hoses. Use new gasket material to ensure a proper air seal.
11. Reassemble all water piping. Test for leaks.
12. Reassemble rear outer jacket panels.
13. Cycle unit and check for proper operation.

## H. LUBRICATION

**Combustion Air Blower:** Each combustion air blower should be checked every 6 months. Clean internal filter to blower as required when installed in a dust or dirt contaminated location. See Combustion Air Blower in the component section for cleaning procedure. The motor and bearings on the combustion air blower are sealed and permanently lubricated requiring no addition of oil or lubricants

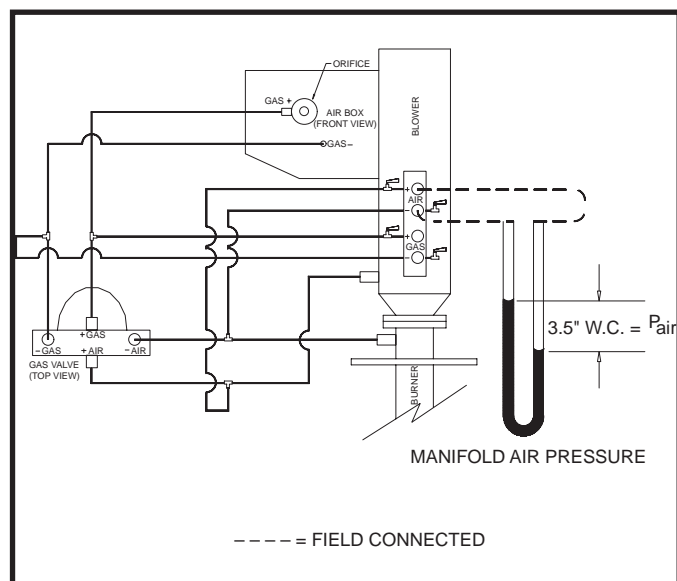
**Water Circulating Pump:** Inspect pump every 6 months and oil as necessary. Use SAE 30 non-detergent oil or lubricant specified by pump manufacturer.

## I. COMBUSTION AND VENTILATION AIR

Check frequently to be sure the flow of combustion and ventilation air to the boiler is not obstructed. Combustion and ventilation air must be provided to the mechanical room with openings sized per the requirements of the National Fuel Gas Code when the appliance is installed with a standard **Category IV** vent system. The optional Direct-Vent and Intelli-Vent systems use a separate combustion air pipe to bring in combustion air from the outdoors directly to the appliance. Ensure that the construction air filter is **NOT** used for continuous service after the construction phase.

## J. CONTROL CIRCUIT VOLTAGE

This appliance uses a transformer to supply a low voltage control circuit. The voltage on the secondary side should be 24 to 28 VAC when measured with a voltmeter. A secondary voltage of 18 VAC or less supplied to 24 VAC components may cause operational problems. A 5 AMP circuit breaker is provided on the secondary side of the transformer. The circuit breaker is located on the left front control panel. A tripped circuit breaker indicates a short in the 24VAC controls that must be corrected.



**FIG. 80 Measuring Combustion Air Pressure Differential to Ratio Gas Valve**

## K. COMBUSTION AIR MEASUREMENT

This appliance uses a variable speed combustion air blower to operate the combustion process and venting system. A single combustion air blower is used to supply combustion air to the burner. The discharge air from the blower is factory pre-set and is not field adjustable. The blower and transition are mounted on the top of the burner. The blower is enclosed inside of the top chamber.

There is a pressure test tree located in the top chamber of the appliance. This pressure test point tree can be accessed by swinging out the front control panel. The pressure test tree is mounted on the front edge of the combustion air blower. It consists of an angle support and four labeled test cocks. There is one cock for + air and one for - air, one cock for + gas and one for - gas. Differential air pressure measurement at the combustion air blower will utilize both the + air and - air test points.

1. Open the front controls panel and swing the controls out. Locate the pressure test tree on the front edge of the combustion air blower. The + and - air pressure terminals will be used to check differential air pressure from the blower discharge to the burner inlet. Each air pressure connection point will have a small manual cock to attach a hose.
2. Connect a hose from the + air and the - air to each of the two sides of a manometer. This will allow the two pressure points to be measured at the same time. Open the two air pressure test points cocks.
3. Set the Command Display to a setpoint which will fire the burner at 100% of rated input.

4. As the appliance comes on and fires, record the inches of water column of displacement on both sides of the manometer. The sum of these two readings as they are effected by the two air pressures in the differential air pressure.
5. The differential air pressure should be 3.5 inches of water column (+ 0.1" w.c.) when the burner is firing at 100% of rated input.
6. If the differential air pressure is not 3.5 inches water column (+ 0.1" w.c.), review the installation. Check for proper installation of the venting system. Review the venting requirements in this manual for the specific venting system installed with this appliance. Correct as required. Ensure that an adequate supply of combustion air is supplied to the appliance. If a separate pipe is used to supply combustion air, ensure that it is installed per the combustion air pipe requirements contained in the venting section of this manual. Correct as required. Check the air inlet screen to the combustion air blower. Clean as required. Check the burner for dirt or contamination and clean as required. Recheck for correct differential air pressure after correcting an installation related problem of after cleaning an obstructed component. Ensure that a combustion air differential of 3.5 inches water column (+ 0.1" w.c.) is present while the appliance is firing at 100% of rated input.
7. This is a reference pressure only and is not field adjustable. An appliance supplied with an unrestricted supply of combustion air from a correctly sized combustion air opening or separate direct vent combustion air pipe will operate at the correct air pressure differential as the burner input varies with temperature demand.
8. Close the two air pressure test cocks on the pressure test tree and remove the hoses to the manometer.
9. Close the front control panel.

#### L. COMBUSTIBLE MATERIALS

### CAUTION

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

## FREEZE PROTECTION

Installations are not recommended in areas where the danger of freezing exists. Proper freeze protection must be provided for appliances 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 appliance by freezing is non-warrantable.

1. **Pump Operation - MOST IMPORTANT** - This appliance is designed for continuous pump operation when the burners are firing. The integral circulating pump will run continuously when the power switch is in the "ON" position and the run/stop switch is in the "RUN" position. **As an optional feature an intermittent pump control system can be provided.** The intermittent pump option allows the integral circulating system pump to be cycled on at each call for heat and cycled off when the set point is satisfied. The intermittent pump will operate for a timed period after the burner cycles off to remove residual heat from the combustion chamber area. If the operating temperature sensor for an intermittent pump system sees a drop in water temperature to 45°F (7.2°C), the integral circulating pump will cycle on. This flow of warm boiler water can help prevent freezing.
2. **Location** - Heating boilers, hot water supply boilers or water heaters must be located in a room having a temperature safely above freezing [32°F(0°C)].
3. **Caution** - A mechanical room operating under a negative pressure may experience a down draft in the flue of an appliance that is not firing. The cold outside air may be pulled down the flue and freeze a heat exchanger. This condition must be corrected to provide adequate freeze protection.
4. Freeze protection for a heating boiler or hot water supply boiler using an indirect coil can be provided by using hydronic system antifreeze. Follow the manufacturers instructions. **DO NOT** use undiluted or automotive type antifreeze.
5. **Shut-down and Draining** - If for any reason, the unit is to be shut off, the following precautionary measures must be taken:
  - (a) Shut off gas supply.
  - (b) Shut off water supply.
  - (c) Shut off electrical supply.

(d) Drain the unit completely. Remove the caps from the two drains located on the rear of the appliance. Open the relief valve and manually open the bypass valve to allow air into the system so the water will drain out. Open the union fitting on the inlet so water can be drained from the secondary heat exchanger.

(e) Ensure that the pump, bypass piping and connecting piping are fully drained.

## 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 or any potable 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 is 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. An increased flow rate through the boiler heat exchanger may be required to achieve proper heat transfer rates in a glycol system. Reduced flow in a boiler due to a high percentage of glycol in the system may result in boiler noise or flashing to steam.
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.

### WARNING⚠

**DO NOT** attempt to fire this appliance without completely filling the heat exchangers, bypass and all related system piping. Ensure that all air is properly bled from the system before firing. Failure to properly fill the boiler and related piping before firing may result in personal injury or non-warrantable property damage.

## HEATING BOILER INSTALLATIONS

### PIPING OF THE BOILER SYSTEM

The drawings in this section show typical boiler piping installations. **This boiler MUST always be installed in a primary/secondary piping system for proper operation.** 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 expansion tank is used. The expansion tank must be installed close to the boiler and on the suction side of the system pump (Boiler Inlet) 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 line/scale build up. This will cause a **NON-WARRANTABLE FAILURE**.

## WATER CONNECTIONS HEATING BOILERS ONLY

All boilers have 3 inch (76.2mm) copper pipe inlet and outlet connections. Installed piping to and from the boiler must be a minimum of 3 inches (76.2mm) diameter and must not exceed the maximum specified piping length. **Caution! Field installed**

**reducing bushings must not be used.** Any reduction in pipe size may decrease flow resulting in high water temperatures, boiler noise, flashing to steam and non-warrantable heat exchanger damage.

## PIPING LENGTHS

The boiler's integral circulator provides the water flow from the primary boiler piping, through the boiler and back to the primary system. Pipe diameter and length are critical to ensure proper flow through the boiler. A 3 inch (76.2 mm) diameter pipe installed from the primary system to the boiler inlet must not exceed 70 equivalent feet (21.2 m) in length. The return piping from the boiler back to the primary boiler piping system must also not exceed 70 equivalent feet (21.2 m) in length. Subtract 8 feet (2.9 m) of equivalent length for each 90° elbow installed in the piping to and from the boiler.

The secondary loop piping to and from the boiler must have a fully ported ball valve installed in both the supply and return side piping. The ball valves must be the same diameter as the installed piping. The ball valve in the piping supplying water to the boiler will only be used as a service valve. The ball valve installed in the discharge from the boiler back to the primary system will be used to adjust boiler flow and temperature rise to ensure proper performance.

## BOILER CIRCULATOR PUMP LIMITATIONS

The integral circulator provided on this boiler **WILL NOT** function as a main system circulator. This boiler was designed for installation in a primary/secondary piping system. The boiler's integral pump is only sized to provide flow in the secondary loop, from the primary system, through the boiler and back to a primary boiler system piping. Pipe diameter and length are critical to ensure proper flow through the boiler and secondary piping. The boiler primary piping system must have a primary circulator installed in the main system loop to carry the heated boiler water to the point of use in the main system.

This is a low mass, high efficiency hot water boiler which must have adequate flow for quiet, efficient operation. The internal circulating pump will provide this flow for a properly installed secondary loop to the boiler. Pipe diameter and length are critical to ensure proper flow through the boiler and secondary piping. 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 (71.1°C) and the boiler outlet temperature is 180°F (82.2°C). This means that there is a 20°F (11.1°C) temperature rise across the boiler. The boiler temperature rise is visible on the Command Display on the boiler's front control panel. When the automatic bypass valve is open, a portion of the heated water is recirculated back into the primary heat exchanger. Operation of the bypass will yield higher discharge temperatures from the boiler.

## PRIMARY LOOP CIRCULATOR PUMP SPECIFICATIONS

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

## CIRCULATOR PUMP OPERATION (Heating Boilers Only)

The boiler pump should run continuously when the boiler is firing. External wire leads are furnished in the electrical junction box to allow separate power supplies to the pump and boiler controls or the two circuits (pump and controls) can be combined for connection to one 120 VAC, 20 AMP circuit for both. As shipped from the factory, the control system will turn on the boiler pump when the main power switch is placed in the "ON" position and the Run/Stop switch is in the "RUN" position.

## INTERMITTENT PUMP OPERATION (Optional)

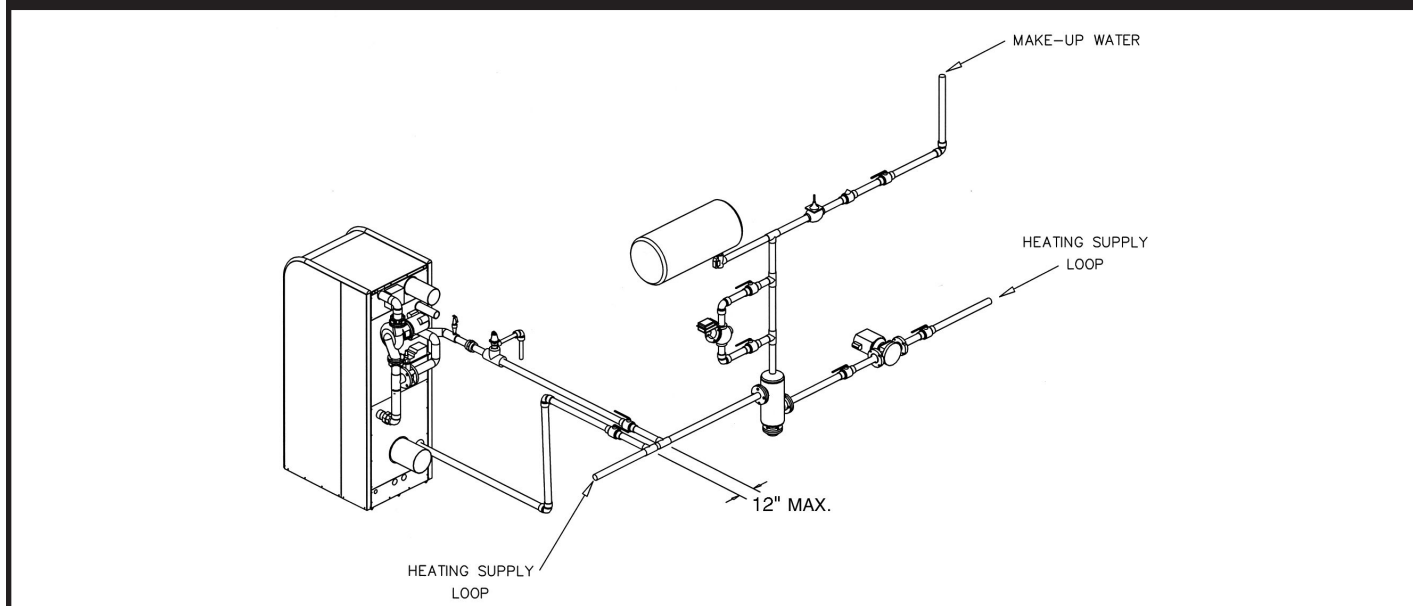
An intermittent pump operation feature is available as an option. When equipped with this option, the boiler's integral circulating pump will cycle on at each call for heat, before the burner fires. The pump will continue to operate while the burner is firing. The pump will run for a 30 second period after the temperature setpoint is satisfied. This will remove any residual heat from the combustion chamber before turning the pump off. See wiring diagram shipped with the unit.

**PUMP MAINTENANCE:** Inspect pump every 6 months and oil as necessary. Use SAE30 non-detergent oil or lubricant specified by pump manufacturer.

This high efficiency boiler **MUST** be installed with a primary/secondary piping system. This type of system uses the integral boiler circulating pump to supply flow to and from the boiler only. This pump is sized based on a specified minimum pipe diameter and maximum length. These limitations are critical to ensure proper flow through the boiler and secondary piping. The length of the secondary piping to and from the boiler to the main system loop must not exceed 70 equivalent feet (21.2 m) in length each direction when installed in 3" (76.2 mm) diameter pipe. Each elbow and fitting installed in the



## PRIMARY/SECONDARY BOILER PIPING



**FIG. 81 Primary/Secondary Piping of a Single Boiler**

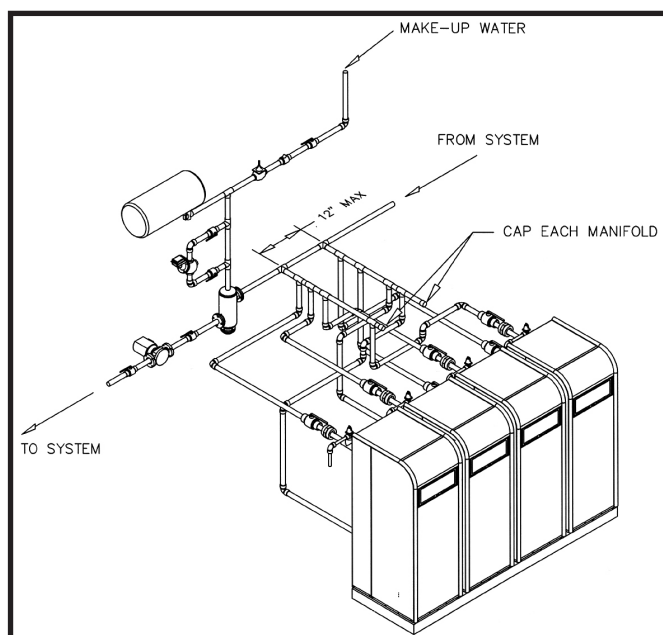
piping to and from the boiler will reduce the available equivalent length of pipe that can be installed. See Water Connection-Piping Lengths for calculation of equivalent length of pipe and reductions in length for installed fittings.

A properly sized primary system pump provides adequate flow to carry the heated boiler water to radiation, air over coils, etc. The fittings that connect the boiler to the primary system should be a maximum of 12" (0.30 m) (or 4 pipe diameters) apart to ensure connection at a point of zero pressure drop in the primary system. There should be 10 pipe diameters of straight pipe before and after the boiler secondary loop connections to prevent turbulent flow at the secondary loop connections. Multiple boilers may also be installed with a primary /secondary manifold system. Multiple boilers should be connected to the common manifold in reverse return to assist in balancing flow to multiple boilers.

The installer must ensure that the boiler has adequate flow without excessive temperature rise. Low system flow can result in overheating of the boiler water which can cause short burner cycles, system noise relief valve discharge and in extreme cases, a knocking flash to steam. These conditions indicate the need to increase boiler flow to and from the boiler. This is generally accomplished by increasing the diameter of the piping that connects the boiler to the primary system. A larger diameter pipe reduces head loss and increases flow.

### CAUTION

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



**FIG. 82 Primary/Secondary Piping of Multiple Boilers**

## MINIMUM BOILER WATER TEMPERATURES

Inlet water temperatures below the specified minimum recommendations can excessively cool the products of combustion resulting in condensation on the primary heat exchanger. The boiler is designed to condense only on the secondary heat exchanger. Condensation on the primary heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components.



The automatic bypass system allows part of the boiler discharge water to be mixed with the inlet water to the primary heat exchanger to increase the boiler inlet temperature above 130°F (55°C). This will prevent the products of combustion from condensing on the primary heat exchanger. A valve must also be provided on the boiler discharge, after the bypass. Closing this discharge valve sets the maximum flow through the appliance. (See Bypass—Initial Set-up of Maximum Water Flow for more details).

A minimum water temperature of 50°F (10°C) has been established for each boiler based on the Btu/hr input at 100% of rated burner input. The temperature setpoint for the Excel 10 controller sensing system must not be set lower than the specified minimum for each model. Maintaining inlet water temperatures to the boiler equal to or higher than the specified minimum setpoint ensures proper operation of the bypass and allows all condensate formation to occur on the secondary heat exchanger. A boiler allowed to sustain operation at water temperatures lower than the specified minimum setpoint may not provide enough heat from the burner to maintain water temperatures in primary heat exchanger above the 130°F (55°C) dew point of flue products. Operation of a boiler at a temperature below the specified minimum setpoint will result in non-warrantable operational problems from the condensate formation on the primary heat exchanger.

**TABLE - CC**  
**Minimum Inlet Water Temperatures**

Input Btu/hr	Minimum Return Temperature	Minimum Setpoint
1,500,000	50°F (10°C)	105°F (40.6°C)
1,700,000	50°F (10°C)	90°F (32.2°C)
2,000,000	50°F (10°C)	70°F (23.9°C)

### CAUTION⚠

A boiler allowed to operate at setpoint temperatures below the specified minimum settings may experience operational problems with the operating controls and safety switches, obstruction of the flue gas passages on the primary heat exchanger, incomplete combustion and possible flue gas spillage. Operation at lower than specified water temperatures may cause hazardous conditions that result in non-warrantable damage to the appliance.

## THREE WAY VALVES

The installation of a three way valve on this boiler is not 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 cycles, system noise, relief valve discharge and in extreme cases, a knocking flash to steam. These conditions can cause operational problems and non-warrantable failures of the boiler.

## MAXIMUM FLOW FOR HEATING BOILER

### CAUTION⚠

The maximum flow rate through the boiler with a copper heat exchanger must not exceed the following:

Btu/hr Input	Maximum Flow
1,500,000 - 2,000,000	90 GPM

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

The heat exchanger is capable of operating within the design flow rates for the boiler secondary loop requirements. Erosion of the finned copper tubes may occur if the flow rate exceed the maximum allowable flow rate through the boiler. The maximum flow through the boiler must be adjusted with the bypass valve in the full closed position. Maximum flow is 90 GPM. Flow rate can be determined by measuring the temperature rise through the boiler when it is firing at full rate input. See Bypass-Initial Setup for adjustment procedure.

## BOILER TEMPERATURE RISE CHART

**TABLE - DD**  
**Temperature Rise at Full Rate Fire**  
**Bypass Fully Closed and 90 GPM Flow**

Btu/hr Input	Temperature Rise
1,500,000	31.5°F (17.5°C)
1,700,000	35.7°F (19.8°C)
2,000,000	42.0°F (23.3°C)

## 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 boiler bypass piping. The gauge has one scale to read system pressure and a separate scale to read water temperature in °F. The temperature/pressure gauge is provided to meet code requirements. Water temperatures can be more accurately monitored from the data provided in the Command Display.

## 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 system pump.
6. Support all water piping.

## PLACING THE BOILER IN OPERATION

### Pre-Start Check List

1. Review the location of the boiler, clearances from combustible surfaces and available service clearances.
2. Review the installed Vent System. Ensure that all vent components are **Category IV** material with adequate clearance from combustibles.
3. Ensure that the boiler condensate drain and all vent system condensate drains are properly routed to an acceptable floor drain or neutralization system.
4. Ensure that an optional condensate neutralization system is properly installed if required by codes.
5. Review the vent termination point for proper location and clearances.
6. Ensure that proper volumes of combustion and ventilation air are provided to the mechanical room.

If a separate combustion air pipe is used, ensure that it is properly sized, sealed and terminated.

7. Review the water piping from the boiler to the system. The boiler must be installed in a primary/secondary piping system. Review the diameter and equivalent length of the installed piping to and from the boiler to ensure proper flow.
8. Ensure that a properly sized primary system pump is installed with an expansion tank.
9. Check system pressure. Ensure a minimum of 12 PSI and not more than the rated pressure of the relief valve.
10. Review the installed gas piping from the meter to the boiler. Ensure that the gas pipe, meter and any regulators are adequately sized.
11. Review the field wiring and electrical service for both the boiler controls and pump. Ensure that the electrical service(s) is adequately sized.
12. Review wiring to an energy management system and wiring to any remote temperature sensors.

### Boiler Set-Up

13. Ensure that the boiler and piping system are full of water. Bleed all air from the secondary loop and bypass piping on the boiler.
14. Check system for any water leaks.
15. Check system for installation of glycol or water treatment.
16. Turn on power to the primary system pump and the integral boiler secondary pump and verify operation.

### Boiler Operational Checks

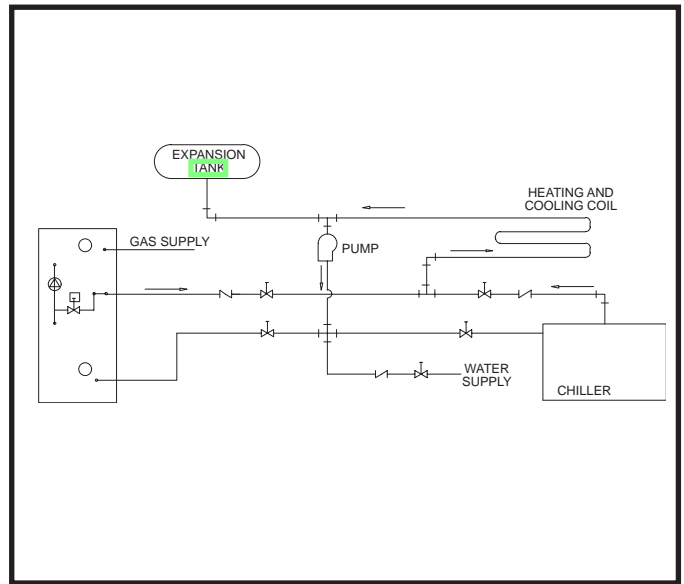
17. Turn the boiler main power switch to the "ON" position and the run/stop switch to the "STOP" position.
18. Verify operation of the Excel 10 and Command Display.
19. Program the adjustable points from the Command Display.
20. Turn the run/stop switch to the "RUN" position to start boiler operation. Note: the bypass must go through the synchronization process before start-up begins.

21. Push the resets for low water level, high water temperature and flame failure.
22. Carefully follow the bypass adjustment procedure to set maximum flow to the boiler at 90 GPM. Verify by checking temperature rise while burner is firing at 100% of rated input.
23. Install a manometer on the gas supply to the boiler and verify minimum gas supply pressure as the burner fires at 100% of rated input.
24. Verify operation of safeties as necessary (low water cut-off, high limit, gas pressure, etc.).
25. Turn the run/stop switch to the "STOP" position.
26. Verify that all adjustable points in the Command Display are set as required.
27. Reconnect any wiring disconnected during the boiler set-up.

### Boiler Operation

28. Turn the run/stop switch to the "RUN" position to start boiler operation.
29. Push the resets for low water level, high water temperature and flame failure.
30. Observe the boiler synchronization process before start-up of the boiler begins.
31. Boiler should begin the start-up process for the sequence of operation.
32. The boiler will fire at 50% of rated input on initial start-up and adjust input as required to meet system demand.
33. The integral bypass valve will automatically adjust to maintain minimum inlet temperatures to the primary heat exchanger.
34. Ensure that inlet water temperature does not fall below the specified minimum for the boiler.
35. Based on system demand, the boiler may run for an extended period of time at a reduced rate of input to maximize efficiency.
36. As system demand is satisfied, the burner will cycle off and the combustion air blower will run for a post purge operation before the boiler shuts down.

## INSTALLATION WITH A CHILLED WATER SYSTEM



**FIG. 83 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.

## BOILER OPERATING TEMPERATURE CONTROL

The operating temperature control for the boiler is the Excel 10 controller. It is located on the back side of the front control panel, behind the front access door. Access to adjust the temperature set point and other owner/operator adjustable points is made through the Command Display located on the front control panel. The sensing element for the operator is placed in a bulb well installed in the inlet connection to the boiler. The outlet sensor is located in a bulb well on the outlet side of the primary heat exchanger top header. Carefully observe the discharge water temperature on the initial boiler on cycles. The location of the temperature sensor may generally require a lower temperature set point on the operating control to achieve the desired discharge water temperature from the boiler. The return/inlet sensing element location allows a boiler to sustain longer burner on cycles.

The location of the operating sensor, inlet or outlet, is selectable from the screen on the Command Display.

The exact temperature set point is based on your system's requirements. Set the control set point(s) to the desired operating water temperature. Observe the boiler discharge temperature after each set point adjustment to ensure proper operation.

**The maximum setpoint for operation of a heating boiler is 220°F (104.4°C) on a standard Excel 10 control. The minimum temperature setting programmed into this standard Excel 10 control is 100°F (37.7°C).**

# DOMESTIC HOT WATER SUPPLY BOILER

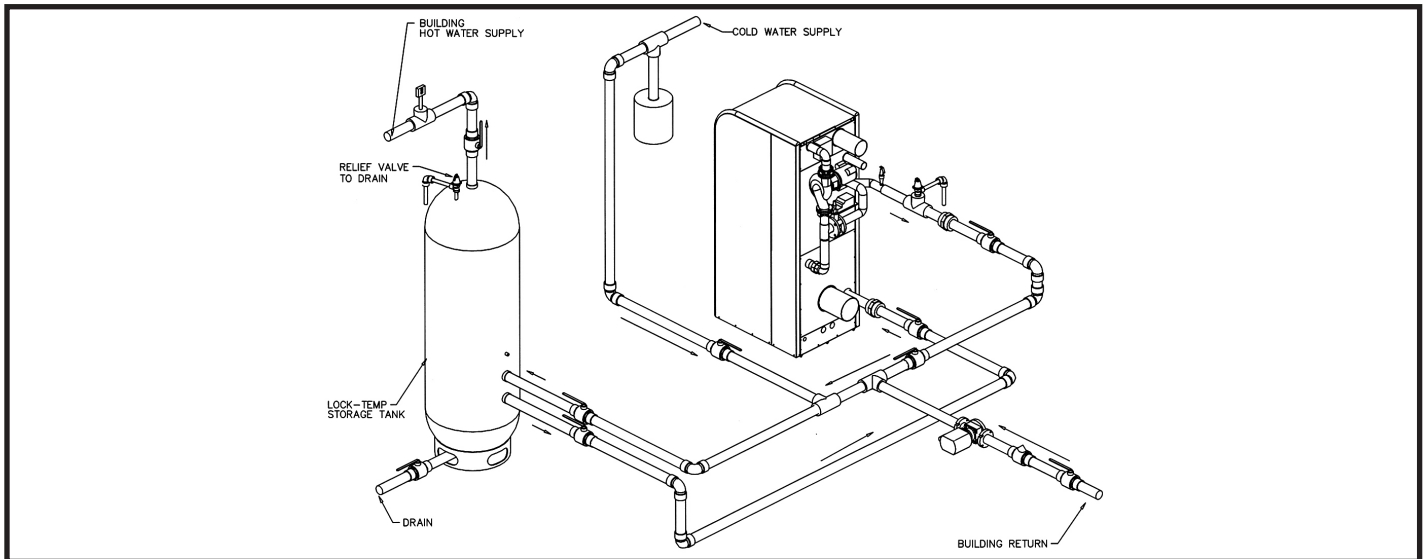
This section applies only to those appliance used to supply domestic hot water, installed with a storage tank(s). The integral circulating pump installed in the bypass piping assembly is used to control water velocity through the appliance. Proper water velocity is important for correct operation of your water heater or hot water supply boiler.

## WATER HEATERS

1,500,000 - 2,000,000 Btu/hr Models

## DOMESTIC HOT WATER SUPPLY BOILERS

1,500,000 - 2,000,000 Btu/hr Models



**FIG. 84 Typical Water Heater Piping with Storage Tank**

This section contains specific instructions for those appliances 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 and water heaters are designed for installation with a storage tank. The operation of the integral circulating pump, properly sizing of the piping between the tank and heater and the control of water velocity, as explained below, are important for correct operation of your water heater or hot water supply boiler.

**Excessive lime/scale build-up in the heat exchanger tubes is a result of restricted flow and too little velocity in the tubes. Excessive pitting or erosion in the tube is caused by high water flow and too much velocity through the tubes. Care should be taken to measure temperature rise and maintain a velocity as follows:**

### ***BYPASS - Initial Set-up of Maximum Water Flow***

On initial start-up of the Intelli-Fin the maximum water flow through the two internal heat exchangers must be manually set before the automatic operation of the bypass begins.

## WATER VELOCITY CONTROL

### IMPORTANT

To ensure proper velocity through the heat exchangers, 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 exchangers when the water heater is firing at 100% of rated input, you may be assured of the proper velocity in the tubes. This will yield long life and economical operation from your water heater or hot water supply boiler.

### CAUTION⚠

The maximum flow rate through an Intelli-Fin water heater with a copper heat exchanger must be set to provide and not exceed 90 GPM.

**TABLE - EE**  
**Maximum Flow Rate**

Btu/hr Input	Maximum Flow
1,500,000 - 2,000,000	90 GPM

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

The heat exchanger is capable of operating within the design flow rates required for the water heater, storage tank(s) and connecting piping. Erosion of the finned copper tubes may occur if the flow rate exceeds the maximum allowable flow rate through the water heater. The maximum flow through the water heater must be adjusted with the bypass valve in the full closed position. Maximum flow is 90 GPM. Flow rate can be determined by measuring the temperature rise through the water heater when it is firing at full rate input. Also see Bypass Initial Setup of Maximum Water Flow for adjustment procedure.

Setting temperature rise on an *Intelli-Fin* with an automatic bypass is accomplished by disconnecting the power leads to the actuator, (multi-pin connector on rear of appliance), declutching the actuator drive and manually closing the bypass valve. **Manual adjustment of the bypass must not be attempted if the 24 VAC power leads are connected to the terminals on the appliance, the appliance is operating or if there is any torque on the bypass valve by the actuator. Disconnect the 24 VAC power leads to the bypass valve actuator.** The declutch button on the actuator must be pushed down and held in the depressed position to disengage the gear driven motor that operates the valve. The declutch button must push in easily without forcing its movement. If the button does not easily move when pushed, the valve is under torque. Forcing the declutch button in will cause non-warrantable damage to the actuator. Torque can be removed by disconnecting the power leads to the valve actuator. With the declutch button fully depressed, move the actuator handle till it is perpendicular to the piping. This fully closes the bypass valve. The position of the handle is the same as the position of the butterfly in the valve seat. With the bypass fully closed, all inlet water flows through the secondary heat exchanger and then through the primary heat exchanger. No water will flow through the bypass at this time. Turn the appliance on and allow the burner to come on and fire at full rate (100% of input as shown on the Command Display). Adjust the field-installed ball valve in the outlet piping from the water heater to the storage tank to achieve the proper temperature rise for your specific model. Adjustment to achieve this temperature rise ensures a maximum of 90 GPM to the bypass and pump when in operation.

**TABLE - FF**  
**Temperature Rise At Full Rate Fire**  
**Bypass Manually Fully Closed**

Btu/hr Input	Temperature Rise
1,500,000	31.5°F (17.5°C)
1,700,000	35.7°F (19.8°C)
2,000,000	42.0°F (23.3°C)

**NOTE:**

The Excel 10 controller makes all internal calculations in °C and converts the displayed temperature to °F. This may limit exact temperature adjustment. Setting of temperature rise to the nearest °F is acceptable when setting maximum flow.

1. The pump must run continuously when the burner is firing.
2. With the pump running and the burner in the water heater or hot water supply boiler in the off cycle, the Return/Inlet temp and Supply/Outlet Temp readings on the Command Display should read the approximately same temperatures. Temp Rise in the Command display should read zero.
3. Turn the water heater or hot water supply boiler on and allow time for the temperature to stabilize. Check the temperature rise in the Command Display when the burner is firing at 100% of rated input.
4. Compare the temperature rise on the Command Display with the required temperature rise. Should adjustment be needed, proceed as follows:

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

1. Check for restrictions in the outlet of the water heater or hot water supply boiler.
2. Check diameter and equivalent length of the piping between the storage tank and water heater.
3. Be sure all valves are open between the water heater or hot water supply boiler and the storage tank. Ensure that all ball valves are fully ported.
4. Check the pump to be sure it is running properly and that the pump motor is running in the proper direction.



5. Be sure the pipes between the water heater or hot water supply boiler and storage tank are not less than 3 inch (76.2 mm) diameter for up to 70 equivalent feet (21.2 m) of pipe to and from the heater. If maximum equivalent length for the specified pipe diameter is exceeded, larger diameter pipe may have to be installed to achieve correct flow and temperature rise.
6. Common manifold piping for multiple unit installations will require larger minimum pipe sizes and tank circulating tappings to ensure proper flow.

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

1. Temperature rise can be increased by slowly closing the field-installed ball valve in the outlet piping from the water heater to the storage tank to achieve the proper temperature rise.
2. Sustained high water velocity and low temperature rise may result in pitting or erosion of the copper tubes in the heat exchangers. This is a non-warrantable failure. Temperature rise must be properly adjusted to achieve the specified flow rate.
3. Once temperature rise has been properly set, reconnect the power leads to the bypass actuator.
4. Turn power on and place the run/stop switch in the "RUN" position and allow the bypass valve to go through the synchronization process before it begins normal operation.

## **WARNING** ⚠

Moving the bypass handle while appliance is firing can result in abnormally high water temperature that may cause sudden relief valve discharge.

## **CAUTION** ⚠

Temperature rise cannot be adjusted when the burner is firing at less than 100% of rate input.

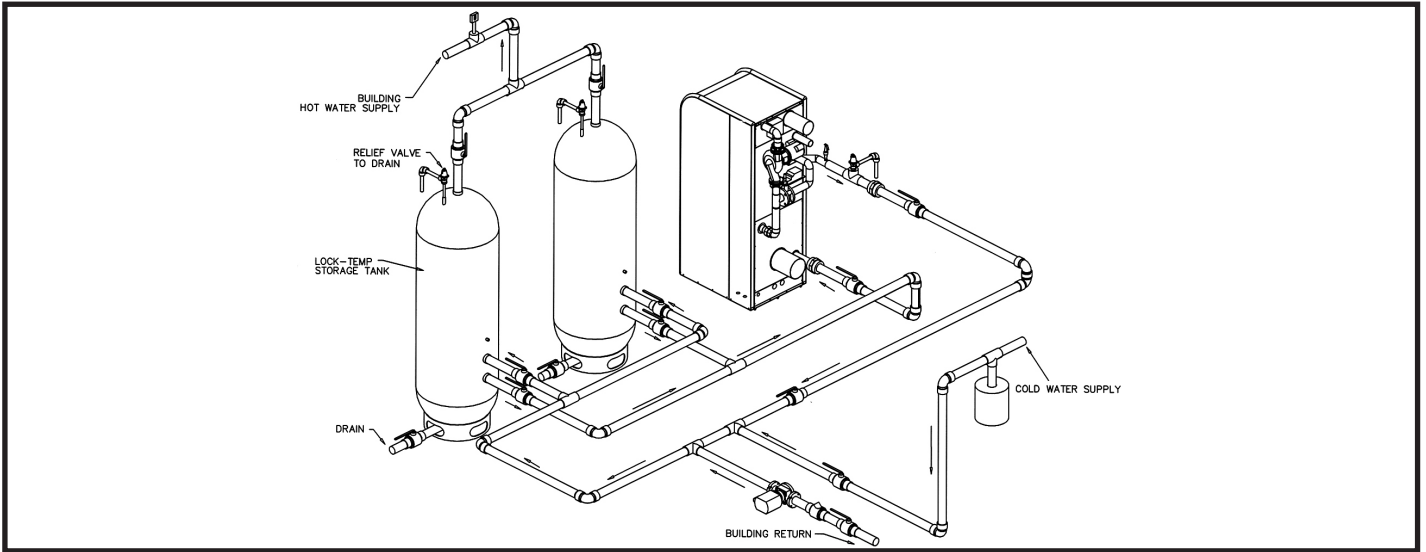
## **WATER CHEMISTRY**

### **NOTE:**

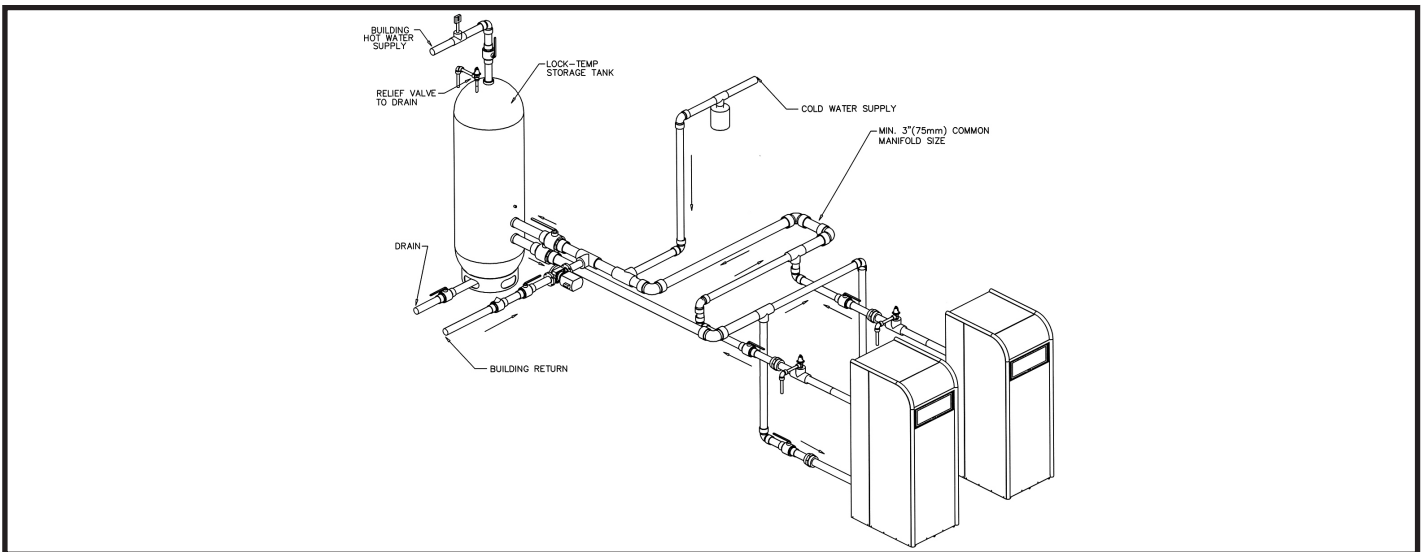
Water temperature rise and maximum flow data are based on heating potable water with a hardness of 5 to 25 grains per gallon and total dissolved solids not exceeding 350 ppm.

The required temperature rise and the standard integral pump are sized 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 may 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.

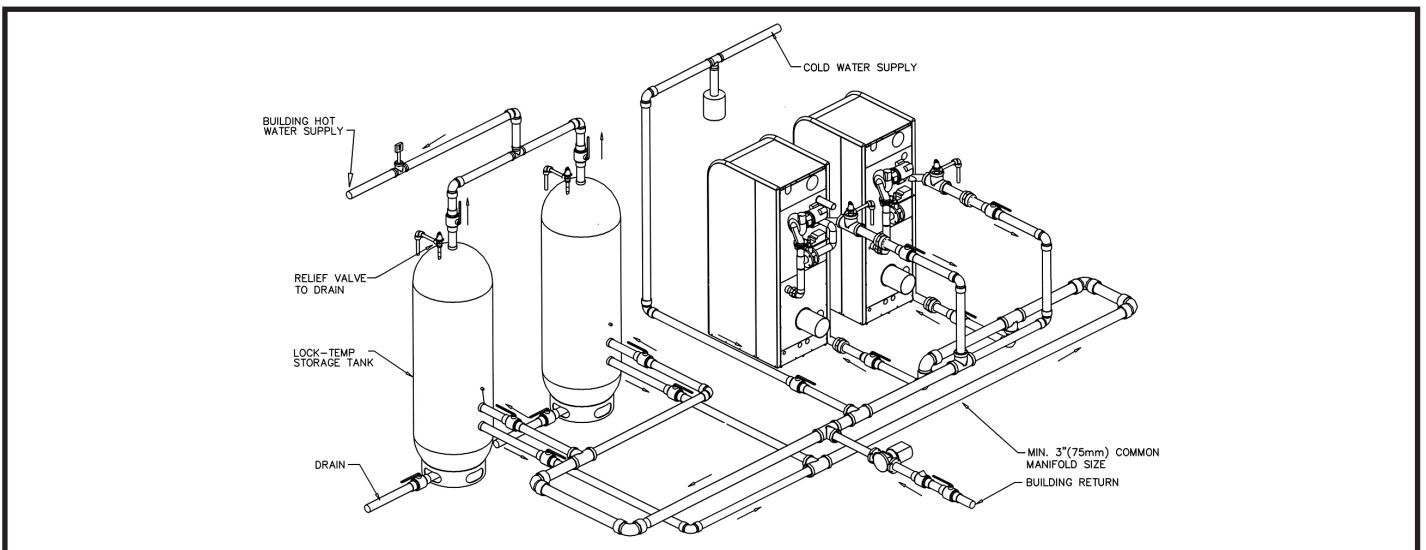
## PIPING - MULTIPLE UNIT INSTALLATIONS



**FIG. 85 Single Water Heater Piping with Two Storage Tanks**



**FIG. 86 Multiple Water Heater Piping with Single Storage Tank**



**FIG. 87 Multiple Water Heater Piping with Multiple Storage Tanks**

**TABLE - GG**  
**Common Water Manifold Size**  
**For Multiple Water Heater**  
**Hot Water Supply Boiler Installations**

**Btu/hr Input                      Temperature Rise**

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

**Number of Units                      Common Manifold  
Size (Min)**

1	3"
2	4"
3	4"
4	5"
5	6"
6	6"

## PUMP OPERATION

1. The water heater or hot water supply boiler has a properly sized integral circulating pump. This pump is sized to circulate water between the heater and storage tank only.
2. The internal pump is sized to the heater input and water chemistry specifications noted in "Water Chemistry."
3. The diameter and length of the piping installed between the storage tank(s) and water heater must be properly sized based on the equivalent length specifications.
4. The pump must run continuously when the water heater or hot water supply boiler is firing. This is the standard operating system for a water heater or hot water supply boiler.

An intermittent pump control function with an all bronze pump is installed as standard equipment on all water heater systems. The pump will operate only while there is a "Call for Heat" and for a timed period after the water temperature setpoint is satisfied to remove any residual heat from the combustion chamber.

5. Lubricate pump to manufacturers recommendations. Pump damage due to inadequate lubrication is non-warrantable.

6. The operating temperature sensor for a water heater or hot water supply boiler is installed in inlet piping to the water heater or hot water supply boiler.

The operating sensor must be installed in the tapping provided in the lower 25% of the storage tank to achieve proper operation. As shipped from the factory, the operating sensor is installed in a bulb well mounted in the inlet piping to the water heater. When the pump cycles off in normal operation, this sensor location may not adequately sense a quick drop in temperature from a draw of hot water from the storage tank. Placing the sensor in the tapping provided on the storage tank will improve temperature response and prevent short cycles of operation when a water heater is equipped with the optional intermittent pump feature.

The standard integral pump on this water heater is sized based on installation of a single storage tank and heater in close proximity. If the number of fittings and straight pipe exceeds the specified maximum equivalent number of straight feet for a specified diameter of pipe, non-warrantable operational problems may be experienced.

When installing multiple water heaters and/or multiple storage tanks, the diameter of the inter connecting pipe and all fittings must be increased. An increase in pipe diameter will decrease head loss in the system piping and ensure proper flow. Proper pipe size between the heater and storage tank **MUST** be maintained to ensure that the standard pump supplied on the water heater will maintain desired flow.

### NOTE:

Minimum pipe diameters and maximum length  
specifications must be per the requirements in this  
section.

## HEAT EXCHANGER

This is a highly sophisticated heat exchanger system, 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, four 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 and glass lined, cast iron, one piece, cored headers make up an entirely rust-proof unit. On all models, header inspection plugs in the primary heat exchanger can be removed for field inspection and cleaning of copper tubes. Each of the heat exchangers may be removed from the unit.

## THERMOSTAT SETTINGS

1. The Excel 10 temperature controller is adjusted to a low test setting when shipped from the factory.
2. Using the Command Display, adjust the temperature setpoint to the lowest settings which will satisfy hot water demands and prevent a risk of scald injury.

## TEMPERATURE ADJUSTMENT

### MINIMUM WATER TEMPERATURES

(Domestic Hot Water Use)

Inlet water temperatures below the specified minimum recommendations can excessively cool the products of combustion resulting in condensation on the primary heat exchanger. The water heater is designed to condense only on the secondary heat exchanger. Condensation on the primary heat exchanger can cause operational problems, bad combustion, sooting, flue gas spillage and reduced service life of the related components.

A minimum water temperature has been established for each model based on the Btu/hr input at 100% of rated burner input. The temperature setpoint for the Excel 10 controller sensing stored water temperature must not be set lower than the specified minimum for each model. Maintaining inlet water temperatures to the water heater equal to or higher than the specified minimum ensures proper operation of the bypass and allows all condensate formation to occur on the secondary heat exchanger. A water heater allowed to sustain operation at water temperatures lower than the specified minimum may not provide enough heat from the burner to maintain water temperatures in primary heat exchanger above the 130°F (55°C) dew point of flue products. Operation of a water heater at a

temperature below the specified minimum will result in non-warrantable operational problems from the condensate formation on the primary heat exchanger.

**TABLE - HH**

### Minimum Inlet Water Temperatures

Input Btu/hr	Minimum Return Temperature	Minimum Setpoint
1,500,000	50°F (10°C)	105°F (40.6°C)
1,700,000	50°F (10°C)	90°F (32.2°C)
2,000,000	50°F (10°C)	70°F (23.9°C)

## CAUTION⚠

An appliance allowed to operate with return temperatures setpoint below the specified minimum settings may experience operational problems with the operating controls and safety switches, obstruction of the flue gas passages on the primary heat exchanger, incomplete combustion and possible flue gas spillage. Operation at lower than specified water temperatures may cause hazardous conditions that result in non-warrantable damage to the appliance.

The maximum temperature setpoint that can be programmed into the Excel 10 controller from the Command Display for water heater operation is 190°F (87.8°C). The Excel 10 control is factory pre-set at approximately 120°F (48.9°C). Facilities with small children or invalids may require 120°F (48.9°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

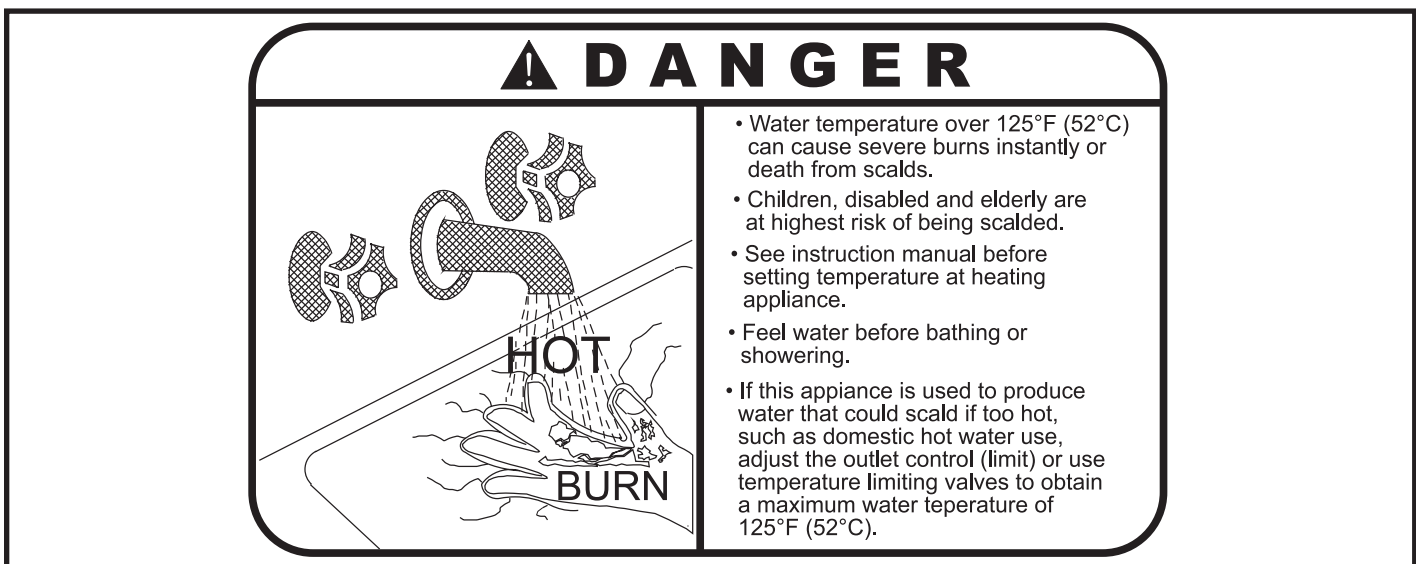


FIG. 88 Warning Label

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-

Incorrect piping of the cold water supply to the system may result in excessive low temperature operation causing condensate formation on the primary 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 the volume of condensate formed.

### CAUTION⚠

Hotter water increases the risk of scald injury. 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 110°F (43.3°C). Storing the water at a higher temperature and thermostatically mixing the water will decrease the size of the storage tank and increase the available quantity of mixed hot water. Storing water at higher temperatures can help to control the level of condensate formed and help prevent the growth of water born bacteria. Caution! Adequate care **MUST** be taken to prevent potential scald injury when storing water at 140°F (60°C) and hotter.

### 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.

## HIGH WATER TEMPERATURE LIMIT CONTROL

A Manual Reset High Limit control is located on the left front of the left front side of the control panel, beside the Command display. Additional switches, alarm indicating lights and optional low water cut-off control switches are also located on this panel. The setting of this control knob limits maximum discharge water temperature. The water heater or hot water supply boiler temperature limit control is adjustable up to a fixed maximum setting of 200°F (93°C). A red reset button, located beside the knob, must be pushed whenever water temperature has exceeded the set point of the manual reset limit. The temperature of the water in the heat exchanger must drop a minimum of 15°F (8.3°C) below the setting of the manual reset high limit control before the reset function can be activated. A red indicating light is illuminated when the water temperature exceeds the setting of the high limit control. A status point alarm of Over Temp will be displayed in the Command Display when water temperature exceeds the Setpoint Temperature programmed into the Excel 10 control.

## OPTIONAL RELIEF VALVE

This water heater or hot water supply boiler is normally supplied with a temperature and pressure relief valve sized in accordance with applicable codes. Units may be supplied with an optional pressure only relief valve. When a water heater or 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 that discharges periodically may be due to thermal expansion in a closed system. A water heater or 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

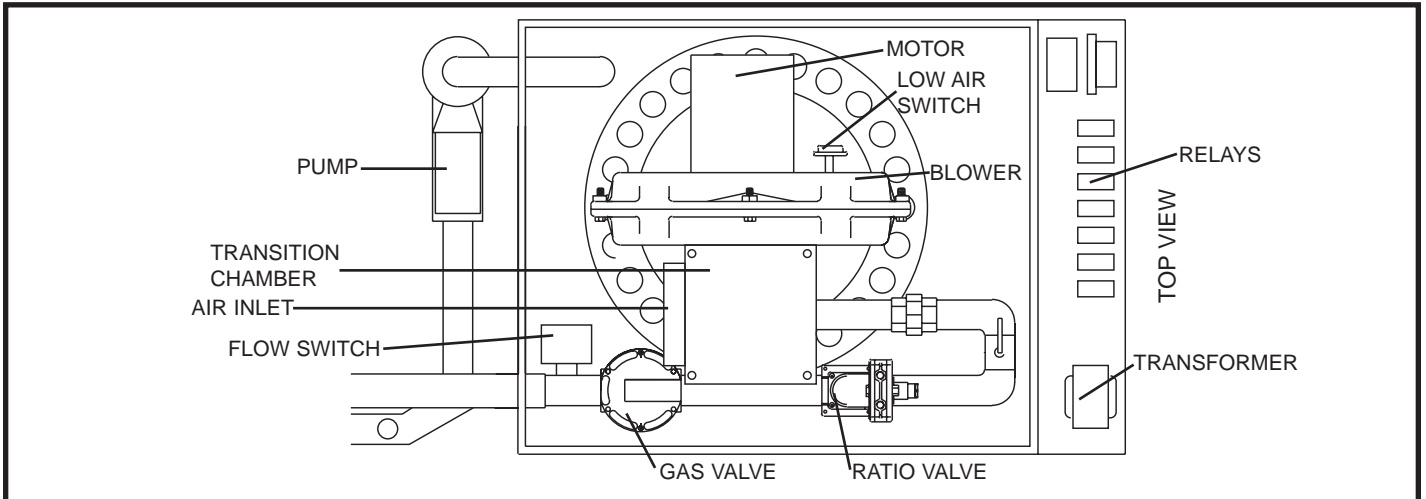


FIG. 89 Top

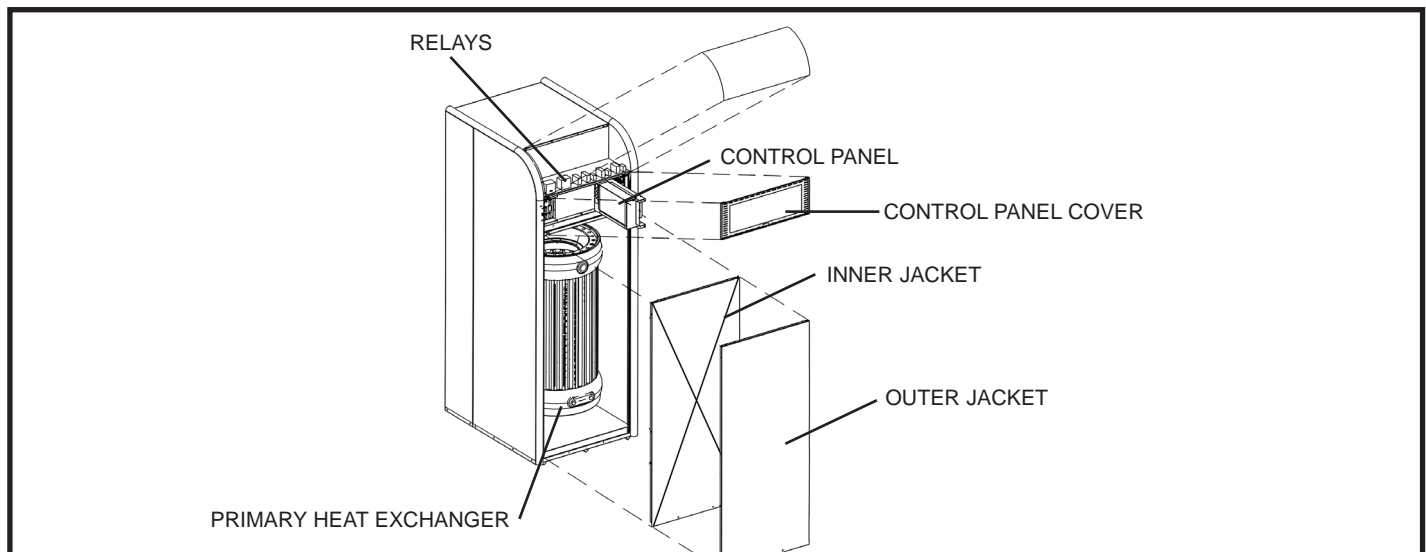


FIG. 90 Front

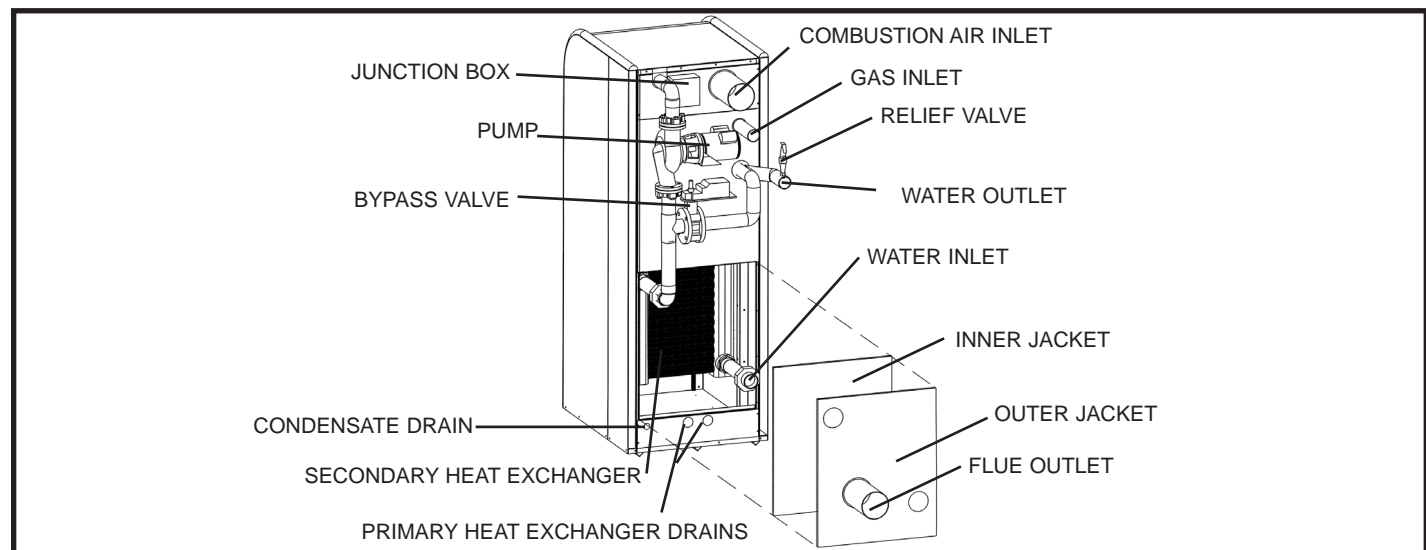


FIG. 91 Rear





