


INSTALLATION AND OPERATING INSTRUCTIONS



**Models HD101–HD401
Types H & WH**

NOTICE

SCAN WITH QR EQUIPPED SMART DEVICE FOR ONLINE MANUAL. SEE PAGE 54 FOR QR CODE.



WARNING: If these instructions are not followed exactly, a fire or explosion may result causing property damage, personal injury or death.

FOR YOUR SAFETY: Do not store or use gasoline or other flammable vapors and liquids or other combustible materials in the vicinity of this or any other appliance. To do so may result in an explosion or fire.

WHAT TO DO IF YOU SMELL GAS:

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

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

This manual should be maintained in legible condition and kept adjacent to the variable speed pump or in a safe place for future use.



Effective: 06-20-23
Replaces: 03-31-21
P/N 241356 Rev. 9

Revision 9 reflects the following changes:

The NOTE on page 8, WARNING on page 11, and CAUTION on page 12 have all been updated. Additionally, a CAUTION statement has been added on page 24. Table H on page 18, Table K on page 24, and Table N on page 28 have been updated. A new section called "Outdoor Reset Concept" has been added on page 30-31. The wiring diagram for Models HD201-HD401 Type WH1 (ON/OFF) has been updated with the latest version on page 37. The "Illustrated Parts List" callouts on page 47-49 have been updated. The "Gas Train" information on page 48 and "Gas Conversion Kits" information on page 52 have been updated. "Fan" section on page 50 has been updated. Added "Decal P/N: 100-10001010" for gas conversion section in IPL.

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THIS INSTALLATION MANUAL MAY NOT BE THE LATEST REVISION PRINTED AT THE TIME OF PRODUCT SHIPMENT. VISIT THE RAYPAK WEBSITE TO VERIFY THE MANUAL DELIVERED WITH YOUR RAYPAK UNIT IS THE MOST UP-TO-DATE VERSION.

1. WARNINGS

Pay Attention to these Terms

▲ DANGER	Indicates the presence of immediate hazards which will cause severe personal injury, death or substantial property damage if ignored.
▲ WARNING	Indicates the presence of hazards or unsafe practices which could cause severe personal injury, death or substantial property damage if ignored.
▲ CAUTION	Indicates the presence of hazards or unsafe practices which could cause minor personal injury or product or property damage if ignored.
CAUTION	CAUTION used without the warning alert symbol indicates a potentially hazardous condition which could cause minor personal injury or product or property damage if ignored.
NOTE	Indicates special instructions on installation, operation, or maintenance which are important but not related to personal injury hazards.

▲ DANGER: Make sure the gas on which the heater will operate is the same type as that specified on the heater rating plate.

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

▲ WARNING: Risk of electrical shock. More than one disconnect switch may be required to de-energize the equipment before servicing.

▲ WARNING: This unit contains refractory ceramic fiber (RCF) insulation in the combustion chamber. RCF, as manufactured, does not contain respirable crystalline silica. However, following sustained exposure to very high temperatures (>2192°F / 1200°C), the RCF can transform into crystalline silica (cristabolite). The International Agency for Research on Cancer (IARC) has classified the inhalation of crystalline silica (cristabolite) as carcinogenic to humans.

When removing the burners or heat exchangers, take precautions to avoid creating airborne dust and avoid inhaling airborne fibers. When cleaning spills, use wet sweeping or High Efficiency Particulate Air (HEPA) filtered vacuum to minimize airborne dust. Use feasible engineering controls such as local exhaust ventilation or dust collecting systems to minimize airborne dust. Wear appropriate personal protective equipment including gloves, safety glasses with side shields, and appropriate NIOSH certified respiratory protection, to avoid inhalation of airborne dust and airborne fiber particles.

▲ WARNING: To minimize the possibility of improper operation, serious personal injury, fire, or damage to the heater:

- Always keep the area around the heater free of combustible materials, gasoline, and other flammable liquids and vapors.
- Heater should never be covered or have any blockage to the flow of fresh air to the heater.

▲ WARNING: Do not use this heater if any part has been under water. Immediately call a qualified service technician to inspect the heater and to replace any part of the control system and any gas control which has been under water.

▲ CAUTION: Operation of this heater in low-temperature systems requires special piping. Harmful internal condensation will occur if the inlet water temperature does not exceed 105°F. Warranty claims will be denied when condensation occurs.

▲ CAUTION: If this heater is to be installed above radiation level, it must be provided with a low water cut-off device at the time of heater installation.

▲ CAUTION: If this heater is to be installed in a negative- or positive-pressure equipment room, there are special installation requirements. Consult factory for details.

▲ CAUTION: This heater requires forced water circulation when the burner is operating. See minimum and maximum flow rates, Table E and Table F. Severe damage will occur if the heater is operated without proper water flow circulation.

2. BEFORE INSTALLATION

Raypak strongly recommends that this manual be reviewed thoroughly before installing your Hi Delta heater. Please review the General Safety information before installing the heater. Factory warranty does not apply to heaters that have been improperly installed or operated (refer to the warranty at the back of this manual). Installation and service must be performed by a qualified installer, service agency or the gas supplier. If, after reviewing this manual, you still have questions which this manual does not answer, please contact your local Raypak representative or visit our website at www.raypak.com.

Thank you for purchasing a Raypak product. We hope you will be satisfied with the high quality and durability of our equipment.

Product Receipt

⚠ WARNING: Pump motors should NOT be supported by any type of stand or support from above due to possible misalignment of pump and motor which may occur.

On receipt of your heater it is suggested that you visually check for external damage to the shipping crate. If the crate is damaged, make a note to that effect on the Bill of Lading when signing for the shipment. Next, remove the heater from the shipping packaging. Report any damage to the carrier immediately.

On occasion, items are shipped loose. Be sure that you receive the correct number of packages as indicated on the Bill of Lading.

Claims for shortages and damages must be filed with the carrier by consignee. Permission to return goods must be received from the factory prior to shipping. Goods returned to the factory without an authorized Returned Goods Receipt number will not be accepted. All returned goods are subject to a restocking charge.

When ordering parts, you must specify the model and serial number of the heater. When ordering under warranty conditions, you must also specify the date of installation.

Purchased parts are subject to replacement only under the manufacturer's warranty. Debits for defective replacement parts will not be accepted. Parts will be replaced in kind only per Raypak's standard warranties.

Model Identification

The model identification number and heater serial number are found on the heater data plate located on the right side jacket of the heater. The model number will have the form H3-HD101 or similar depending on the heater size and configuration. The first group of characters in the model number identifies application and firing mode (H3 = 2-stage Hydronic Heating System, WH1 = on/off Hot Water Supply System). The last three places identify the size of the heater.

Ratings and Certifications

Standards:

- Gas-Fired Low Pressure Steam and Hot Water Heaters, ANSI Z21-13 • CSA 4.9 - latest edition
- Industrial and Commercial Gas-Fired Package Heaters, CAN 3.1 - latest edition
- Gas Water Heaters, ANSI Z21.10.3 • CSA 4.3 - latest edition

All Raypak heaters are National Board registered, and design-certified and tested by the Canadian Standards Association (CSA) for the U.S. and Canada. Each heater is constructed in accordance with Section IV of the American Society of Mechanical Engineers (ASME) Heater Pressure Vessel Code and bears the ASME stamp. H models bear the "H" stamp. WH models bear the "HLW" stamp. The heater also complies with the latest edition of ASHRAE 90.1 Standard.

⚠ WARNING: Altering any Raypak pressure vessel by installing replacement heat exchangers, tube bundle headers, or any ASME parts not manufactured and/or approved by Raypak will instantly void the ASME and CSA ratings of the vessel and any Raypak warranty on the vessel. Altering the ASME or CSA ratings of the vessel also violates national, state, and local approval codes.

Installations at Elevation

Rated inputs are suitable for up to 2000 ft (610 m) elevation without de-rate. Consult the Factory for installations at any altitude in excess of 2000 ft (610 m).

Component Locations

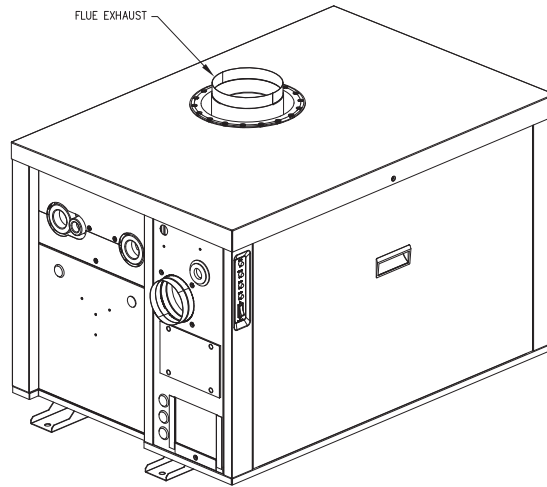


Figure 1. Component Locations — General

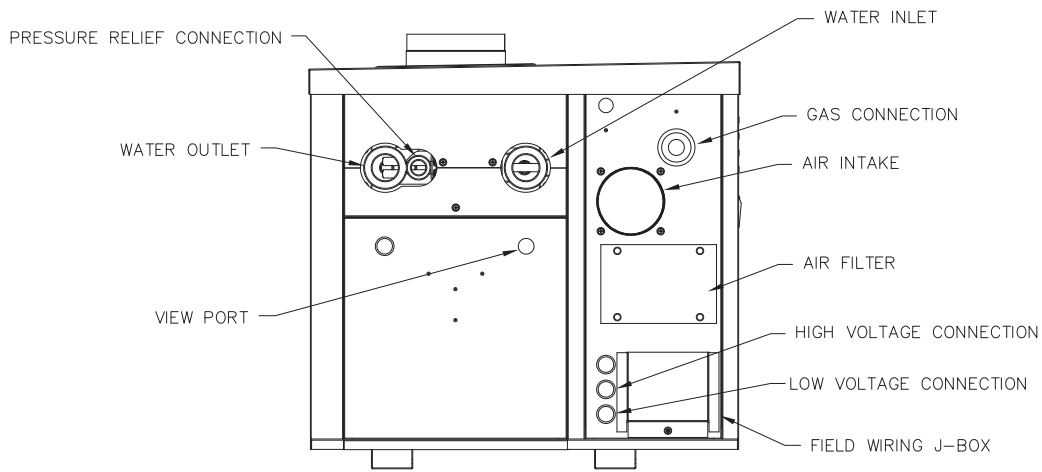


Figure 2. Component Locations — Left Side

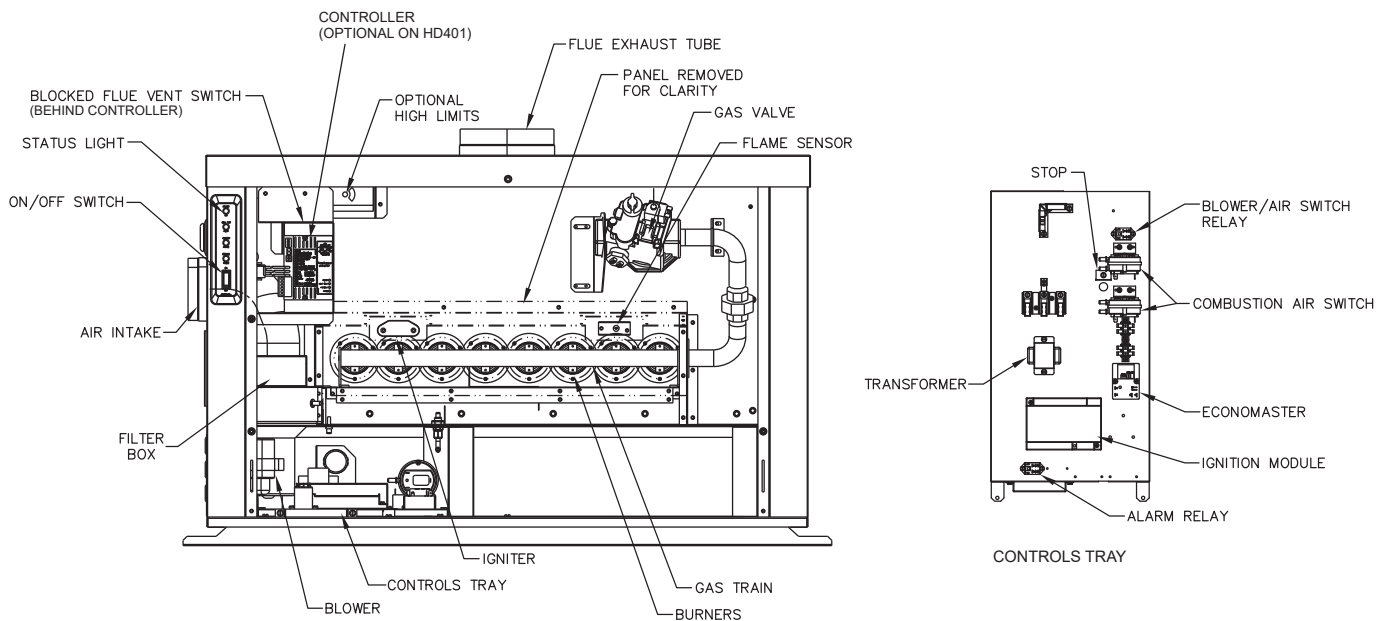


Figure 3. Component Locations — Front (Panels removed for clarity)

General Information

Model No.	Quantity of Burners	Vent Size in. (cm)	
		Flue	Intake
HD101	2	4 (10.1)	4 (10.1)
HD151	3	4 (10.1)	
HD201	4	5 (12.7)	
HD251	5	5 (12.7)	
HD301	6	5 (12.7)	
HD401	8	6 (15.2)	

Table A. Basic Data

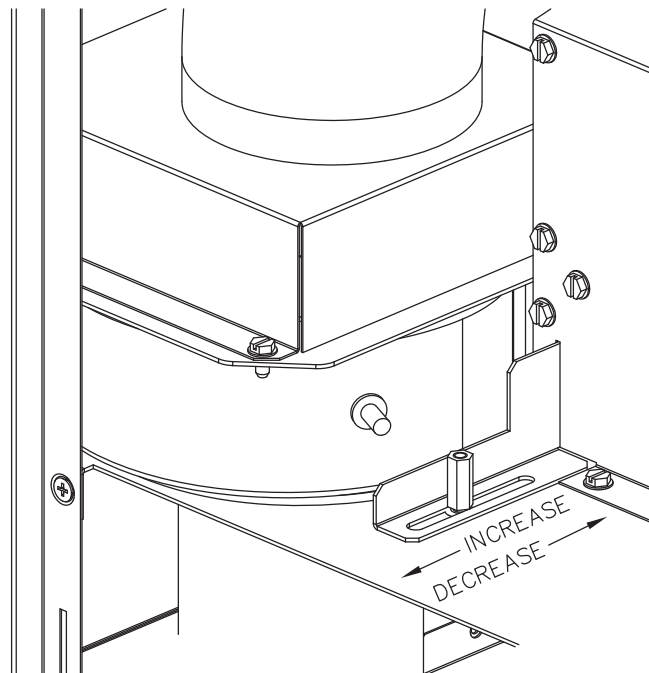


Figure 4. Air Shutter Adjustment

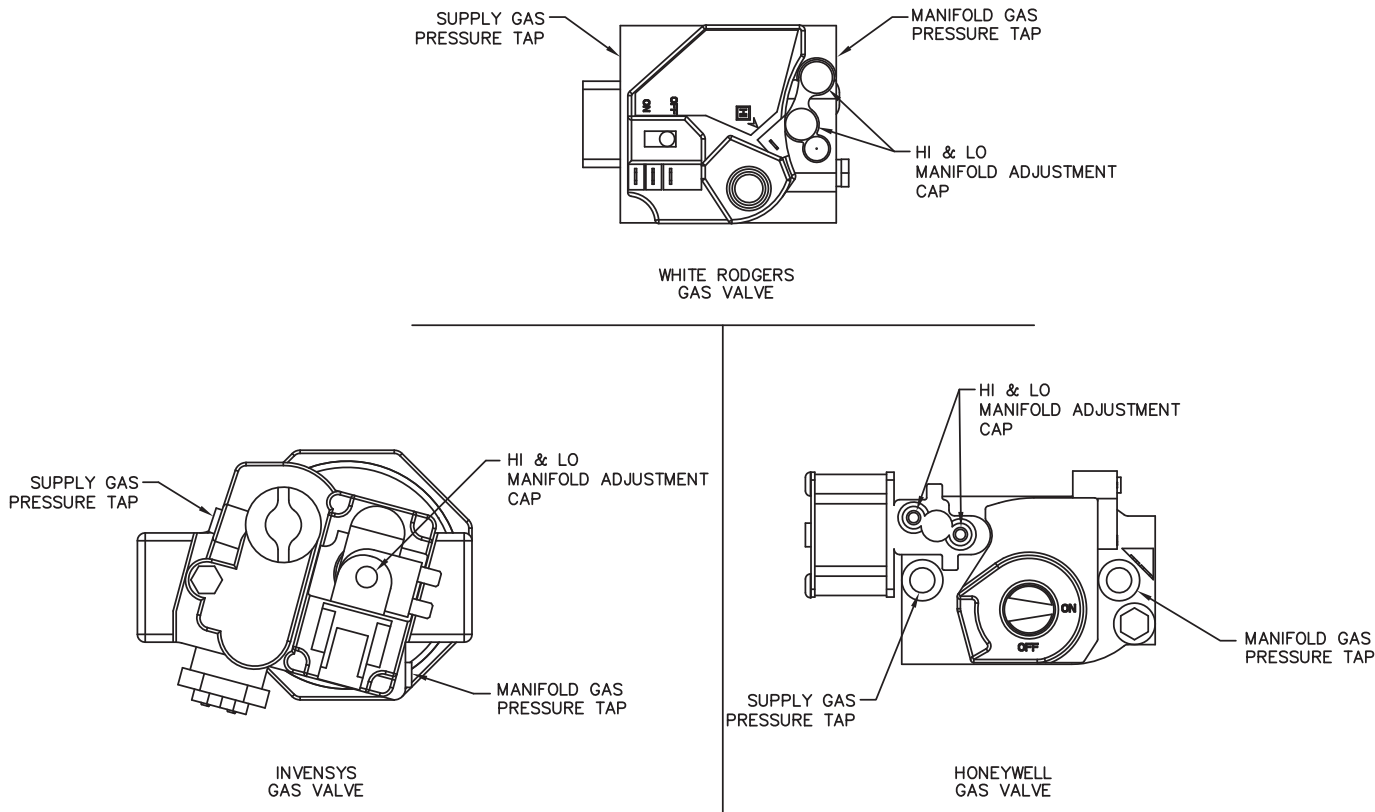


Figure 5. Gas Valves

3. GENERAL SAFETY

To meet commercial hot water use needs, the high limit safety control on this water heater will shut off the main gas valve before the outlet temperature reaches 210°F (99°C). However, water temperatures over 125°F (52°C) can cause instant severe burns or death from scalds. When supplying general purpose hot water, the recommended initial setting for the temperature control is 125°F (52°C).


Safety and energy conservation are factors to be considered when setting the water temperature on the thermostat. The most energy-efficient operation will result when the temperature setting is the lowest that satisfies the needs of the application.

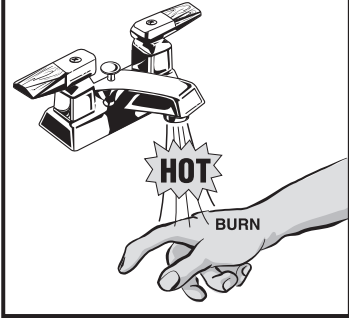
Water temperature over 125°F (52°C) can cause instant severe burns or death from scalds. Children, disabled and elderly are at highest risk of being scalded.

- Feel water before bathing or showering.
- Temperature limiting valves are available.

NOTE: When this unit is supplying general-purpose hot water for use by individuals, a thermostatically-controlled mixing valve for reducing point-of-use water temperature is recommended to reduce the risk of scald injury. Contact a licensed plumber or the local plumbing authority for further information.

Maximum water temperatures occur just after the heater's burner has shut off. To determine the water temperature being delivered, turn on a hot water faucet and place a thermometer in the hot water stream and read the thermometer.





Water temperature over 125°F (52°C) can cause instant severe burns or death from scalds.

Children, disabled, and elderly are at highest risk of being scalded.

See instruction manual before setting temperature at water heater

Feel water before bathing or showering.

Temperature limiting valves are available, see manual.

Time/Temperature Relationships in Scalds

The following chart details the relationship of water temperature and time with regard to scald injury and may be used as a guide in determining the safest water temperature for your applications.

Water Temp.	Time to Produce Serious Burns
120°F (49°C)	More than 5 minutes
125°F (52°C)	1-1/2 to 2 minutes
130°F (54°C)	About 30 seconds
135°F (57°C)	About 10 seconds
140°F (60°C)	Less than 5 seconds
145°F (63°C)	Less than 3 seconds
150°F (66°C)	About 1-1/2 seconds
155°F (68°C)	About 1 second

Table courtesy of The Shriners Burn Institute

Table B. Time to Produce Serious Burn

Raypak offers several optional temperature controllers for regulation of the water temperature in the heater. Type H models 101 through 301 are equipped as standard with an onboard operating controller to provide reset of the water temperature based on outdoor air temperature. To comply with safety regulations, the temperature controller will be set at the lowest setting when shipped from the factory.

To adjust the water temperature, insert a small straight screwdriver into the adjustment wheel on the front of temperature control and turn the wheel to the desired setting (See Figure 6).

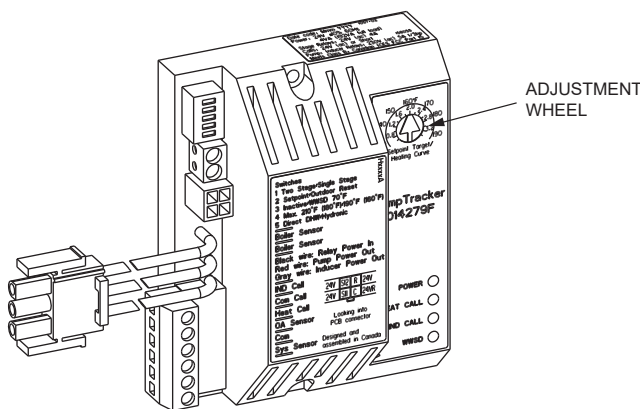


Figure 6. Temperature Controller

CAUTION: Hotter water increases the risk of scalding! There is a hot water scald potential if the thermostat is set too high.

4. INSTALLATION

Installation Codes

Installations must follow these codes:

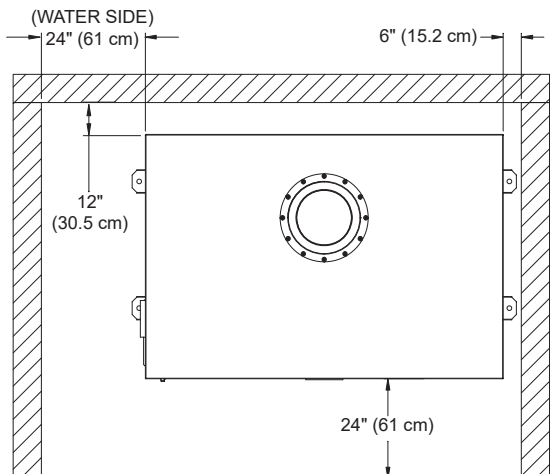
- Local, state, provincial, and national codes, laws, regulations and ordinances.
- National Fuel Gas Code, ANSI Z223.1- latest edition (NFGC).
- National Electrical Code, ANSI/NFPA 70 - latest edition (NEC).
- Standard for Controls and Safety Devices for Automatically Fired Heaters, ANSI/ASME CSD-1, when required (CSD-1).
- For Canada only: CAN/CGA B149 Installation Code (B149) and C.S.A. C22. 1 C.E.C. Part 1 (C22. 1).

Equipment Base

The heater should be mounted on a level, structurally sound surface. The heater is approved for installation on a combustible surface but must NEVER be installed on carpeting. Gas-fueled equipment installed in enclosed parking garages must be located at least 18 in. (45.7 cm) above the floor.

⚠ CAUTION: The heater should be located in an area where water leakage will not result in damage to the area adjacent to the appliance or to the structure. When such locations cannot be avoided, it is recommended that a suitable catch pan, adequately drained, be installed under the appliance. The pan must not restrict air flow.

In addition, the heater shall be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation or service (circulator replacement, control replacement, etc.).



⚠ WARNING: This product must be installed by a licensed plumber or gas fitter when installed within the Commonwealth of Massachusetts.

Clearances

Indoor/Closet Installations

Heater Side	Minimum Installed Combustible Clearance in. (cm)
Front	24 (61)
Rear	2 (5)
Floor*	0
Top	24 (61)
Left**	12 (30.5)
Right**	6 (15)
Water Side	24 (61)

*DO NOT install on carpeting.

**When water connections are on other side.

Table C. Combustible Clearances — Indoor/Closet Installations

⚠ CAUTION: Service clearances less than the minimums may require removal of the heater to service either the heat exchanger or the burners.

The heater must be installed in a manner that will enable the heater to be serviced without removing any structure around the heater.

Outdoor Installations

These heaters are design-certified for outdoor installation. Heaters must not be installed under an overhang unless clearances are in accordance with local installation codes and the requirements of the gas supplier. Three sides must be open in the area under the overhang (see **Figure 8**). Roof water drainage must be diverted away from heaters installed under overhangs.

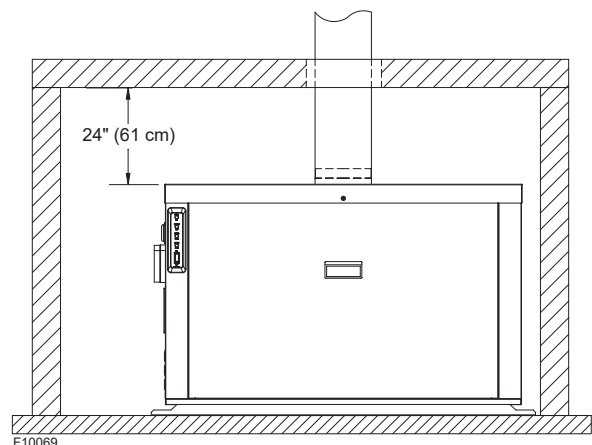


Figure 7. Minimum Installed Service Clearances — Indoor/Closet Installations

These clearances are required when the outdoor vent cap is used. If installing the heater outdoors with a vent stack, the indoor clearances may be utilized.

The combustion air intake hood **MUST** be used for outdoor installations. The hood is shipped loose and installed on the side of the heater over the filter box at the job site.

Heater Side	Minimum Installed Service Clearance in. (cm)
Front	24 (61.0)
Rear	12 (30.5)
Top	Unobstructed
Other Side	36 (91.4)
Water Side	36 (91.4)

Table D. Service Clearances — Outdoor Installations

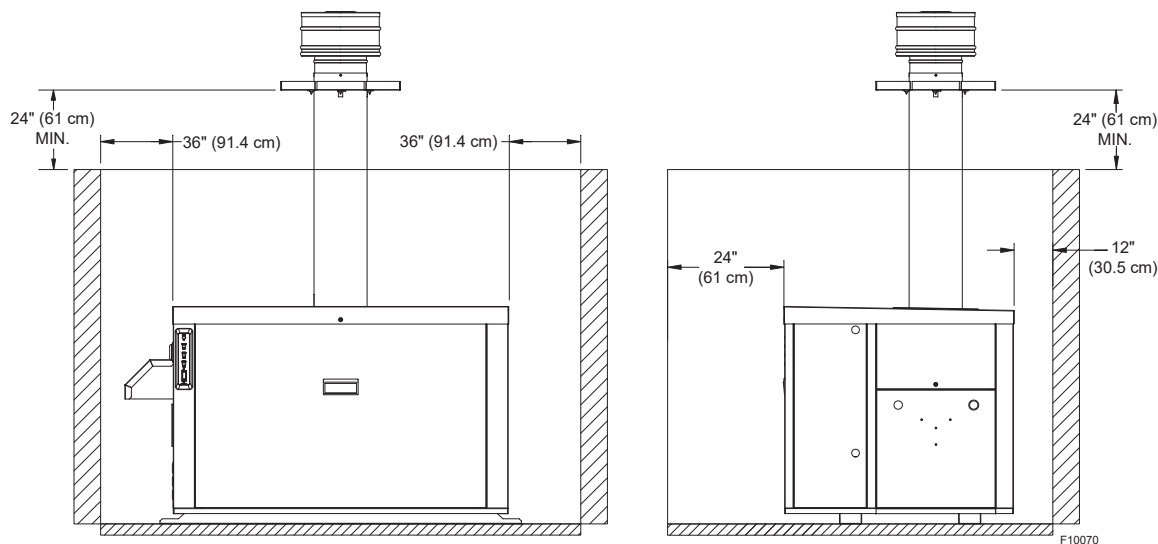


Figure 8. Minimum Installed Service Clearance — Outdoor Installations with Vent Stack

Conventional Combustion Air Supply

U.S. Installations

All Air from Inside the Building

The confined space shall be provided with **two** permanent openings communicating directly with an additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. The total input of all gas utilization equipment installed in the combined space shall be considered in making this determination. Each opening shall have a minimum free area of 1 in.² per 1,000 BTUH (22 cm² per kW) of the total input rating of all gas utilization equipment in the confined space, but not less than 100 in.² (645 cm²). One opening shall commence within 6-3/4 in. (17.1 cm) of the top, and one opening shall commence within 6-3/4 in. (17.1 cm) of the bottom, of the enclosure. The minimum dimension of air openings shall be not less than 3 in. (7.6 cm) in any direction.

All Air from Outdoors

The confined space shall communicate with the outdoors in accordance with methods 1 or 2 below. The minimum dimension of air openings shall not be less than 3 in. (7.6 cm) in any direction. Where ducts are used, they shall be

of the same cross-sectional area as the free area of the openings to which they connect.

- Two permanent openings**, one commencing within 12 in. (30.5 cm) of the top, and one commencing within 12 in. (30.5 cm) of the bottom, of the enclosure shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces (crawl or attic) that freely communicate with the outdoors.
 - Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 in.² per 4000 BTUH (5.5 cm² per kW) of total input rating of all equipment in the enclosure.
 - Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 in.² per 2000 BTUH (11 cm² per kW) of total input rating of all equipment in the enclosure.
- One permanent opening**, commencing within 12 in. (30.5 cm) of the top of the enclosure, shall be permitted where the equipment has clearances of at least 1 in. (2.5 cm) from the sides and back and 6 in. (15.2 cm) from the front of the appliance. The opening shall directly communicate with the outdoors

or shall communicate through a vertical or horizontal duct to the outdoors or spaces (crawl or attic) that freely communicate with the outdoors, and shall have a minimum free area of:

- a. 1 in.² per 3000 BTUH (7 cm² per kW) of the total input rating of all equipment located in the enclosure, and
- b. \Not less than the sum of the areas of all vent connectors in the confined space.

▲ WARNING: Do not use the "one permanent opening" method if the equipment room is under negative-pressure conditions or the equipment is common vented with other gas-fired appliances.

Installations in Canada

▲ CAUTION: All combustion air must be drawn from the air outside of the building; the mechanical equipment room must communicate directly with the outdoors.

1. Ventilation of the space occupied by the heater shall be provided by an opening(s) for ventilation air at the highest practical point communicating with outdoors. The total cross-sectional area of such an opening(s) shall be at least 10% of the area required in (2) and (3), but in no case shall the cross-sectional area be less than 10 in.² (6500 mm²).
2. For heaters using a barometric damper in the vent system, and when air supply is provided by natural air flow from the outdoors for natural draft, partial fan assisted, fan-assisted or power draft-assisted burners, there shall be a permanent air supply opening(s) having a cross section area of not less than 1 in.² per 7000 BTUH (310 mm² per kW) up to and including 1 million BTUH, plus 1 in.² per 14000 BTUH (155 mm² per kW) in excess of 1 million BTUH. This opening(s) shall be either located at or ducted to a point not more than 18 in. (45.7 cm) nor less than 6 in. (15.2 cm) above the floor level. The duct can also "Goose Neck" through the roof. The duct is preferred straight down 18" (45.7 cm) from floor, but do not place near piping. This air supply opening requirement shall be in addition to the air opening for ventilation air required in (1).
3. For heaters not using a barometric damper in the vent system, and when air supply is provided by natural air flow from outdoors for a power burner and there is no draft regulator, draft hood or similar flue gas dilution device installed in the same space, in addition to the opening for ventilation air required in (1), there shall be a permanent air supply opening(s) having a total cross-sectional area of not less than 1 in.² for each 30,000 BTUH (70 mm² per kW) of total rated input of the burner(s), and the location of the opening(s) shall not interfere with the intended purpose of the opening(s) for ventilation air referred to (1). This opening(s) can be ducted to a point not

more than 18 in. (45.7 cm) nor less than 6 in. (15.2 cm) above the floor level. The duct can also "Goose Neck" through the roof. The duct is preferred to be straight down 18" (45.7 cm) from floor, but do not place near piping.

4. Refer to the latest version of the B149 for additional information.

Combustion and Ventilation Air

Contamination of Combustion Air

All heaters experience some condensation during start-up. The condensate from flue gas is slightly acidic. In most cases the pH level is not harmful to vents or drains. When combustion air is contaminated by vapors from products in areas listed below, the acidic levels in the condensate increase. Higher acidic levels attack many materials, including stainless steel commonly used in high-efficiency systems.

The heater can use special corrosion-resistant nonmetallic intake vent material. You may, however, choose to use outside combustion air for one or more of these reasons:

- installation is in an area containing contaminants listed below which will induce acidic condensation.
- you want to reduce infiltration into your building through openings around windows and doors.
- you are using AL29-4C stainless steel vent pipe, which is more corrosion-resistant than standard metallic vent pipe. In extremely contaminated areas, this may also experience deterioration.

Products causing contaminated combustion air:

- spray cans containing chloro/fluorocarbons
- permanent wave solutions
- chlorinated waxes/cleaners
- chlorine-based swimming pool chemicals
- calcium chloride used for thawing
- sodium chloride used for water softening
- refrigerant leaks
- paint or varnish removers
- hydrochloric acid/muriatic acid
- cements and glues
- antistatic fabric softeners used in clothes dryers
- chloride-type bleaches, detergents, and cleaning solvents found in household laundry rooms
- adhesives used to fasten building products and other similar products.

Areas causing contaminated combustion air:

- dry cleaning/laundry areas and establishments
- metal fabrication plants

- beauty shops
- refrigeration repair shops
- photo processing plants
- auto body shops
- plastic manufacturing plants
- furniture refinishing areas and establishments
- new building construction
- remodeling areas.

Check for areas and products as listed above before installing heater. If found:

- remove products permanently, OR
- provide outdoor combustion air.

Ducted Combustion Air

If outside air is drawn through the intake pipe directly to the unit for combustion:

1. Install combustion air duct in accordance with the venting section of this manual, see 24 to 27.
2. Provide adequate ventilation of the space occupied by the heater(s) by an opening(s) for ventilation air at the highest practical point communicating with the outdoors. The total cross-sectional area shall be at least 1 in.² of free area per 20,000 BTUH (111 mm² per kW) of total input rating of all equipment in the room when the opening is communicating directly with the outdoors or through vertical duct(s). The total cross-sectional area shall be at least 1 in.² of free area per 10,000 BTUH (222 mm² per kW) of total input rating of all equipment in the room when the opening is communicating with the outdoors through horizontal duct(s). This opening must meet the location requirements of the National Fuel Gas Code.
3. In cold climates, and to mitigate potential freeze-up, Raypak highly recommends the installation of a motorized sealed damper to prevent the circulation of cold air through the heater during non-operating hours.
4. If the combustion air ducting is sealed (RTV recommended) and sealed-joint flue material is used, the resulting installation will meet direct-vent requirements.

Combustion Air Filter

This heater is supplied with an integral combustion air filter. This filter will reduce the amount of particulates passed through the combustion system and heat exchanger but will not protect against chemical inside air contamination (See **page 11**). The filter must be checked periodically to verify that adequate combustion air is being supplied to the heater. See "MAINTENANCE" on page 45 for information on checking the filter and establishing service intervals.

Indoor Units

The heater must be supplied with sufficient quantities of non-contaminated air to support proper combustion and equipment ventilation. Combustion air can be supplied via conventional means where combustion air is drawn from the area immediately surrounding the heater, or via duct, where combustion air is drawn directly from outside. All installations must comply with the requirements of the NFGC (U.S.) and B149 (Canada), and all local codes.

⚠ CAUTION: Combustion air must not be contaminated by corrosive chemical fumes which can damage the heater, causing damage which will not be covered under warranty (See "Contamination of Combustion Air" on page 11.)

Water Piping

General

The heater should be located so that any water leaks will not cause damage to the adjacent area or structures.

⚠ CAUTION: This heater requires forced water circulation when the burner is operating. See Table E and Table F for minimum and maximum flow rates and water pump selection. The pump must be interlocked with the heater to prevent heater operation without water circulation.

Reversing Water Connections

Follow these instructions to change the water connections from the left-hand side (standard) to the right-hand side. This is an ASME-Certified pressure vessel. It is the installer's responsibility to ensure that the pressure vessel is properly sealed after making these changes.

1. Disconnect all electrical power from the heater (if applicable).
2. Label all electrical connections and conduit lines. This may include the flow switch, low water cut-off probe and/or pump.
3. Disconnect or isolate the main gas pipe from the heater (if applicable).
4. Remove both in/out and return header access panels by removing all sheet metal screws.
5. Remove all plumbing fittings to the header. This will include both inlet and outlet water pipe unions and the pressure relief valve and drain piping.
6. Remove limits, control bulbs and/or sensors.
7. Remove the six flange nuts and the in/out header from the left-hand side.
8. Remove the six flange nuts and the return header from the right-hand side.
9. Remove the header stud bolts from each tube sheet.
10. Reverse the headers and stud bolts to the new location.

11. Install NEW red beveled O-rings flush against both tube sheets with the bevel facing outward.
12. Push the header firmly against the O-rings. Install and tighten the flange nuts onto the stud bolts until finger tight.
13. Slowly tighten the flange nuts, starting from the center nut (number 1) in **Figure 9** and working sequentially around the header as indicated. Torque all nuts to 25 ft/lb. DO NOT OVER-TIGHTEN.
14. Re-route the capillary(s), wiring, etc., to the new location, adding thermal paste and shim to the capillary well.

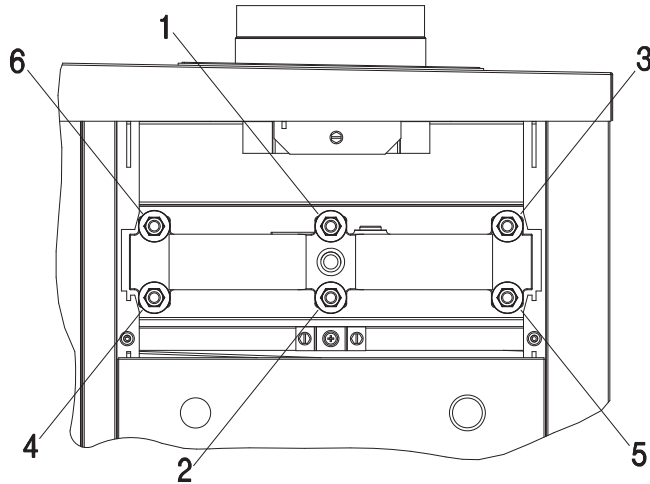


Figure 9. Torque Sequence

Relief Valve Piping

▲ WARNING: Pressure relief valve discharge piping must be piped near the floor and close to a drain to eliminate the potential of severe burns. Do not pipe to any area where freezing could occur. Refer to local codes.

Hydrostatic Test

Unlike many other types of heaters, Raypak heaters do not require hydrostatic testing prior to being placed in operation. The heat exchanger has already been factory-tested and is rated for 160 psi maximum operating pressure. However, Raypak does recommend hydrostatically testing the piping connections to the heater and the rest of the system prior to operation. This is particularly true for hydronic systems using expensive glycol-based antifreeze. Raypak recommends conducting the hydrostatic test before connecting gas piping or electrical supply.

Leaks must be repaired at once to prevent damage to the heater. NEVER use petroleum-based stop-leak compounds.

1. Connect fill water supply. Fill heater with water (be sure bleed valve is open). When water flows from bleed valve, shut off water. Close bleed valve. Carefully fill the rest of the system, being sure to eliminate any entrapped air by using high point vents. Close feed valve. Test at standard operating pressure for at least 24 hours.
2. Make sure constant gauge pressure has been maintained throughout test.
3. Check for leaks. Repair if found.

Low Temperature System

Heater requires minimum inlet temperature of 105°F (40.5°C). Consult the following sections for piping details.

Temperature & Pressure Gauge

The temperature and pressure gauge is shipped loose for field installation.

Hydronic Heating

System Design

Hot water heating systems all have unique levels of operating diversity. Raypak equipment design utilizes as little water mass as possible to ensure maximum operating efficiency. Primary / Secondary piping arrangement is the method recommended and the only method supported by Raypak for installation of Raypak heating equipment. Proper system design should always include system flow in excess of the connected boiler flow for proper operation (Boiler Flow + 15% = Min. System Flow). When appropriate, a Buffer/De-coupler Tank can be used where system flow may be reduced below the connected boiler flow. Failure to design for adequate system flow (i.e. bypasses, 3-way control valves, flow limiting balance devices, buffer tanks, etc.) will result in boiler short-cycling and poor system performance. Always contact your local Raypak representative for system design assistance to avoid these issues.

Pump Selection

In order to ensure proper performance of your boiler system, you must install a properly-sized pump. Raypak recommends using a 20°F (11°C) ΔT as design ΔT . (ΔT is the temperature difference between the inlet and outlet water when the heater is firing at full rate). If a ΔT other than 20°F (11°C) is necessary, see **Table E** for flow rate requirements.

Model No.	Input MBTUH	Output MBTUH	ΔT 10°F (5.5°C)		ΔT 20°F (11°C)		ΔT 30°F (17°C)		Min. Flow			Max. Flow		
			gpm (lpm)	ΔP (ft)	gpm (lpm)	ΔP (ft)	gpm (lpm)	ΔP (ft)	gpm (lpm)	ΔP (ft)	ΔT °F (°C)	gpm (lpm)	ΔP (ft)	ΔT °F (°C)
HD101	100	85	17 (64)	1.3					13 (49)	0.7	14 (8)	44 (167)	8.8	4 (2)
HD151	150	128	26 (98)	3.0	13 (49)	0.7			13 (49)	0.7	20 (11)	44 (167)	8.8	6 (3)
HD201	199	169	34 (129)	5.3	17 (64)	1.3			13 (49)	3.4	27 (15)	44 (167)	8.9	8 (4)
HD251	250	213	44 (167)	9.2	21 (79)	2.1	14 (53)	1.0	13 (49)	0.7	34 (19)	44 (167)	9.2	10 (5.5)
HD301	299	254			25 (95)	3.1	17 (64)	1.4	13 (49)	0.8	40 (22)	44 (167)	9.4	12 (7)
HD401	399	335			34 (129)	5.6	22 (83)	2.5	17 (64)	1.4	40 (22)	44 (167)	9.8	15 (8)

*Flow switch will not activate at less than 12 gpm (45 lpm).

NOTE: Basis for minimum flow — 13 gpm (49 lpm) or 40°F (22°C) ΔT maximum flow — gpm, except for header.

Table E. Flow and Pressure Drop, H Models

Pressure Drop in Feet of Head Feedwater Regulator

Raypak recommends that a feedwater regulator be installed and set at 12 psi minimum pressure at the highest point of system. Install a check valve or back flow device upstream of the regulator, with a manual shut off valve as required by local codes.

Piping—Heating Boilers

All high points should be vented. Purge valves and a bypass valve should be installed. A boiler installed above radiation level must be provided with a low water cut-off device. The boiler, when used in connection with a refrigeration system, must be installed so the chilled medium is piped in parallel with the boiler with appropriate valves to prevent the chilled medium from entering the boiler.

The boiler piping system of a hot water heating boiler connected to heating coils located in air handling units where they may be exposed to circulating refrigerated air, must be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle. It is highly recommended that the piping be insulated.

System flow must always exceed boiler flow for proper operation. Raypak strongly recommends a minimum system flow of 115% of the boiler flow.

Air-Separation/Expansion Tank

All boilers should be equipped with a properly sized expansion tank and air separator fitting as shown in the piping diagrams (Figure 10 through Figure 13).

Three-Way Valves

Valves designed to blend water temperatures or reduce water circulation through the boiler should not be used. Raypak boilers are high recovery low mass boilers not subject to thermal shock. Raypak offers a full line of electric sequencers that produce direct reset of boiler water temperature. Refer to the Controls Section in our Complete Catalog.

Domestic Hot Water Piping

When designing the water piping system for domestic water applications, water hardness should be considered. Table F indicates the suggested flow rates for soft, medium and hard water. Hardness is specified as grains per gallon.

PIPE SIZES		
HI DELTA	UNIT	MAIN
HD101–HD401	1–1/2"	2"
302–902	2"	3"
992–2342	2–1/2"	4"

- NOTES:
1. PLUMB SWING CHECK VALVE IN GRAVITY-CLOSED POSITION.
 2. PIPE ALL RELIEF VALVES TO DRAIN, OR AS LOCAL CODES REQUIRE.
 3. MINIMUM FLOW IN MAIN LINE MUST EXCEED FLOW THROUGH BOILER.
 4. PROVIDE FOR THERMAL EXPANSION OF HOT WATER IF A BACKFLOW PREVENTER, CHECK VALVE, WATER METER OR PRESSURE-REDUCING VALVE IS INSTALLED IN THE COLD WATER LINE.
 5. SEE CHART "PIPE SIZES" FOR PIPE SIZES, CALCULATED AT MAXIMUM FLOW, NOT TO EXCEED 7.5 FT/SEC.

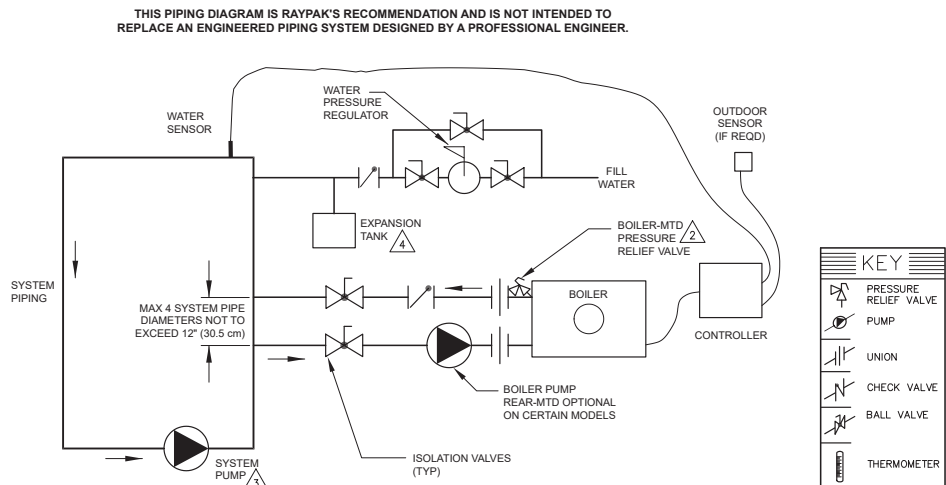


Figure 10. Single Boiler — Primary/Secondary Piping

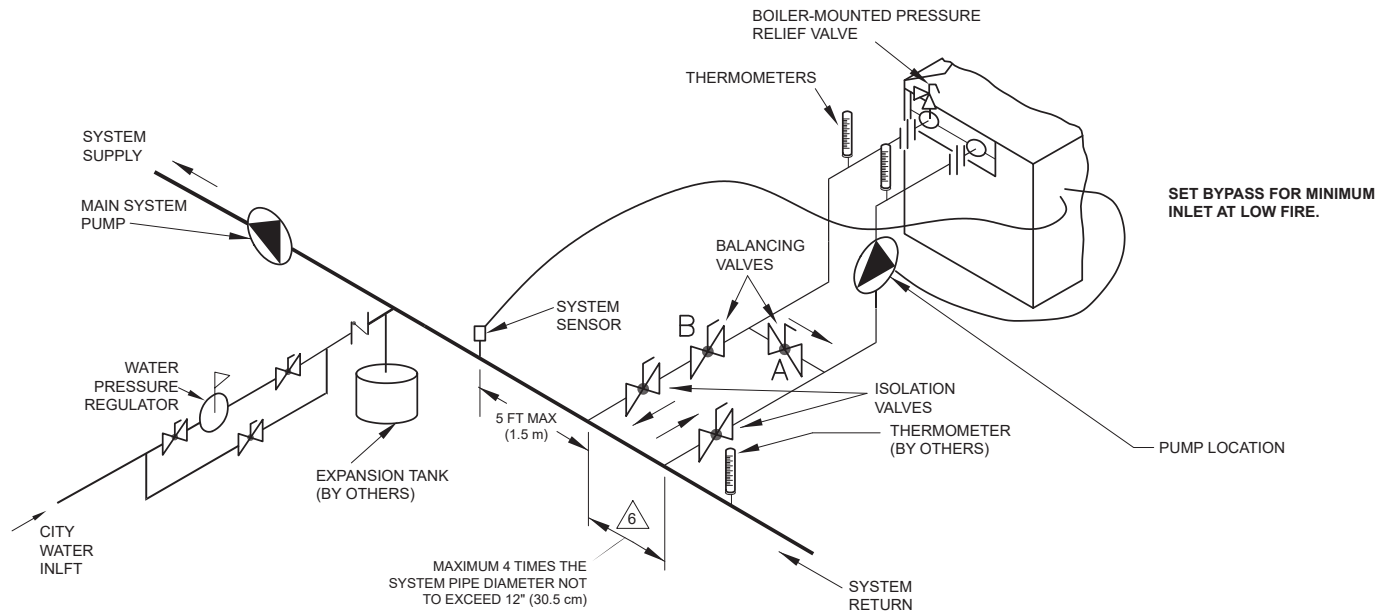


Figure 11. Single Boiler — Low-Temperature Application (Heat Pump) Primary/Secondary Piping

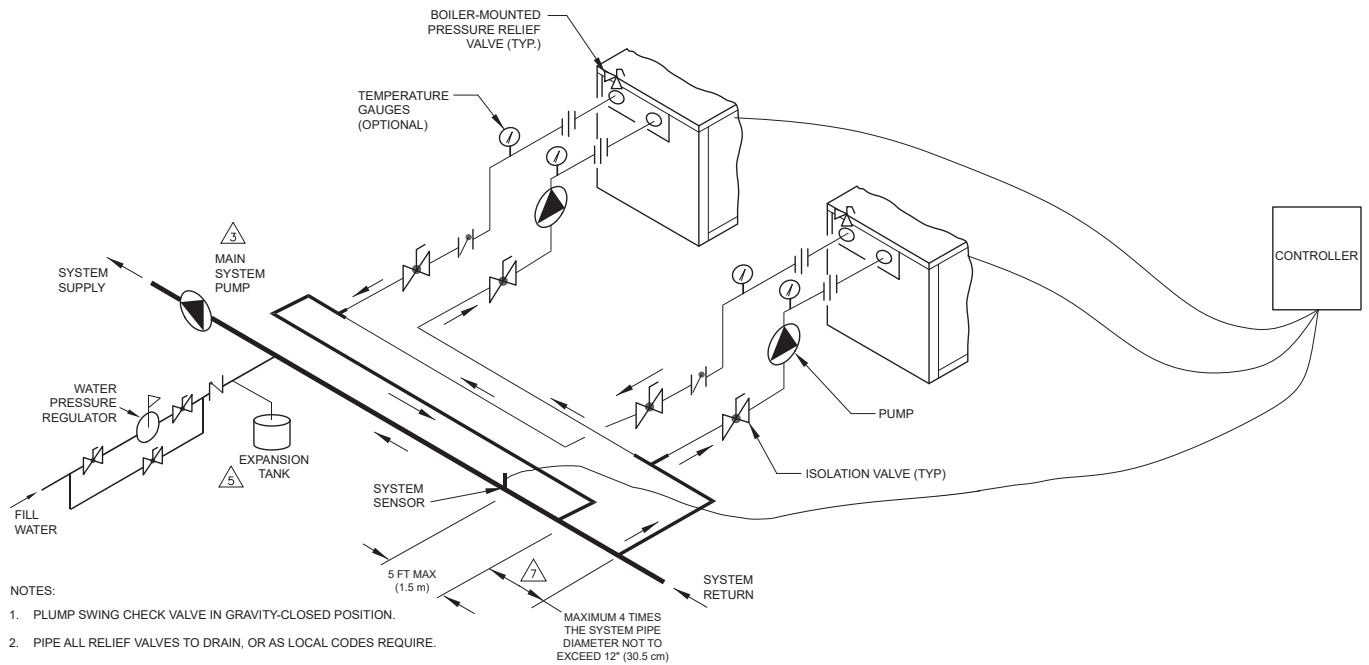
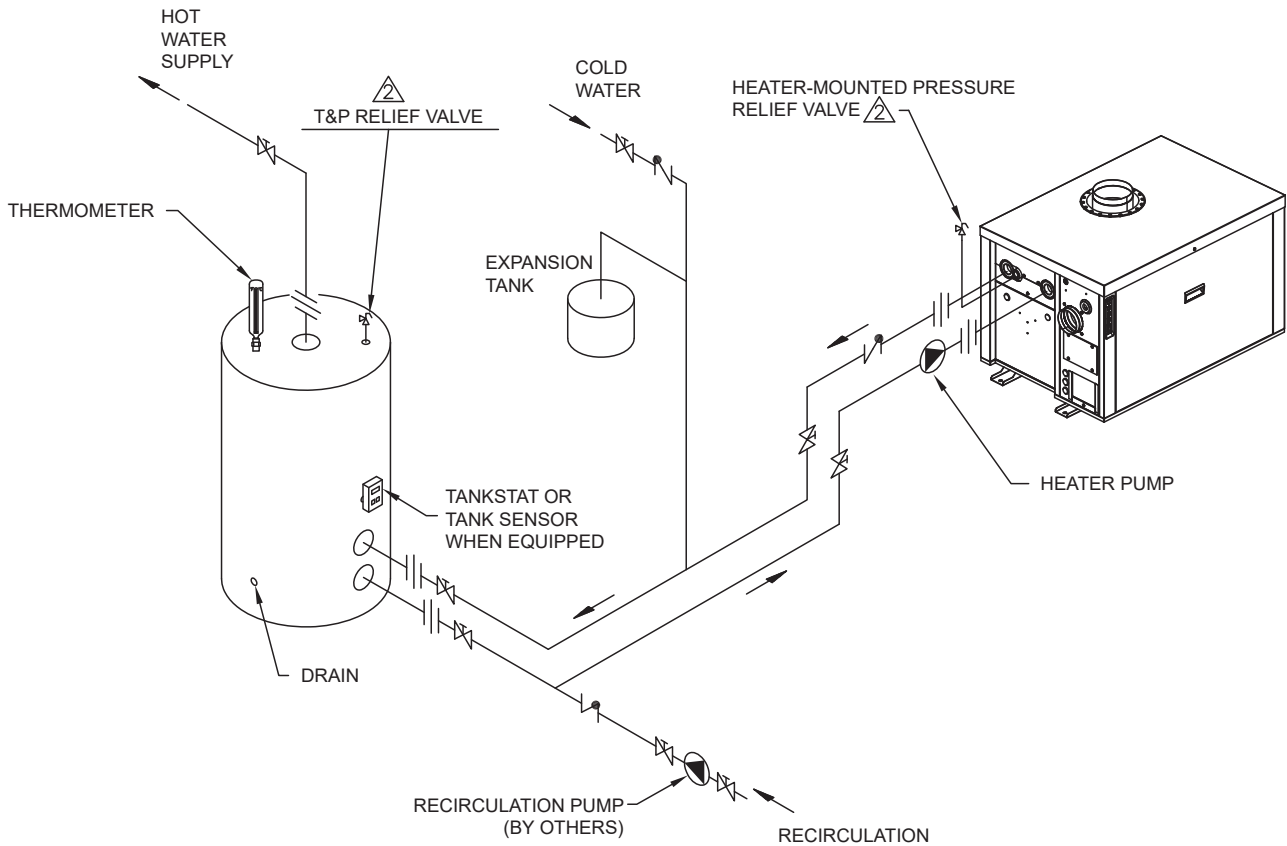


Figure 12. Dual Boiler—Primary/Secondary Piping



NOTES:


1. PLUMP SWING CHECK VALVE IN GRAVITY-CLOSED POSITION.
-  PIPE ALL RELIEF VALVES TO DRAIN, OR AS LOCAL CODES REQUIRE.

Figure 13. Single Heater — Domestic Hot Water with One Storage Tank

Model No.	Input MBTUH	Output MBTUH	Soft (0–4 grains per gallon)				Medium (5–15 grains per gallon)				Hard (16–25* grains per gallon)						
			ΔT °F (°C)	gpm (lpm)	ΔP	MTS	SHL	ΔT °F (°C)	gpm (lpm)	ΔP	MTS	SHL	ΔT °F (°C)	gpm (lpm)	ΔP	MTS	SHL
HD101	100	85	9 (5)	20 (76)	1.8	1-1/2	3.8	7 (4)	26 (98)	3.0	1-1/2	6.3	4 (2)	45 (170)	9.2	1-1/2	18.0
HD151	150	128	13 (7)		1.8		3.8	10 (5.5)		3.1		6.3	6 (3)		9.2		18.1
HD201	199	169	17 (9)		1.9		3.9	13 (7)		3.2		6.4	8 (4)		9.4		18.2
HD251	250	213	21 (12)		1.9		3.9	16 (9)		3.2		6.5	9 (5)		9.6		18.5
HD301	299	254	25 (14)		1.9		3.9	20 (11)		3.2		6.5	11 (6)		9.8		18.7
HD401	399	339	34 (19)		2.0		4.0	26 (14)		3.3		6.6	15 (8)		10.3		19.1

ΔT = Temperature rise, °F (°C).

ΔP = Pressure drop through heat exchanger, ft.

SHL = System head loss, ft. (System head loss is based on the heater and tank placed no more than 5 feet apart and 50 feet equivalent length of tubing and fittings.)

gpm = Gallons per minute, flow rate.

MTS = Minimum tubing size.

*With Hard Water (16-25 grains per gallon), the operating control must be set no higher than 130°F (54°C) for scale-free operation. For operating temperatures above 130°F (54°C), a water softener must be utilized.

Table F. Flow Requirements, WH Models

Gas Supply

⚠ DANGER: Make sure the gas on which the heater will operate is the same type as specified on the heater's rating plate.

Gas piping must have a sediment trap ahead of the heater gas controls, and a manual shutoff valve located outside the heater jacket. A pounds-to-inches regulator must be installed to reduce the natural gas supply pressure to under 10.5 in. WC (13.0 in. WC for propane gas). The regulator should be placed a minimum distance of 10 times the pipe diameter upstream of the heater gas controls. All gas piping must be tested after installation in accordance with local codes. The heater and its gas connection must be leak-tested before placing it in operation.

Gas Supply Connection

⚠ CAUTION: The heater and its manual shutoff valve must be disconnected from the gas supply during any pressure testing of the gas supply system at test pressures in excess of 1/2 psi (3.45 kPa). The heater must be isolated from the gas supply piping system by closing the manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or greater than 1/2 psi. Relieve test pressure in the gas supply line before reconnecting the heater and its manual shutoff valve to the gas supply line. **FAILURE TO FOLLOW THIS PROCEDURE MAY DAMAGE THE GAS VALVES.** Over-pressurized gas valves are not covered by warranty. The heater and its gas connections shall be leak tested before placing the appliance in operation. Use soapy water for leak test: **DO NOT** use open flame.

⚠ CAUTION: Do not use Teflon tape on gas line pipe thread. A pipe compound rated for use with gas systems is recommended. Apply sparingly only on male pipe ends.

⚠ CAUTION: Support gas supply piping with hangers, not by the heater or its accessories. Ensure the gas piping is protected from physical damage and freezing where required.

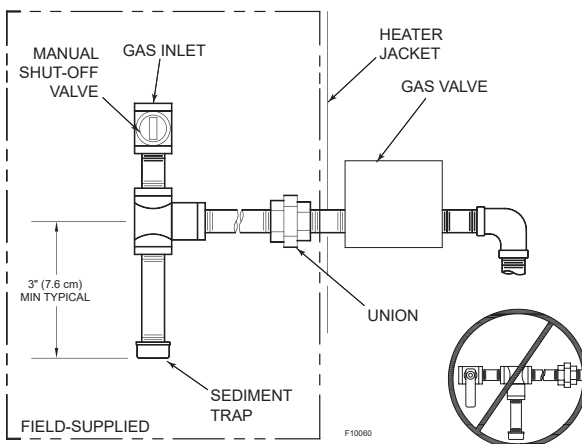


Figure 14. Sediment Trap Orientation

Gas Supply Pressure

A minimum of 4 in. WC and a maximum of 10.5 in. WC upstream gas pressure is required under load and no load conditions for natural gas. A minimum of 11 in. WC and a maximum of 13 in. WC is required for propane gas. The gas pressure regulator supplied on the heater is for low pressure service. If upstream pressure exceeds 14 in. WC, an intermediate gas pressure regulator, of the lockup type, must be installed.

When connecting additional gas utilization equipment to the gas piping system, the existing piping must be checked to determine if it has adequate capacity.

Firing Stage	Gas Valve	Gas Type	
		Natural	LP/Propane
Hi-Fire +/- 0.2"WC	Invensys	3.4" WC	
	Honeywell or White-Rodgers	3.1" WC	9.6" WC
Lo-Fire +/- 0.1"WC	Invensys	1.1" WC	
	Honeywell or White-Rodgers	1.2" WC	3.6" WC

Table G. Pressure at Gas Valve Outlet Tap

Gas Pressure Regulator

The gas valve pressure regulator(s) on the heater are nominally preset at 3 in. WC for natural gas, and 10.0 in. WC for propane gas manifold pressure. The pressure at the gas valve outlet tap, measured with a manometer, while in operation should be as indicated in **Table G**. If an adjustment is needed, turn the adjustment screw clockwise to increase pressure or counter-clockwise to decrease pressure.

Gas Regulator Best Practices

From the gas pressure regulator it is recommended to have no less than 10 pipe diameters of straight smooth pipe downstream of the regulator discharge and to have no less than 10 linear feet (not including fittings) between the regulator and the inlet to the appliance for proper operation.

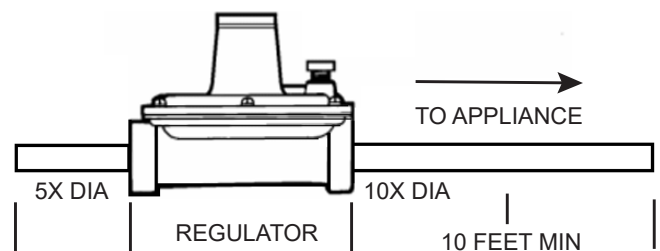


Figure 15. Gas Regulator Distances

Model No.	Maximum Equivalent Length (ft/m)								
	Input (MBTUH)	3/4"		1"		1-1/4"		1-1/2"	
		NAT	PRO	NAT	PRO	NAT	PRO	NAT	PRO
HD101	100	105 (32.0)	385 (117.3)	340 (103.6)					
HD151	150	50 (15.2)	180 (54.9)	160 (48.8)	530 (161.5)	600 (182.9)			
HD201	199	30 (9.1)	95 (29.0)	95 (29.0)	355 (108.2)	360 (109.7)			
HD251	250	20 (6.1)	50 (15.2)	60 (18.3)	230 (70.1)	240 (73.2)			
HD301	299	15 (4.6)	35 (10.7)	45 (13.7)	170 (51.8)	170 (51.8)	550 (167.6)	360 (109.7)	
HD401	399	5 (1.5)	20 (6.1)	25 (7.6)	80 (24.4)	100 (30.5)	365 (111.3)	210 (64.0)	

Natural gas – 1,000 BTUH per ft³, .60 specific gravity at 0.5 in. WC pressure drop

Propane gas – 2,500 BTUH per ft³, 1.50 specific gravity at 0.5 in. WC pressure drop

Elbow = 10 ft effective length

Table H. Gas Supply Piping

Electrical Power Connections

Installations must follow these codes:

- National Electrical Code and any other national, state, provincial or local codes or regulations having jurisdiction
- Safety wiring must be N.E.C. Class 1
- Heater must be electrically grounded as required by N.E.C.
- In Canada, C22.1

The heater is wired for 120 VAC, less than 12 AMPS. The voltage is indicated on the tie-in leads. Consult the wiring diagram shipped with the heater in the instruction packet. The remote tank control stat, thermostat, or electronic heater control as applicable, may be connected to stage selector terminal (see wiring diagram). 24 Volts are supplied to this connection through the heater transformer. DO NOT attach line voltage to the stage connections. Before starting the heater check to ensure proper voltage to the heater and pump.

Install a separate disconnect means for each load.

⚠ WARNING: Connecting line voltage to the stage connection terminal block will cause damage to the unit that is not covered by warranty.

Use appropriate-sized wire as defined by NEC, CSA and/or local code. All primary wiring should be 125% of minimum rating.

It is strongly recommended that all individually-powered control modules and the heater should be supplied from the same power source.

Surge Protection

Microprocessor-based and solid state controls are vulnerable to damage from voltage and amperage fluctuations in the power supply. All sensitive control components should be protected by a suitable commercial-grade surge protection device.

If any of the original wire as supplied with the heater must be replaced, it must be replaced with 105°C wire or its equivalent.

Check the Power Source

⚠ WARNING: Using a volt-ohm meter (VOM), check the following voltages at the terminal block inside the unit. Make sure proper polarity is followed and house ground is proven.

AC = 108 Volts AC Minimum, 132 Volts AC MAX

AB = 108 Volts AC Minimum, 132 Volts AC MAX

BC = < 1 Volt AC

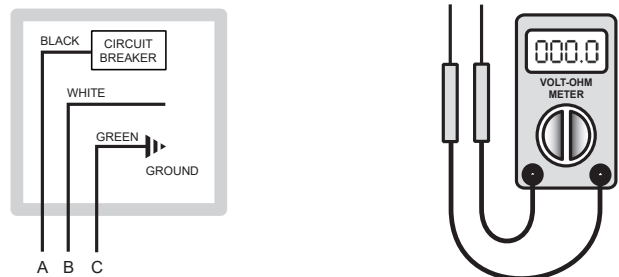


Figure 16. Check Power Source

Making the Electrical Connections

Refer to **Figure 16** and the Wiring Diagram.

1. Verify circuit breaker is properly sized by referring to heater rating plate. A dedicated circuit breaker should be provided.
2. Turn off all power to the heater. Verify that power has been turned off by testing with a volt-ohm meter prior to working with any electrical connections or components.
3. Observe proper wire colors while making electrical connections. Many electronic controls are polarity sensitive. Components damaged by improper electrical installation are not covered by warranty.

- Provide an external surge suppressor capable of maintaining system integrity.
- Provide overload protection and a disconnect means for equipment serviceability as required by local and state code.
- Install heater controls, thermostats, or building management systems in accordance with the applicable manufacturer's instructions.
- Conduit should not be used as the ground. There must be a solidly wired ground.

NOTE: A grounding electrode conductor shall be used to connect the equipment grounding conductors, the equipment enclosures, and the grounded service conductor to the grounding electrode.

Electrical Connections — Domestic Hot Water

⚠ DANGER—SHOCK HAZARD: Make sure electrical power to the heater is disconnected to avoid potential serious injury or damage to components.

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

NOTE: Minimum 18 AWG, 105°C, stranded wire must be used for all low voltage (less than 30 volts) external connections to the unit. Solid conductors should not be used because they can cause excessive tension on contact points. Install conduit as appropriate. All high voltage wires must be the same size (105°C, stranded wire) as the ones on the unit or larger.

Installer action is required to electrically enable your Hi Delta heater to operate after making the power connections. You must use Terminal Block connections 1 through 4 for the temperature controller, as shown in **Figure 17**. This will be done based on the controller option selected with your heater order.

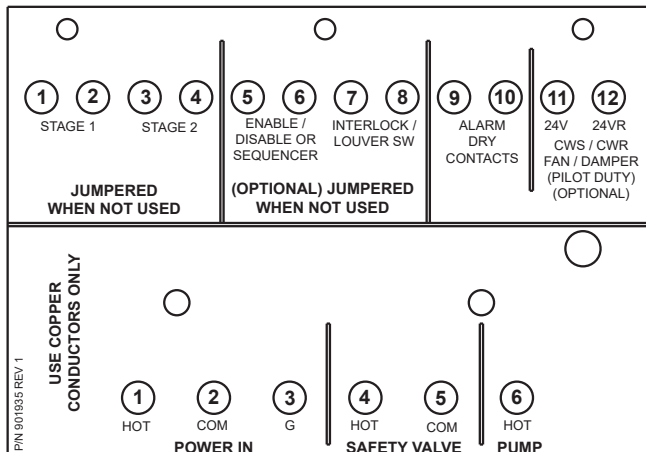
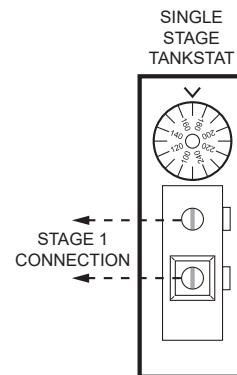


Figure 17. Terminal Block Connections

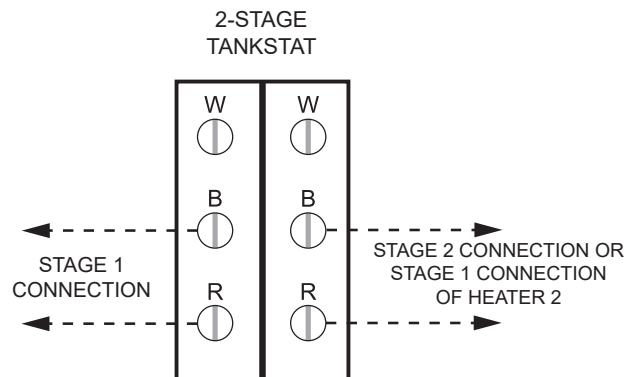
For operation with a Temp-Tracker controller, refer to the Temp-Tracker Installation and Operating Instructions, Raypak P/N 241177.

Consult the wiring diagram shipped with the heater in the instruction packet. The Stage 1 connections are for the remote tank control through the heaters 24 volt transformer. **DO NOT attach line voltage to the Stage 1 connection.** Before starting heater, check to ensure proper voltage to heater and pump.



ATTACH STAGE 1 CONNECTIONS ON HEATER TO THE SINGLE STAGE TANKSTAT AS SHOWN IN THE DIAGRAM ABOVE.

Figure 18. Single Stage Tankstat



ATTACH STAGE 1 CONNECTIONS ON HEATER TO STAGE 1 CONNECTION ON TANKSTAT. ATTACH STAGE 2 CONNECTIONS OR STAGE 1 CONNECTION OF HEATER 2 TO STAGE 2 CONNECTION ON TANKSTAT AS SHOWN IN THE DIAGRAM.

Figure 19. 2-Stage Tankstat

Heater must be electrically grounded in accordance with NEC and C22.1(in Canada).

NOTES:

- Field installed ground to inside of junction box.
- If any of the original wire as supplied with the heater must be replaced, it must be replaced with 105°C wire or its equivalent.

Venting

General

⚠ CAUTION: Proper installation of flue venting is critical for the safe and efficient operation of the heater.

Definition of Appliance Categories

Heaters are divided into four categories based on the pressure produced in the exhaust and the likelihood of condensate production in the vent.

Category I. A heater which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Category II. A heater which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

Category III. A heater which operates with a positive vent pressure and with a vent gas temperature that avoids excessive condensate production in the vent.

Category IV. A heater which operates with a positive vent pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

See **Table I** for appliance category requirements for the Hi Delta.

NOTE: For additional information on appliance categorization, see appropriate ANSI Z21 Standard and the NFGC (U.S.), or B149 (Canada), or applicable provisions of local building codes.

Determination of Appliance Category for Venting Purposes and Venting Arrangements

⚠ WARNING: Contact the manufacturer of the vent material if there is any question about the appliance categorization and suitability of a vent material for application on a Category III or IV vent system. Using improper venting materials can result in personal injury, death or property damage.

Barometric Damper

A barometric damper may be required when vent heights exceed 25 ft (7.6 m) or when the draft is greater than -0.08 in. WC. In these installations, a barometric damper (single-acting) is required.

The damper should be installed 5 ft (1.5 m) higher than the discharge of the unit and no closer than 18 in. (45.7 cm) from a combustible ceiling. The damper can be installed in horizontal or vertical runs of vent pipe as necessary. Installation in a bull-head tee is acceptable as shown in the NFGC.

The weights on the damper should be adjusted per the damper manufacturer's instructions for proper operation, to maintain -0.01 to -0.08 in. WC, 12 in. (30.5 cm) from the heater outlet, at all firing conditions.

Support of Vent Stack

The weight of the vent stack or chimney must not rest on the heater vent connection. Support must be provided in compliance with applicable codes. The vent should also be supported to maintain proper clearances from combustible materials.

Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

Combustion Air Supply	Exhaust Configuration	Venting Category	Certified Appliance Material	Combustion Air Inlet Material
From Inside Building (Non-Direct Venting)	Vertical Natural Draft Venting	I Fan-Assisted	Type B or any Category I Venting System*	
	Horizontal Thru-wall Venting	III	Stainless Steel (Gas Tight)	
From Outside Building (Direct Venting)	Vertical Venting	I Fan-Assisted	Type B or any Category I Venting System*	Galvanized Steel PVC ABS CPVC
	Horizontal Thru-wall Venting	III	Stainless Steel (Gas Tight)	

*As defined in the latest edition of the NFGC, or in Canada, the B149.

Table I. Venting Category Requirements

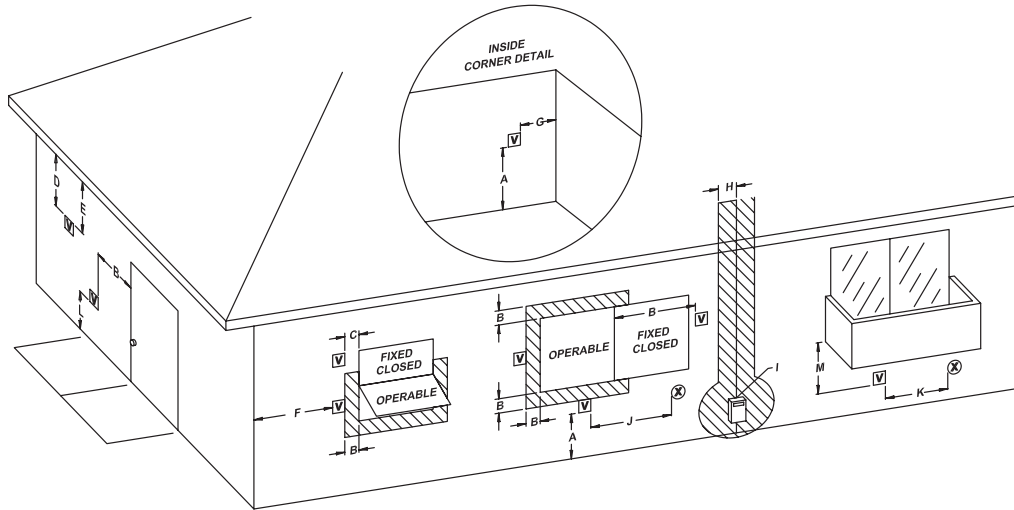


Figure 20. Minimum Clearances from Vent/Air Inlet Terminations – Indoor and Outdoor Installations

		U.S. Installations¹	Canadian Installations²
A	Clearance above grade, veranda, porch, deck, or balcony	1 ft (30 cm)	1 ft (30 cm)
B	Clearance to window or door that may be opened	4 ft (1.2m) below or to side of opening; 1 foot (30 cm) above opening	3 ft (91 cm)
C	Clearance to permanently closed window	*	*
D	Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 ft (61cm) from the centerline of the terminal	5 ft (1.5m)	*
E	Clearance to unventilated soffit	*	*
F	Clearance to outside corner	*	*
G	Clearance to inside corner	6 ft (1.83m)	*
H	Clearance to each side of center line extended above meter/regulator assembly	*	3 ft (91 cm) within a height 15 ft above the meter/regulator assembly
I	Clearance to service regulator vent outlet	*	6 ft (1.83m)
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	4 ft (1.2m) below or to side of opening; 1 ft (30 cm) above opening	3 ft (91 cm)
K	Clearance to mechanical air supply inlet	3 ft (91 cm) above if within 10 ft (3m) horizontally	6 ft (1.83m)
L	Clearance above paved sidewalk or paved driveway located on public property	7 ft (2.13m)	7 ft (2.13m) ³
M	Clearance under veranda, porch, deck or balcony	*	12 in. (30 cm) ⁴

¹ In accordance with the current ANSI Z223.1/NFPA 54 National Fuel Gas Code

² In accordance with the current CAN/CSA-B149 Installation Codes

³ Vent terminal shall not terminate directly above sidewalk or paved driveway located between 2 single family dwellings that serves both dwellings

⁴ Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor and top of terminal and underside of veranda, porch, deck or balcony is greater than 1 ft (30cm)

* Clearances in accordance with local installation codes and the requirements of the gas supplier

Table J. Vent/Air Inlet Termination Clearances

Vent Terminal Location

NOTE: During winter months check the vent cap and make sure no blockage occurs from build up of snow.

1. Condensate can freeze on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition.
2. Give special attention to the location of the vent termination to avoid possibility of property damage or personal injury.
3. Gases may form a white vapor plume in winter. The plume could obstruct a window view if the termination is installed in close proximity to windows.
4. Prevailing winds, in combination with below freezing temperatures, can cause freezing of condensate and water/ice build-up on buildings, plants or roofs.
5. The bottom of the vent terminal and the air intake shall be located at least 12 in. (30.5 cm) above grade, including normal snow line.
6. Un-insulated single-wall metal vent pipe shall not be used outdoors on cold climates for venting gas utilization equipment.
7. Through-the-wall vents for Category II and IV appliances and non-categorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and III appliances, this provision shall also apply.
8. Locate and guard vent termination to prevent accidental contact by people or pets.
9. DO NOT terminate vent in window well, stairwell, alcove, courtyard or other recessed area.
10. DO NOT terminate above any door, window, or gravity air intake. Condensate can freeze, causing ice formations.
11. Locate or guard vent to prevent condensate from damaging exterior finishes. Use a rust resistant sheet metal backing plate against brick or masonry surfaces.
12. DO NOT extend exposed vent pipe outside of building. Condensate could freeze and block vent pipe.

US Installations

Refer to latest edition of the National Fuel Gas Code.

Vent termination requirements are as follows:

- a. Vent must terminate at least 4 ft (1.2 m) below, 4 ft (1.2 m) horizontally, or 1ft (30.5 cm) above any door, window or gravity air inlet to the building.

- b. The vent must not be less than 7 ft (2.1 m) above grade when located adjacent to public walkways.
- c. Terminate vent at least 3 ft (0.9 m) above any forced air inlet located within 10 ft (3.0 m).
- d. Vent must terminate at least 4 ft (1.2 m) horizontally, and in no case above or below unless 4 ft (1.2 m) horizontal distance is maintained, from electric meters, gas meters, regulators, and relief equipment.
- e. Terminate vent at least 6 ft (1.8 m) away from adjacent walls.
- f. DO NOT terminate vent closer than 3 ft (1 m) below roof overhang.
- g. The vent terminal of a direct vent appliance with an input over 50,000 BTUH per hour shall require a 12 in. (30.5 cm) vent terminal clearance.
- h. Terminate vent at least 1 ft (30.5 cm) above grade, including normal snow line.
- i. Multiple direct vent installations require a 4 ft (1.2 m) clearance between vent caps.

Installations in Canada

Refer to latest edition of CAN/CGA-B149.

A vent shall not terminate:

- a. Directly above a paved sidewalk or driveway which is located between two single family dwellings and serves both dwellings.
- b. Less than 7 ft (2.1 m) above a paved sidewalk or paved driveway located on public property.
- c. Within 6 ft (1.8 m) of a mechanical air supply inlet to any building.
- d. Above a meter/regulator assembly within 3 ft (91.4 cm) horizontally of the vertical center-line of the regulator.
- e. Within 6 ft (1.8 m) of any gas service regulator vent outlet.
- f. Less than 1 ft (30.5 cm) above grade level.
- g. Within 3 ft (91.4 cm) of a window or door which can be opened in any building, any non-mechanical air supply inlet to any building or the combustion air inlet of any other appliance.
- h. Underneath a veranda, porch or deck, unless
 - i. the veranda, porch or deck is fully open on a minimum of two sides beneath the floor, and
 - ii. the distance between the top of the vent termination and the underside of the veranda, porch or deck is greater than 1 ft. (30.5 cm).

Venting Installation Tips

Support piping:

- horizontal runs- at least every 5 ft (1.5 m).
- vertical runs - use braces:
- under or near elbows

Follow items listed below to avoid personal injury or property damage.

- Cut nonmetallic intake pipe with fine-toothed hacksaw.
- Do not use nonmetallic intake pipe or fittings that are cracked or damaged.
- Do not use nonmetallic intake fittings if they are cut or altered.
- Do not drill holes, or use screws or rivets, in nonmetallic intake pipe or fittings.

To make metallic vent joints:

- Do not install seams of vent pipe on bottom of runs.
- 100% Seal all joints and seams with high temperature silicone sealant.

⚠ WARNING: Examine the venting system at least once a year. Check all joints and vent pipe connections for tightness, corrosion or deterioration.

NOTE: The words "Flue Exhaust", "Flue" and "Exhaust Vent" are used interchangeably.

Venting Configurations

For heaters connected to gas vents or chimneys, vent installations shall be in accordance with the section on, Venting of Equipment, of the latest edition of NFGC, or in Canada, B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

Natural Draft Vertical Venting System Installation

Natural draft venting uses the natural buoyancy of the heated flue products to create a thermal driving head that expels the exhaust gases from the flue. The negative draft must be within the range of -0.01 in. to -0.08 in. WC as measured 12 in. (30.5 cm) from the appliance flue outlet to ensure proper operation. Vent material must be listed by a nationally recognized test agency.

The maximum and minimum venting length for Category I appliance shall be determined per the latest edition of the NFGC (U.S.) or B149 Installation Code (Canada). Use the "FAN" column of the standard venting tables.

The diameter of vent flue pipe should be sized according to Part 11 of the latest edition of the NFGC (U.S.) and part 7 and appendix B of the B149 Installation

Code (Canada). The minimum flue pipe diameter for conventional negative draft venting using double-wall B type vent is 4" for HD101 and HD151, 5" for HD201, HD251 and HD301, and 6" for HD401.

NOTE: Use a field-supplied single-wall to double-wall adapter to connect B-vent to the unit.

The connection from the appliance vent to the stack must be as direct as possible and shall be the same diameter as, or larger than the vent outlet. The horizontal breaching of a vent must have an upward slope of not less than 1/4 inch per linear foot from the heater to the vent terminal. The horizontal portions of the vent shall also be supported for the design and weight of the material employed to maintain clearances and to prevent physical damage or separation of joints.

NOTE: When an existing category I appliance is removed or replaced, the original venting system may no longer be sized to properly. Improperly sized venting system can cause formation of condensate, leakage and spillage, etc.

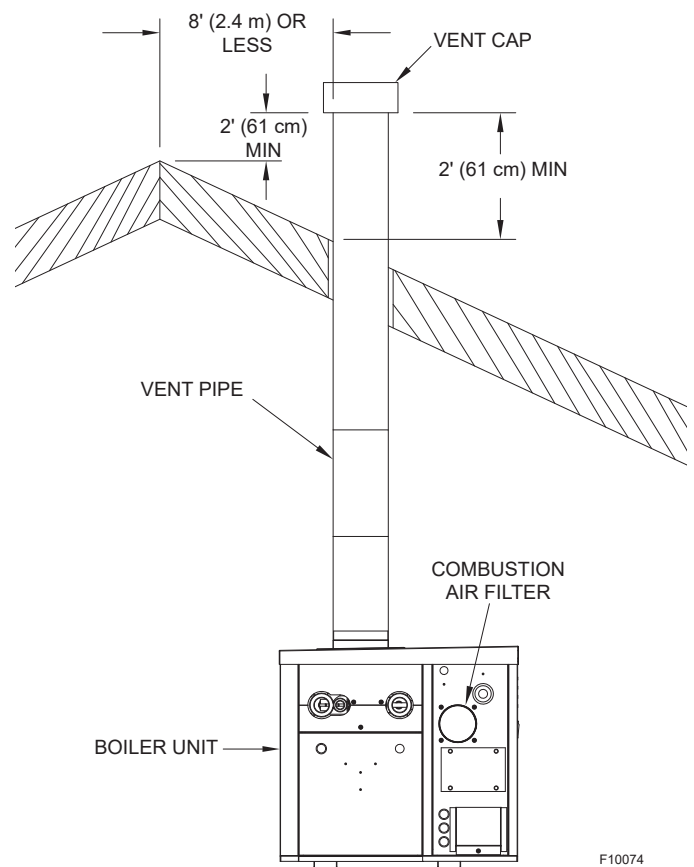


Figure 21. Natural Draft Vertical Venting (Category I)

Natural Draft Vertical Vent Termination

The vent terminal should be vertical and should terminate outside the building at least 2 ft (61 cm) above the highest point of the roof that is within 10 ft (3.0 m). The vent cap

should have a minimum clearance of 4 ft (1.2) horizontally from and in no case above or below (unless a 4 ft (1.2 m) horizontal distance is maintained) electric meters, gas meters, regulators and relief equipment. The distance of the vent terminal from adjacent public walkways, adjacent buildings, open windows and building openings must be consistent with the NFGC, or in Canada, the B149 Installation Code for Gas Burning Appliances and Equipment. Gas vents supported only by flashing and extended above the roof more than five feet should be securely guyed or braced to withstand snow and wind loads.

▲ CAUTION: Listed vent cap terminal must be used and sized adequately to evacuate the flue products from the heaters.

Natural Draft Vertical Venting with Common Venting System, Category I Appliance Only

Manifolds that connect more than one heater to a common chimney must be sized to handle the combined load. Consult available guides for proper sizing of the manifold and the chimney. At no time should the area of the vent be less than the area of the largest heater exhaust outlet.

▲ WARNING: Vent connectors serving appliances vented by natural draft shall not be connected into any portion of mechanical draft systems operating under a positive pressure.

▲ CAUTION: Vent connectors for natural draft venting systems must be type “B” vent or better.

Common venting systems may be too large when an existing unit is removed. At the time of removal of an existing appliance, the following steps must be followed with each appliance remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common venting system are not in operation.

- a. Seal any unused opening in the common venting system.
- b. Visually inspect the venting system for proper size and horizontal pitch and determine there is

no blockage or restriction, leakage, corrosion or other unsafe condition.

- c. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliances remaining connected to the common venting system are located and other spaces of the building. Turn on clothes dryers and any appliance not connected to the common vent system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate summer exhaust fan. Close fireplace dampers.
- d. Place in operation the appliances being inspected. Follow the manufacturers instructions for lighting each appliance. Adjust thermostat so appliance will operate continuously.
- e. Check the pressure at a pressure tap located 12 in. (30.5 cm) above the bottom joint of the first vertical vent pipe. Pressure should be anywhere between -.01 to -.08 in. WC.
- f. After it has been determined that each appliance remaining connected to the common venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and other gas burning appliances to their previous conditions of use.
- g. Any improper operation of the common venting system should be corrected so that the installation conforms with the latest edition of the NFGC (US) and the B149 Installation Code (Canada). When re-sizing any portion of the common venting system, the common venting system should be re-sized to approach the minimum size as determined using the appropriate tables in Appendix G in the NFGC (US) and Appendix B of the B149 Installation Code (Canada).

Horizontal Thru-wall Venting System (Category III) Installation

These installations utilize the heater-mounted blower to vent the combustion products to the outdoors. Combustion air is

Model No.	Appliance Category	Certified Venting Material	Minimum Recommended Vent Size in. (cm)	Min./Max. Venting Length without Barometric Damper (ft / m)**		Air Inlet Max. Length (feet)
				Min.	Max.	
HD101	I Fan-assisted	Type B or Equivalent	4 (10.1)	6 (1.8)	25 (7.6)	100 (30.5)
HD151						
HD201			5 (12.7)	6 (1.8 m)		
HD251						
HD301			6 (15.2)	11 (3.4)		
HD401				8 (2.4)		

**Vent lengths are based on a lateral length of 2 feet (61 cm). Refer to the latest edition of the NFGC for further details. (ANSI Z223.1) Maximum 4 elbows.

Table K. Natural Draft Vertical Venting

taken from the space and the vent is installed horizontally through the wall to the outdoors. Adequate combustion and ventilation air must be supplied in accordance with the NFGC or, in Canada, the B149 Installation Code.

The total length of the horizontal thru-wall exhaust vent system should not exceed 100 ft (30.5 m) in length. If horizontal run exceeds 100 ft (30.5 m), an appropriately sized extractor must be used. Each elbow used is equal to 10 ft (3.0 m) of straight pipe. This will allow installation in one of the four following combinations.

- 100' (30.5 m) of straight flue pipe.
- 90' (27.4 m) of straight flue pipe and one elbow.
- 80' (24.4 m) of straight flue pipe and two elbows.
- 70' (21.3 m) of straight pipe and three elbows.
- 60' (18.3 m) of straight pipe and four elbows.

The vent cap is not considered in the overall length of the venting system. The vent must be installed to prevent the flue gas leakage. Care must be taken during assembly to ensure that all joints are sealed properly and are airtight.

The horizontal portions of the vent shall also be supported

for the design and weight of the material employed to maintain clearances and to prevent physical damage or separation of joints. They shall also be adequately supported to prevent sagging.

The vent must be installed to prevent the potential accumulation of condensate in the vent pipes. It is recommended that:

- a. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the vent terminal.
- b. The vent be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

- a. The vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In this case, an approved condensate trap must be installed per applicable codes.
- b. The vent be insulated through the length of the horizontal run.

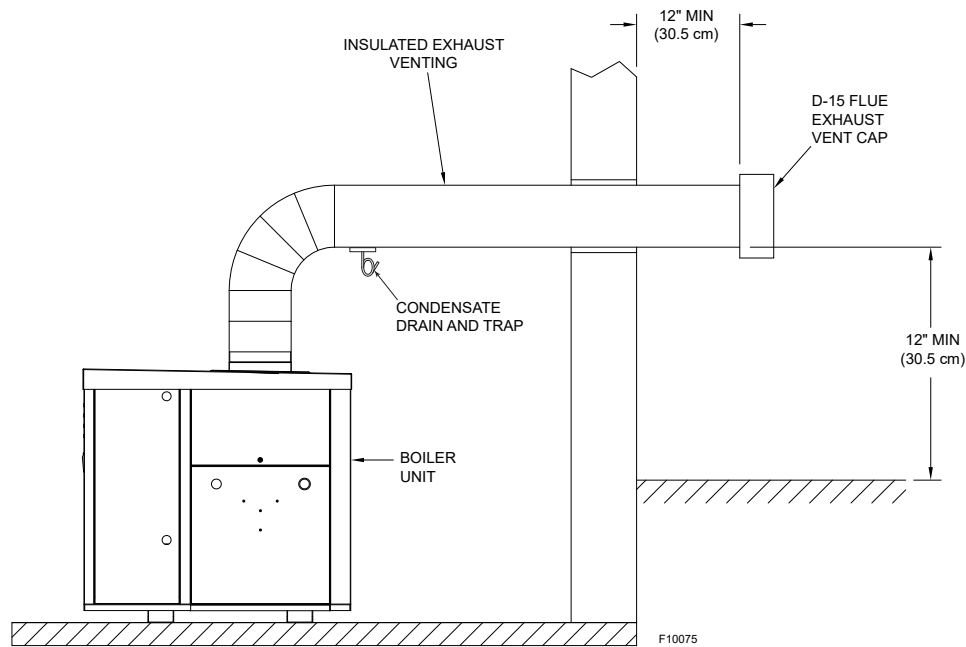


Figure 22. Horizontal Thru-Wall Venting (Category III)

Model No.	Appliance Category	Certified Venting Material	Vent Size Size in. (cm)	Max. Venting Length ft (m)
HD101 HD151	III	Stainless Steel (Gas Tight)	4 (10.1)	100 (30.5)
HD201 HD251 HD301			5 (12.7)	
HD401			6 (15.2)	

Maximum 4 elbows.

Table L. Horizontal Thru-Wall Venting (Category III)

Horizontal Thru-wall Direct Vent Termination

The flue exhaust direct vent cap **MUST** be mounted on the exterior of the building. The direct vent cap cannot be installed in a well or below grade. The direct vent cap must be installed at least 1 ft (30.5 cm) above ground level and above normal snow levels.

Multiple direct vent caps **MUST NOT** be installed with one combustion air inlet directly above a direct vent cap. This vertical spacing would allow the flue products from the direct vent cap to be pulled into the combustion air intake installed above. This type of installation can cause non-warrantable problems with components and poor operation of the unit due to the recirculation of flue products. Multiple direct vent caps should be installed in the same horizontal plane with a 3 ft (91.4 cm) clearance from the side of one vent cap to the side of the adjacent vent cap(s).

Combustion air supplied from outdoors must be free of particulate and chemical contaminants. To avoid a blocked flue condition, keep the vent cap clear of snow, ice, leaves, debris, etc.

⚠ WARNING: No substitutions of flue pipe or vent cap material are allowed. Such substitutions would jeopardize the safety and health of inhabitants.

The flue exhaust direct vent cap must be furnished by the heater manufacturer in accordance with its listing. Use only the special gas vent pipes listed for use with Category III gas burning heaters, such as the stainless steel vent by Heat Fab Inc (800-772-0739), Protech Systems, Inc. (800-766-3473) or Z-Flex (800-654-5600). Pipe joints must be positively sealed. Follow the vent manufacturers installation instructions carefully.

Raypak does not support common venting under Category III (positive-pressure) conditions.

Model No.	Appliance Category	Certified Venting Material	Vent Size in.(cm)	Max. Venting Length ft (m)	Combustion Air Intake Pipe Material	Air Inlet Size in. (cm)	Max. Air Intake Length (ft/m)
HD101 HD151	III	Stainless Steel (Gas Tight)	4 (10.1)	100 (30.5) 4 Elbows Max.	Galvanized Steel PVC ABS CPVC	4 (10.1)	100 (30.5)
HD201 HD251 HD301			5 (12.7)				
HD401			6 (15.2)				

Maximum 4 elbows, for either intake or vent.

Table M. Horizontal Thru-Wall Venting

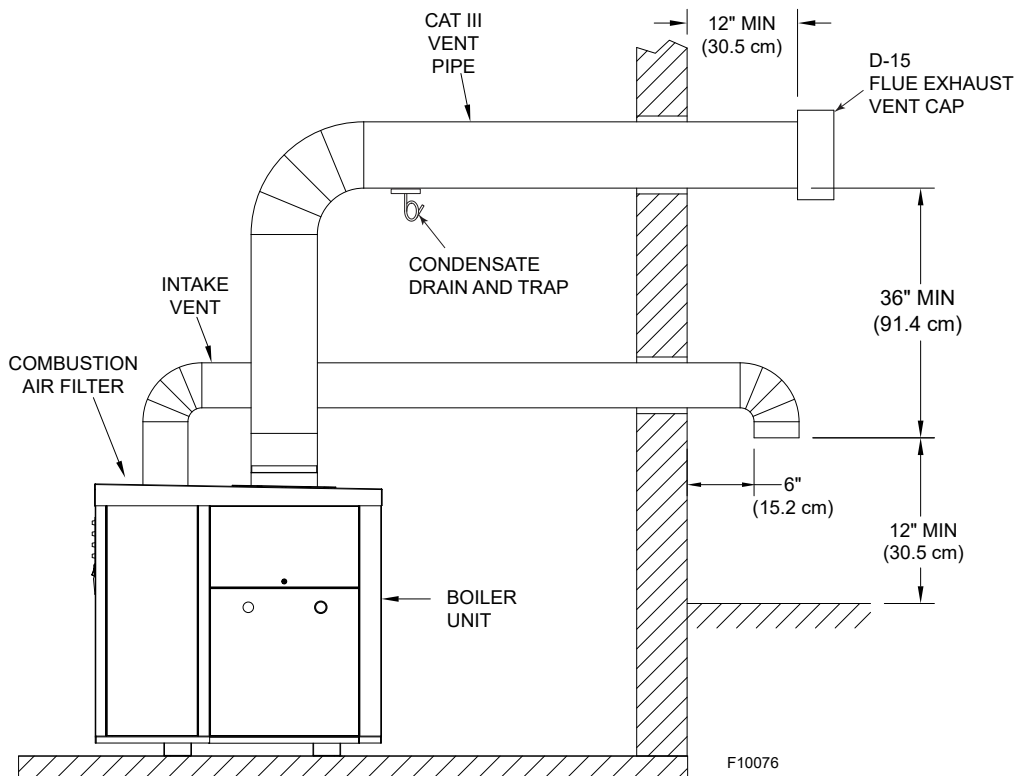


Figure 23. Direct Vent Horizontal Thru-Wall Venting (Category III)

Vertical Direct Vent System Installation

These installations utilize the heater-mounted blower to draw combustion air from outdoors and uses the natural buoyancy of the heated flue products to create a thermal driving head that expels the exhaust gases from the flue. The negative draft must be within the range of -0.01 to -0.08 in. WC as measured 12 in. (30.5 cm) from the appliance outlet to ensure proper operation. The vent material must be in accordance with the above instructions for vent materials. Vent material must be listed by a nationally recognized test agency.

The maximum and minimum venting length for Category I appliance shall be determined per the latest edition of the NFGC (U.S.) and B149 Installation Code (Canada).

The connection from the appliance exhaust vent to the stack must be as direct as possible and should be the same as or larger than the vent outlet. The vent must be installed to prevent accumulation of condensate and, where necessary, have means provided for drainage of condensate. The horizontal breaching of a vent must have an upward slope of not less than 1/4 inch per linear foot from the heater to the vent terminal. The horizontal portions of the vent shall also be supported for the design and weight of the material employed to maintain clearances and to prevent physical damage or separation of joints.

Vertical Direct Vent Termination

The exhaust vent terminal should be vertical and should terminate outside the building at least 2 ft (61 cm) above the highest point of the roof within 10 ft (3 m). The vent cap should have a minimum clearance of 4 ft (1.2 m) horizontally from and in no case above or below (unless a 4 ft (1.2 m) horizontal distance is maintained) electric meters, gas meters, regulators and relief equipment. The distance of the vent terminal from adjacent public walkways, adjacent buildings, open windows and building openings must be consistent with the NFGC, or in Canada, the B149 Installation Code. Gas vents supported only by flashing and extended above the roof more than five feet should be securely guyed or braced to withstand snow and wind loads.

The vertical vent cap is designed for roof top mounting only. The air inlet opening MUST be installed 1 ft (30.5 cm) above the roof line or above normal snow levels that might obstruct combustion air flow. This dimension is critical to the correct operation of the heater and venting system and reduces the chance of blockage from snow. The vent cap must have a minimum 3 ft (91.4 cm) clearance from the air inlet opening.

Outdoor Installation

Outdoor models are self-venting when installed with the factory-supplied vent assembly and air intake cover and require no additional vent piping. This special vent assembly is provided with the heater in accordance with CSA requirements. It must be installed directly on the heater. See the Venting section starting from 20 for correct clearances.

Care must be taken when locating the outdoor unit because the flue gases discharged from the vent assembly can condense as they leave the assembly. Improper location can result in damage to adjacent structures or building finish. For maximum efficiency and safety, the following precautions must be observed:

- a. Outdoor models must be installed outdoors and must use the outdoor vent assembly and air intake cover supplied by the manufacturer. See sales option D-11.
- b. Periodically check venting system. The heater's venting areas must never be obstructed in any way and minimum clearances must be observed to prevent restriction of combustion and ventilation air. Keep area clear and free of combustible and flammable materials.
- c. Do not locate adjacent to any window, door walkway, or gravity air intake. The vent must be located a minimum of 4 ft (1.2 m) horizontally, or 4 ft (1.2 m) below, or 1 ft (30.5 cm) above such areas.
- d. Install above grade level and above normal snow levels.
- e. Vent must be at least 3 ft (91.4 cm) above any forced air inlet located within 10 ft (3 m).
- f. Adjacent brick or masonry surfaces must be protected with a rust-resistant sheet metal plate.
- g. Multiple Outdoor Vent installations require a 4 ft (1.2 m) clearance between vent assemblies.

NOTE: Condensate can freeze on the vent assembly. Frozen condensate on the vent assembly can result in a blocked flue condition.

The vent assembly must be furnished by the heater manufacturer in accordance with its listing.

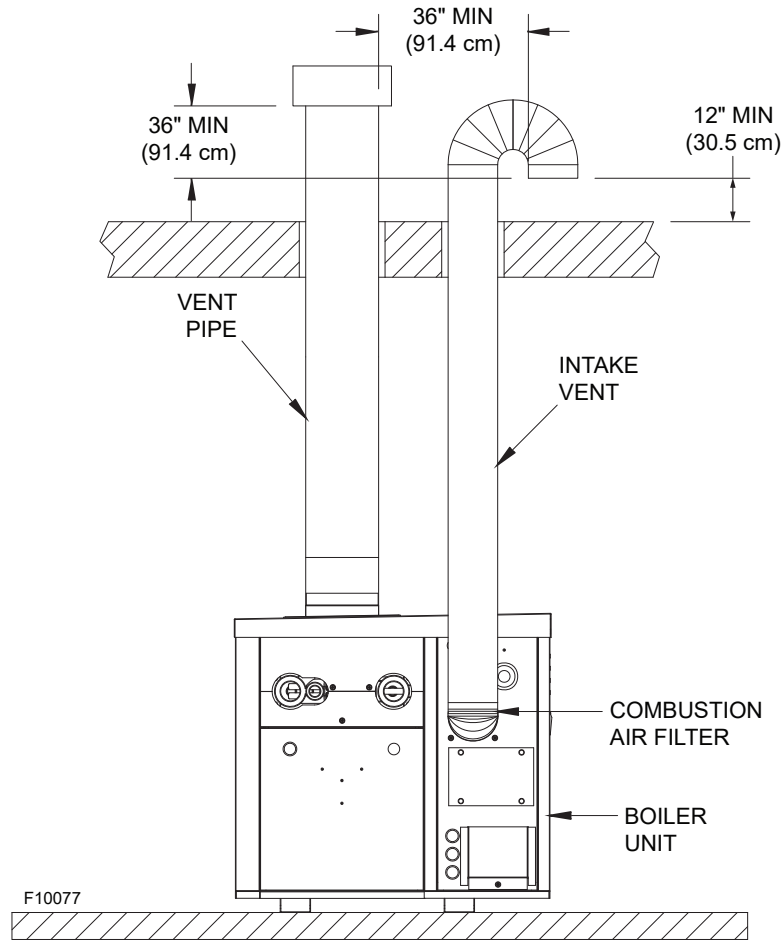


Figure 24. Direct Vent — Vertical Venting (Category I)

Model No.	Appliance Category	Certified Venting Material	Vent Size in. (cm)	Min./Max. Vertical Venting Height ft. (m)		Combustion Air Intake Pipe Material	Air Inlet Size in. (cm)	Max. Air Intake Length ft. (m)
				Min.	Max.			
HD101 HD151	I	Type B Equivalent	4 (10.1)	6 (1.8)	25 (7.6)*	Galvanized Steel PVC ABS CPVC	4 (10.1)	100 (30.4)
HD201 HD251 HD301			5 (12.7)	(HD201) 6 (1.8) (HD251) 6 (1.8) (HD301) 11 (3.3)				
HD401			6 (15.2)	8 (2.4)				

*Over 25 feet, use single-acting barometric damper. Consult the factory for additional information.
Maximum 4 elbows, for either intake or vent.

Table N. Vertical Venting

5. CONTROLS

⚠ WARNING: Installation, adjustment and service of heater controls including timing of various operating functions must be performed by a qualified installer, service agency or the gas supplier. Failure to do so may result in control damage, heater malfunction, property damage, personal injury, or death.

⚠ WARNING: Turn off the power to the heater before installation, adjustment or service of the heater controls. Failure to do so may result in heater malfunction, property damage, personal injury, or death.

⚠ CAUTION: This appliance has provisions to be connected to more than one (1) supply source. To reduce the risk of electric shock, disconnect all such connections before servicing.

⚠ CAUTION: Risk of electric shock. More than one (1) disconnect switch may be required to de-energize the equipment before servicing.

Ignition Control Module

The interrupted proved ignition device conserves energy. When additional heat is needed, the combustion air blower starts to purge all air from the combustion chamber for about 15 seconds. On proof of air flow, the air proving switch closes and the igniter is energized, eliminating the fuel costs of maintaining a constant pilot.

To ensure safe operation, the gas valve cannot open until the igniter is verified as capable of igniting the gas. The ignition module is an electronic device which closes the main gas valve within 8/10 of a second whenever the flame is interrupted. The main burner is automatically lit when the device is powered and pre-purged. The unit performs its own safety check.

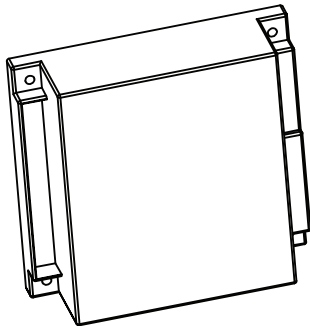


Figure 25. Ignition Module

LED	FAULT
ON	Control fault
1 flash	Air flow fault
2 flashes	Flame / no call for heat
3 flashes	Ignition lockout

Table O. Flash Codes

Outdoor Air Reset Temperature Controller

The Outdoor Air Reset Temperature Controller is a standard feature in Models HD101 through HD301 Type H and is also available as sales option B-42 for Model HD401 and all Type WH models. This electronic controller is designed to adjust the heating water temperature of the system based on changes in outdoor temperature. It offers a user-defined reset ratio that allows the system target water temperature to reset between 120°F (49°C) and 200°F (93°C), and permits a maximum boiler outlet temperature of 210°F (99°C).

In addition to this, the controller offers two-stage firing of an H3 boiler, ensuring that the system is highly efficient and capable of adapting to various weather conditions. The controller comes with a connection for an external thermostat input, which can be used for indirect loads such as an indirect DHW tank for hot water production. When used for direct DHW in combination with a storage tank, the controller can be configured to provide fixed setpoint operation.

Overall, the Outdoor Air Reset Temperature Controller is an essential component of any heating system that ensures energy efficiency and comfort throughout the year. It allows the system to operate at the optimal temperature at all times, reducing energy consumption and prolonging the life of the equipment.

For more information on the topic, please refer to "Outdoor Reset Concept" section, on page 30.

The primary functions of the controller are set using the Operating Temperature dial and the DIP switches. See **Table P**.

The controller has 4 LEDs to indicate its condition:

Power

Solid on when receiving 24 Vac power supply.

Heat Call

Solid on for a heat call (short or 0-32 Vac) and flashes for a boiler outlet sensor error.

IND Call - (Indirect DHW)

Solid on for an IND Call (short or 0-32 Vac) and flashes for a system supply sensor error.

WWSD

Solid on for Outdoor Reset mode and active WWSD feature, flashes for outdoor sensor error. Operation at fixed target temp of 140°F (60°C) based on 32°F. (-2°C)

Item	Feature	Setting / Description	Default
Dial	Operating Temperature	Reset Ratio 0.4 to 3.6 / Setpoint Target 120°F (49°C) to 200°F (93°C)	Reset Ratio 0.4 to 3.6
DIP #1	Firing Mode	Single Stage (On) / Two Stage (Off)	Single Stage (On)
DIP #2	Configuration	Outdoor Reset (On) / Setpoint (Off)	Outdoor Reset (On)
DIP #3	Warm Weather Shut Down	Active 70°F (21°C) (On) / Inactive (Off)	Active 70°F (21°C) (On)
DIP #4	Boiler Max Outlet Setting	Boiler Maximum (dependent on DIP #5) - Default: On • If DIP #5 set to Hydronic (On): 210°F (99°C) (Off) / 190°F (88°C) (On) • If DIP #5 set to Direct DHW (Off): 180°F (82°C) (Off) / 160°F (71°C) (On)	190°F (88°C) (On)
DIP #5	Space Heating or Direct Domestic Hot Water	Direct DHW (Off) / Hydronic (On) - Default: Hydronic (On) Note: If DIP #5 is set to Direct DHW (Off), the operation is based on Setpoint regardless of DIP #2 setting.	Hydronic (On)

Table P. Outdoor Air Reset Temperature Controller Settings

Outdoor Reset Concept

The Temperature controller can change the System Setpoint based on outdoor temperature (Outdoor Reset). The temperature controller varies the temperature of the circulating heating water in response to changes in the outdoor temperature. The heating water temperature is controlled through the modulation and/or sequencing of the cascade.

The Temperature controller can also control the system circulating pump with an adjustable Outdoor Cutoff. When the outdoor temperature is above the Outdoor Cutoff, the pump is turned off and no heating water is circulated through the system. When the outdoor temperature drops below the Outdoor Cutoff, the system pump relay is activated and the heating water circulates through the system. The temperature of the heating water is controlled by the Reset Ratio, Water Offset, and changes with the outdoor temperature.

Reset Ratio/Outdoor Reset

When a building is being heated, heat escapes through the walls, doors, and windows to the colder outside air. The colder the outside temperature, the more heat escapes. If you can input heat into the building at the same rate that it is lost out of the building, then the building temperatures will remain constant. The Reset Ratio is an adjustment that lets you achieve this equilibrium between heat input and heat loss. See **Figure 26**.

The starting point for most systems is the 1.00 (OD):1.00 (SYS) (Outdoor Temperature: Heating Water Temperature) ratio. This means that for every degree the outdoor temperature drops, the temperature of the heating water will increase one degree. With the VERSA, both ends of the slope are adjustable. It is factory set at 70°F (21°C) water temperature (Boil START) at 70°F (21°C) outdoor air (OUT START), and 180°F (82°C) water temperature (Boil DESIGN) at 10°F (-12°C) outdoor air (OUT DESIGN).

Each building has different heat loss characteristics. A very well insulated building will not lose much heat to the outside air, and may need a Reset Ratio of 2.00 (OD):1.00 (SYS) (Outdoor: Water). This means the outdoor temperature would have to drop 2 degrees to increase the water temperature 1 degree. On the other hand, a poorly insulated building may need a Reset Ratio of 1.00 (OD):2.00 (SYS). This means that for each degree the outdoor temperature dropped the water temperature will increase 2 degrees. The control Reset Ratio allows for full customization to match any buildings heat loss characteristics.

A heating curve that relies not only on Outdoor temperature but also on the type of radiation will improve heat comfort. The user can fine tune these adjustments based on the specific building need.

Reset Ratio Settings

The controller uses the four following settings to determine the reset ratio:

1. Heater Start (**Boil START**)

The Boil START temperature is the theoretical heater supply water temperature that the heating system requires when the outdoor air temperature equals the OUT START temperature setting. The Boil START is typically set to the desired building temperature.

2. Outdoor Start (**OUT START**)

The OUT START temperature is the outdoor temperature at which the control provides the Boil START water temperature to the system. The OUT START is typically set to the desired building temperature.

3. Outdoor Design (OUT DESIGN)

The OUT START is the outdoor temperature that is typical coldest annual temperature where the building is located. This temperature is used when completing heat loss calculation for the building.

4. Heater Design (Boil DESIGN)

The Boil DESIGN temperature is the water temperature required to heat the heater zones when the outdoor air is as cold as the OUT DESIGN temperature.

Warm Weather Shut Down (WWSD)

When the outdoor air temperature rises above the WWSD setting, the control turns on the WWSD segment in the display. When the control is in the Warm Weather Shut Down, the Dem 1 segment is displayed if there is a heat demand. However, the control does not operate the heater to satisfy this demand. The control continues to respond to DHW demands.

Reset Ratio

The controller uses the following four settings to calculate the Reset Ratio (RR):

For example, when using the default values, the RR is:

$$\text{RESET RATIO} = \frac{(\text{OUTDOOR START} - \text{EXTERIOR DESIGN})}{(\text{BOILER DESIGN} - \text{STARTING THE BOILER})}$$

$$\text{RR} = (70 - 10) / (180 - 70) = 0.55$$

Therefore, the RR is 0.55:1 (Outdoor : Water).

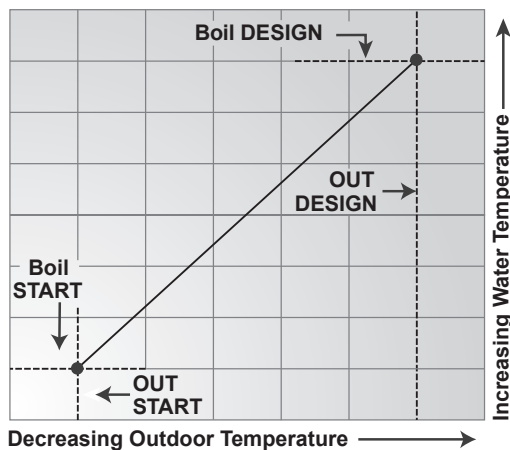


Figure 26. Reset Ratio

NOTE: The wiring diagrams in this manual show all standard options. Refer to the large wiring diagram provided with your heater for options installed on your specific unit(s).

Hydronic with Outdoor Air Reset

For hydronic operation with outdoor air reset, the System Supply Sensor (S2) is used as the operating sensor. Boiler Outlet Sensor (S1) is used for boiler outlet maximum limiting. Boiler Pump (P1) is controlled by the boiler and is cycled off using a 5 minute fixed purge delay after burner operation has ceased.

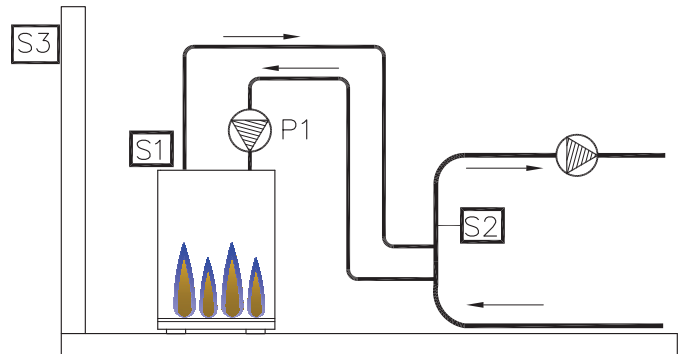


Figure 27. Hydronic with Outdoor Air Reset

S1 = Boiler Outlet Sensor

S2 = System Supply Sensor

S3 = Outdoor Air Sensor

P1 = Boiler Pump

The DIP switch settings are as follows:

- DIP 1 ON (ON/OFF) – OFF (2-STAGE)
- DIP 2 ON (OUTDOOR RESET)
- DIP 3 ON (WWSD 70°F) (21°C)
- DIP 4 ON 190°F (88°C) BOIL MAX)
- DIP 5 ON (HYDRONIC)

Hydronic, Outdoor Air Reset with Indirect DHW

For hydronic operation with outdoor air reset and Indirect DHW, the System Supply Sensor (S2) is used as the operating sensor. Boiler Outlet Sensor (S1) is used for boiler outlet maximum limiting. Contact closure from an aquastat (A1) located on an indirect DHW tank will cause the controller to operate to a boost temperature to satisfy the indirect call for heat. Once the aquastat opens, the controller will return to normal operation. The indirect pump is operated by an external relay (by others). The Boiler Pump (P1) is controlled by the boiler and is cycled off using a fixed 5-minute purge delay after burner operation has ceased.

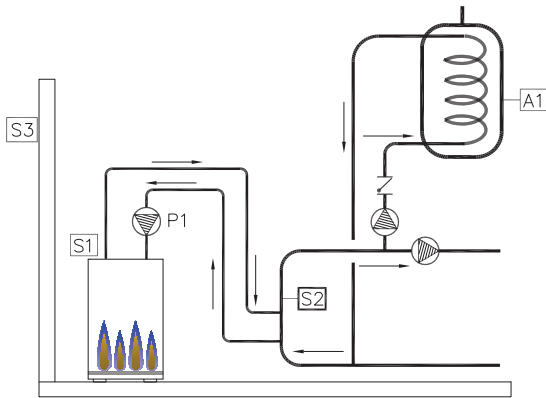


Figure 28. Hydronic with Outdoor Air Reset and Indirect DHW

The DIP switch settings are as follows:

- DIP 1 ON (ON/OFF) – OFF (2-STAGE)
- DIP 2 ON (OUTDOOR RESET)
- DIP 3 ON (WWSD 70°F) (21°C)
- DIP 4 ON 190°F (88°C) BOIL MAX)
- DIP 5 ON (HYDRONIC)

Direct Domestic Hot Water

In this configuration the controller will operate to maintain a set temperature in the storage tank. The differential is fixed at 5°F (3°C) below target. The System Supply Sensor (S2) is used as the operating sensor. Boiler Outlet Sensor (S1) is used for boiler outlet maximum limiting. Boiler Pump (P1) is controlled by the boiler and is cycled off using a 5 minute fixed purge delay after burner operation has ceased.

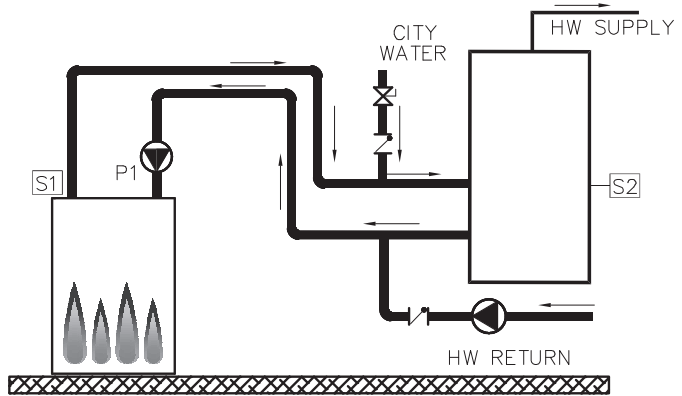


Figure 29. Direct Domestic Hot Water

The DIP switch settings are as follows:

- DIP 1 ON (ON/OFF) – OFF (2-STAGE)
- DIP 2 OFF (SETPOINT)
- DIP 3 OFF (WWSD INACTIVE)
- DIP 4 ON (160°F (71°C) BOIL MAX)
- DIP 5 OFF (DIRECT DHW)

Digital Temperature Control

The WH-101 thru WH-401 heaters can be equipped with a Raypak digital temperature control. For operation with this control, refer to the Temp-Tracker Installation and Operating Instructions, Raypak P/N 241177.

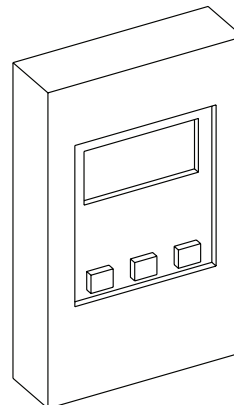


Figure 30. Digital Temperature Control

High Limit (Manual Reset)

The heater is equipped with a manual reset high limit temperature device. If the optional adjustable limit is used, push the reset button and adjust the setting to 30°F (17°C) or 40°F (22°C) above desired operating temperature.

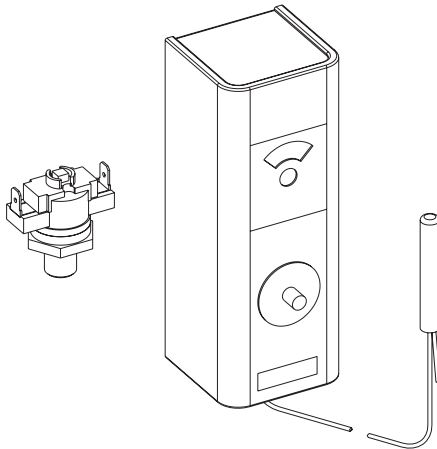


Figure 31. Manual Reset High Limit

High Limit – Auto Reset (Optional)

This heater may be equipped with an optional adjustable auto reset high limit temperature device.

The optional adjustable auto reset high limit is located behind the front panel (see **Figure 3**). Adjust the setting to approx. 20°F (11°C) above desired outlet temperature.

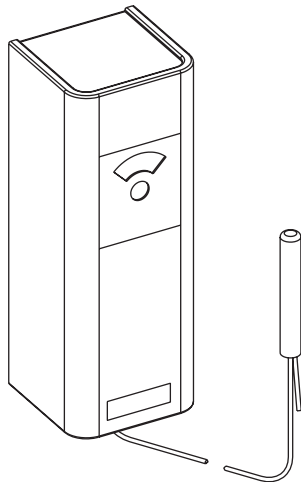


Figure 32. High Limit — Auto Reset (Optional)

Flow Switch

Dual-purpose control shuts off heater in case of pump failure or low water flow. Mounted and wired in series with the main gas valve.

NOTE: Flow switch will not operate if flow is less than 12 gpm (45 lpm).

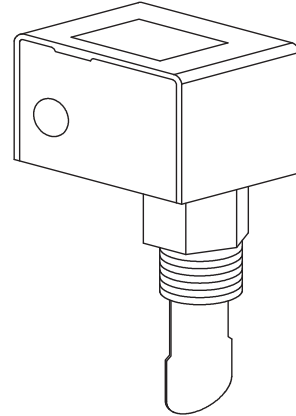


Figure 33. Flow Switch

High and Low Gas Pressure Switches (Optional)

The low gas pressure switch (optional) connection mounts upstream of the gas valve to ensure that sufficient gas pressure is present for proper regulator performance. The low gas pressure switch automatically shuts down the heater if gas supply drops below the recommended setting of 4.0 in. WC for natural gas, and 9.0 in. WC for propane gas.

The high gas pressure switch (optional) connection mounts downstream of the gas valve. If the gas pressure regulator fails, the high gas pressure switch automatically shuts down the burner. The high gas pressure switch automatically shuts down the heater if gas manifold pressure rises above the recommended setting of 4.0 in. WC for natural gas, and 10.5 in. WC for propane gas.

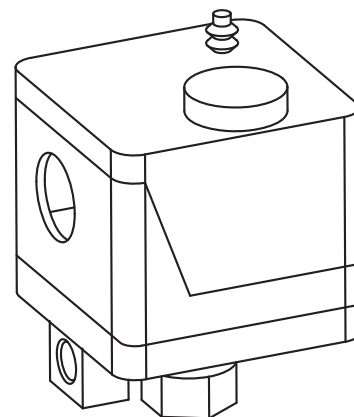


Figure 34. Gas Pressure Switch

Low Water Cut Off (Optional)

The low water cut off automatically shuts down the burner whenever water level drops below the level of the sensing probe. A 5-second time delay prevents premature lockout due to temporary conditions such as power fluctuations or air pockets.

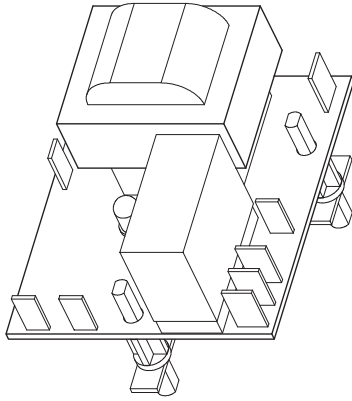
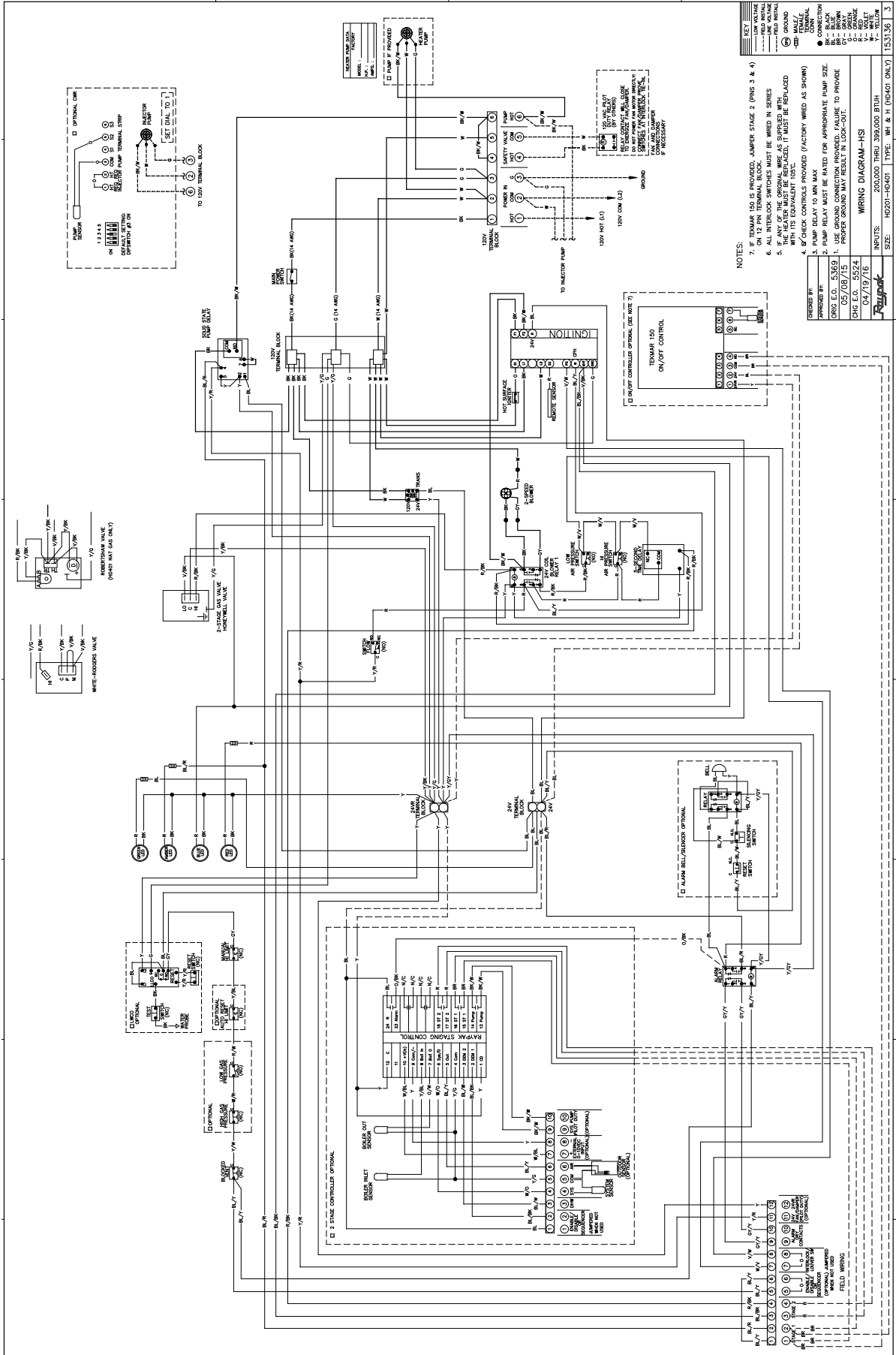


Figure 35. Low Water Cut Off

Model HD401 Type H3 (2-Stage)



7. PRE-START-UP

Filling System-Heating Heaters

Fill system with water. Purge all air from the system using purge valve sequence. After system is purged of air, lower system pressure. Open valves for normal system operation, fill system through feed pressure. Manually open air vent on the compression tank until water appears, then close vent.

Domestic Hot Water Heaters

Purge all air from system before lighting heater. This can be normally be accomplished by opening a downstream valve.

Inspect Venting System:

1. Check all vent pipe connections and flue pipe material.
2. Ensure vent terminations are installed per code and are clear of all debris or blockage.

Pre-Start-Up Check

1. Verify heater is filled with water.
2. Check system piping for leaks. If found, repair immediately.
3. Vent air from system. Air in system can interfere with water circulation.
4. Purge air from gas line up to heater.

8. INITIAL START-UP

Tools Needed

- One 8–0–8, 16" scale manometer
- Two 6–0–6, 12" scale manometers
- 7/16" open end wrench
- 1/2" open end wrench
- Screwdriver (Standard & Phillips)
- 3/8" open end wrench
- Multi-meter
- 3/16" Allen wrench
- 3/32" Allen wrench (Honeywell or White-Rodgers gas valve)
- 5/32" Allen wrench (Invensys gas valve)
- #10 Torx driver w/center hole (Invensys gas valve)

NOTE: Digital manometers are not recommended.

Preparation for Start-Up

WARNING: Do not turn on gas at this time.

Check Power Supply

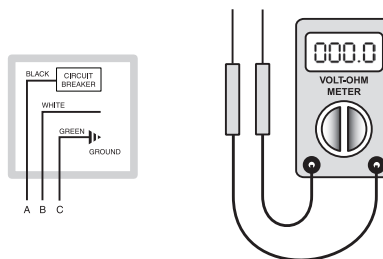


Figure 36. Check Power Source

With volt meter at incoming power check voltage between:

Hot - Common (~120 VAC)

Hot - Ground (~120 VAC)

Common - Ground (< 1 VAC)

WARNING: If Common - Ground is > 1 VAC, STOP: Contact electrician to correct ground failure. Failure to do this may burn out 120V-24V transformer, or may cause other safety control damage or failure.

Attach Manometers to Measure Pressures

- Attach 16" scale manometer to the main gas shut-off valve supply pressure tapping.
- Attach one 12" scale manometer to the manifold gas pressure tapping. (See **Figure 8**.)
- Attach one 12" scale manometer to the tee near the blower housing.

Check the Gas Supply Pressure

1. Slowly turn on main gas shut-off valve.
2. Read the gas supply pressure from the manometer; minimum supply pressure is 4 in. WC, recommended supply is 7 in. WC for natural gas (minimum 11.0 in. WC for LP gas).
3. If pressure is > 14 in. WC, turn off the valve.
4. Check if the service regulator is installed and/or adjust the service regulator.

Start-Up

Blower Adjustment



1. A nylon tee fitting is connected with hoses in-line with the air pressure switches. Disconnect the plugged side and connect a manometer.
2. Close the gas valve.
3. Turn power on.

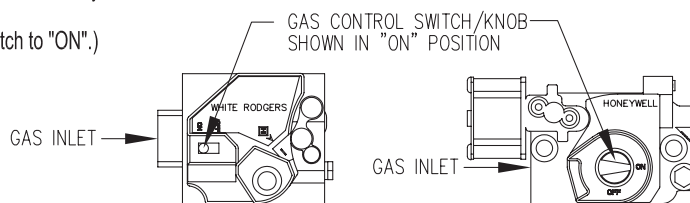
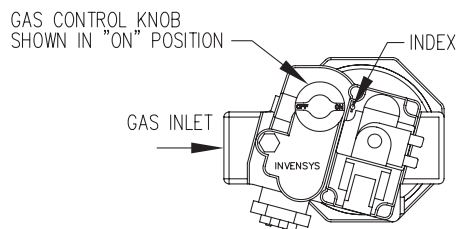
FOR YOUR SAFETY READ BEFORE OPERATING

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


- 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 all around the appliance area for gas. Be sure to smell next to the floor because some gas is heavier than air and will settle on the floor.
- 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.
- C. Use only your hand to push in or turn the gas control knob. Never use tools. If the knob will not push in or turn by hand, do not 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 to inspect the appliance and to replace any part of the control system and any gas control which has been under water.

OPERATING INSTRUCTIONS

1. **STOP!** Read the safety information above on this label.
2. Set the thermostat to the lowest setting.
3. Turn off all electric power to the appliance.
4. 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.
5. Remove heater door panel.
6. Turn gas control knob clockwise  to "OFF". (Or push switch to "OFF".)
7. Wait five (5) minutes to clear out any gas. Then smell for gas, including near the floor. If you smell gas STOP! Follow "B" in the safety information above on this label. If you don't smell gas, go to the next step.
8. Turn gas control knob counter clockwise  to "ON". (Or push switch to "ON".)
9. Replace heater door panel.
10. Turn on all electric power to the appliance.
11. Set thermostat to desired setting.
12. 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 thermostat to the lowest setting.
2. Turn off all electrical power to the appliance if service is to be performed.
3. Remove heater door panel.
4. Turn gas control knob clockwise  to "OFF". (Or push switch to "OFF".)
5. Replace heater door panel.

4. During startup or Lo-Fire, the air pressure should read 0.45 ±0.05 in. WC. During Hi-Fire, the reading should be between 0.9 in. WC and 1.2 in. WC. If these are not the observed manometer readings, adjust the air shutter on the blower to attain the correct values. (See **Figure 4**, air shutter adjustment).
5. Turn power off.
6. Reinstall rubber plug on tee.
5. Main burner ignition – check manifold gas pressure at gas valve manifold pressure tap. (See **Table Q**).
6. If the pressure reading differs by more than the tolerance given, adjust the gas valve accordingly. See gas valve adjustment section below for instructions.

Gas Valve Adjustment

Honeywell Gas Valve

1. Turn off unit.
2. Open manual firing valve.
3. Turn on the unit, wait 15 seconds, and the igniter should glow. There's a sight glass to check igniter at both ends of the heater. Gas valve should be open after 45 seconds.
4. If burner does not light on first trial. It will retry, up to 3 times.
1. While the heater is running, remove plastic cap located behind ON/OFF knob.
2. Locate the HI or LO screw to adjust.
3. Using a small flat screwdriver, turn clockwise to increase and counterclockwise to decrease manifold pressure. See nominal gas valve manifold settings in **Table Q** above.
4. Replace plastic cap when pressure is set.

White Rodgers Gas Valve

1. While the heater is running, locate the HI or LO cap located adjacent to ON/OFF switch.
2. Remove the appropriate cap.
3. Using a flat screwdriver, turn clockwise to increase and counterclockwise to decrease manifold pressure. See nominal gas valve manifold settings above.
4. Replace cap(s) when pressure is set.

Invensys (Model HD401 Natural Only)

1. Turn heater off.
2. Locate and remove the Torx tamper resistant screw. (Shown in **Figure 37**)

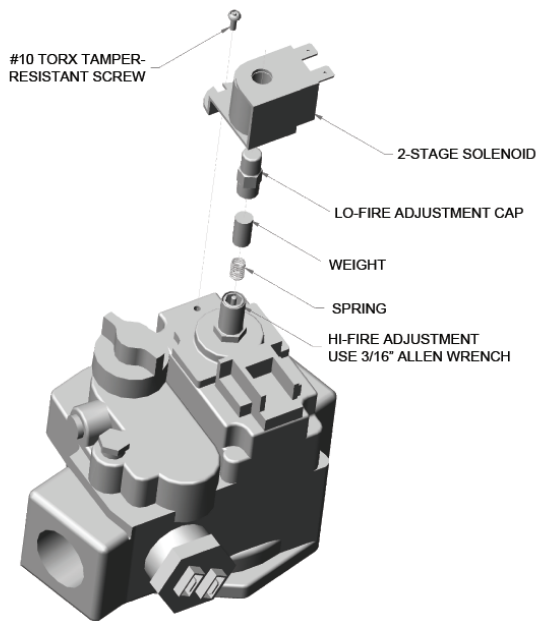


Figure 37. Gas Valve Adjustment (Invensys Valve)

3. Carefully remove 2-stage solenoid.
4. Skip to Step 9 for LO-fire adjustment only.
5. Locate and remove Lo-fire adjustment cap.
6. Carefully remove the spring & weight.
7. Using an allen wrench, turn clockwise to increase and counterclockwise to decrease the HI-fire manifold pressure. Heater will not run while adjusting HI-fire pressure.
8. Carefully place the spring & weight back in before replacing LO-fire adjustment cap.
9. For LO-fire adjustment, tighten the cap to increase the pressure, loosen to decrease.
10. When correct settings are set, replace the solenoid and tamper screw in place.

Gas Type Conversion on Valve

⚠ WARNING: Burner orifices must be changed when changing gas type.

NOTE: Model HD401 requires replacement of valve.

1. Turn off gas supply at the appliance service level.
2. Remove the pressure regulator cover assembly.
3. Remove the existing stem/spring assembly.
4. Insert the replacement stem/spring assembly.
5. Replace the pressure regulator cover assembly and tighten screws.
6. Mount conversion labels on the gas valve.

Firing Stage	Gas Valve	Gas Type	
		Natural	LP/Propane
Hi-Fire +/- 0.2" WC	Invensys	3.4" WC	
	Honeywell or White-Rodgers	3.1" WC	9.6" WC
Lo-Fire +/- 0.1" WC	Invensys	1.1" WC	
	Honeywell or White-Rodgers	1.2" WC	3.6" WC

Table Q. Gas Valve Pressures

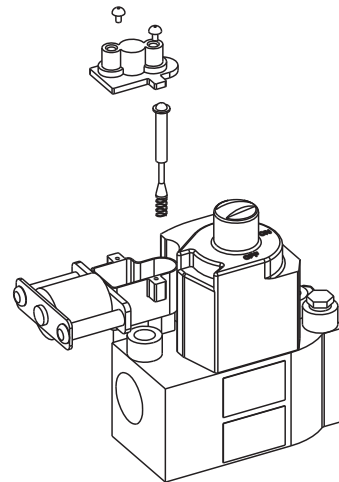


Figure 38. Gas Type Conversion on Honeywell Valve

Firing Stage	Expected Settings	Gas Type	
		Natural	LP/ Propane
Lo-Fire	CO ₂	8.2 +/- 0.2%	9.7 +/- 0.3%
	CO	< 50ppm	< 50 ppm
	Air	0.45" +/- 0.05" WC	0.45" +/- 0.05" WC
Hi-Fire	CO ₂	8.7 +/- 0.2%	10.1 +/- 0.4%
	CO	< 150ppm	< 150ppm
	Air	1.05" +/- 0.1" WC	1.05" +/- 0.1" WC

Table R. Expected Settings

Safety Inspection

- Replace main gas manifold adjustment screw cap.
- Check all thermostats and high limit settings.
- During the following safety checks leave manometers hooked up, check and record.
- If other gas fired equipment are in the room and on same gas main check all pressures on the Hi Delta SS with all other equipment running.
- Check thermostats for ON/OFF operation.
- Check High limits for ON/OFF operation.
- While in operation, check flow switch operation.
- Check the low gas pressure switches (For proper adjustment, if available, use the attached manometers to set pressure. The scales on the switch are approximate only); Low gas pressure switch (optional) must be set at 3.5 in. WC for natural gas and 10.5 in. WC for LP gas.
- High gas pressure switch (optional) at 1 in. WC above manifold pressure.
- Insert ignition control lockout tests as safety check.

Follow-Up

- Safety checks must be recorded as performed.
- Turn unit on.

After main burner ignition:

- Check Manometer(s) for proper reading(s).
- Cycle unit several times and recheck readings.
- Re-analyze with unit running record or print results.
- Remove all Manometers and replace hose, replace all gas pressure caps.
- Check for gas leaks one more time.

9. POST START-UP CHECK

Check off steps as completed:

1. Heater and heat distribution units or storage tank filled with water?
2. Automatic air vent, if used, open two full turns during venting procedure?
3. Air purged from system?
4. Air purged from gas piping? Piping checked for leaks?
5. Followed start-up procedure for proper start-up?
6. Is burner flame visible?
7. Test safety controls: If heater is equipped with a low water cut-off or additional safety controls, test for operation as outlined by manufacturer. Burner should be operating and should go off when controls are tested. When safety devices are restored, burners should reignite after pre-purge time delay.
8. Test limit control: While burner is operating, move indicator on high limit control below actual heater water temperature. Burner should go off while blower and circulator continue to operate. Raise setting on limit control above heater water temperature and burner should reignite after pre-purge time delay.

NOTE: This test doesn't apply to fixed setting high limits.

9. Test ignition system safety device:
 - Turn on manual gas valve. Turn power on.
 - Set thermostat to call for heat.
 - When the unit is in operation. Disconnect combustion air blower pressure switch, burner should go off immediately.
 - Wait 5 minutes.
 - Reconnect combustion air pressure switch, burner should reignite after pre-purge time delay.
10. To restart system, follow lighting instructions in the Operation section.
11. Is the high limit control set to design temperature requirements of system? For multiple zones: is flow adjusted as required in each zone?
12. Heater cycled with thermostat? Raise to highest setting and verify heater goes through normal start-up cycle. Reduce to lowest setting and verify heater goes off.
13. Observed several operating cycles for proper operation?
14. Set room thermostat or tankstat to desired temperature?
15. Reviewed all instructions shipped with this heater with owner or maintenance person, returned to envelope and given to owner?

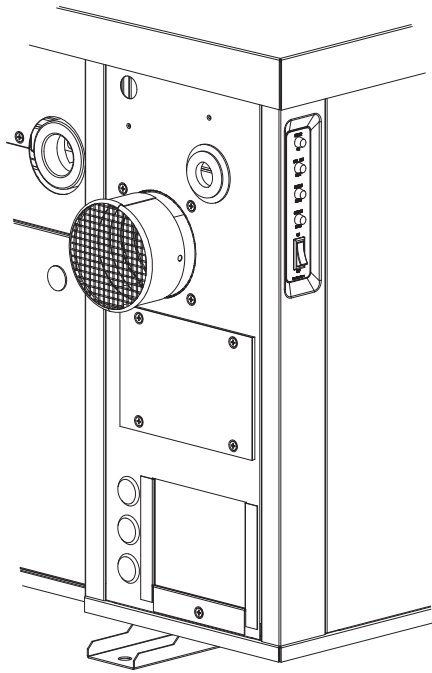


Figure 39. Locate the Air Filter Panel

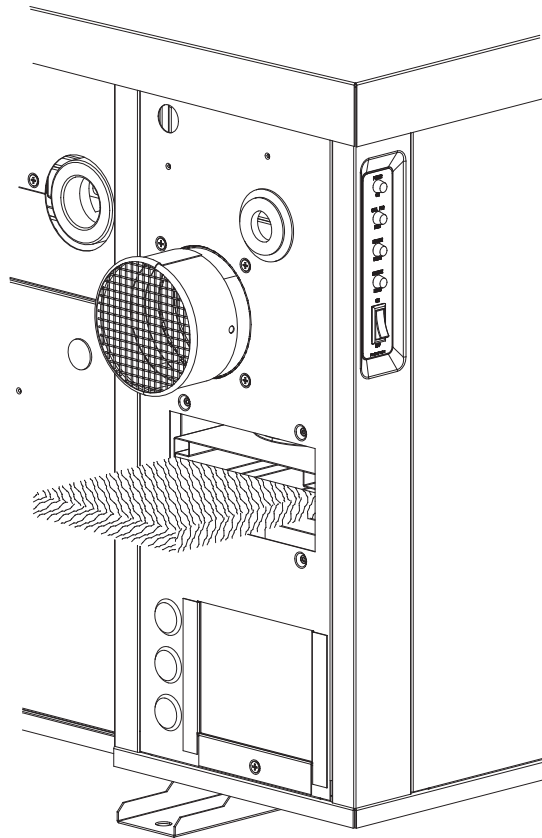


Figure 41. Inspect the Air Filter

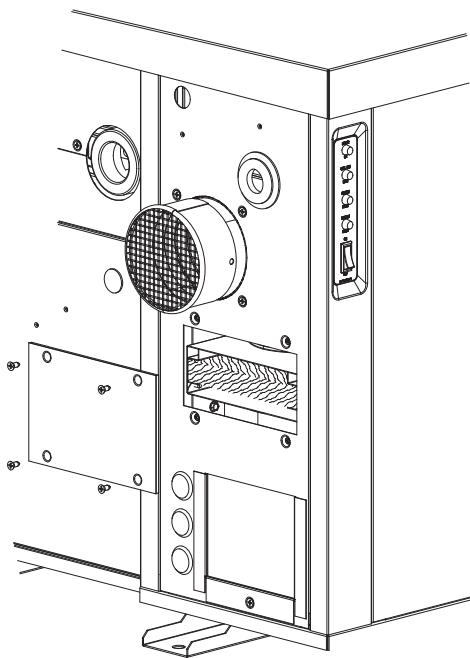


Figure 40. Remove the Screws and Panel

Air Filter Inspection/Removal

1. Turn power off.
2. Locate the Air Filter panel below the air intake duct.
3. Remove the (4) screws holding the panel in place.
4. Pull the air filter out for inspection. Replace if necessary.
5. Replace the panel and screws before operating.

Heat Exchanger Removal

Refer to **Figure 42** for the following procedure.

1. Before beginning, make sure the heater is cool to the touch. Shut water, gas and electricity off, close valves and relieve pressure, then remove the relief valve. Remove side inspection panels.
2. Remove screw behind inspection panels holding the jacket top down.
3. Remove the front panel. Remove two additional screws holding the jacket top to the top support.
4. Disconnect vent pipe from the flue exhaust and set aside.
5. Remove jacket top, then disconnect vent switch hose.
6. Remove two rows of screws holding the flue collector to the combustion chamber. Remove two additional screws located on the front combustion panel. Cut any silicone holding the flue collector and heat exchanger in place.
7. Carefully lift and remove the flue collector.
8. Lift heat exchanger straight up being careful not to damage the refractory.
9. Reverse the above procedure to re-install. Make sure sufficient high temperature silicone sealant (RTV) is placed along the vertical sides of the tube sheet and flue collector.

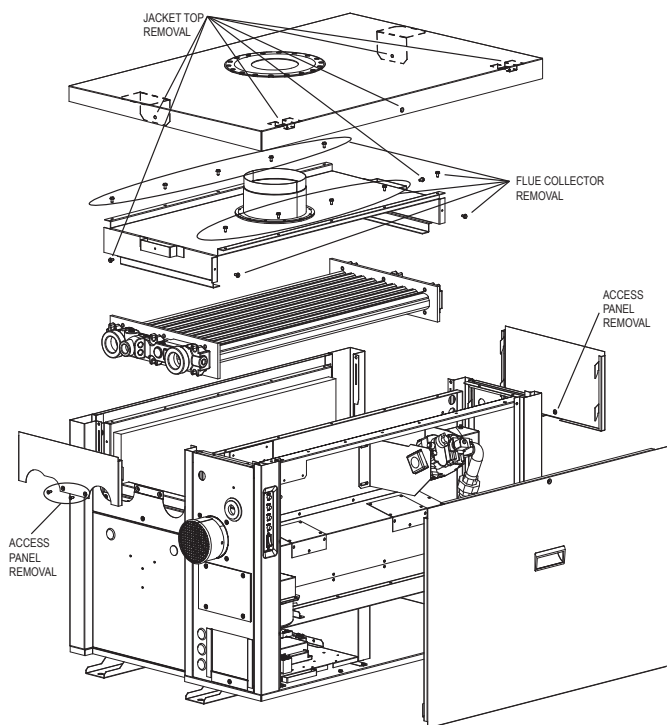


Figure 42. Heat Exchanger Removal

10. MAINTENANCE

Suggested Minimum Maintenance Schedule:

Regular service by a qualified service agency and maintenance must be performed to ensure maximum heater operating efficiency. Maintenance as outlined below may be performed by the owner.

Yearly (Beginning of each heating season):

1. Annual service call by qualified service agency.
2. Visually check top of vent for soot. Call service person to clean. Some sediment at bottom of vent is normal.
3. Visually inspect venting system for proper function, deterioration or leakage.
4. Check that heater area is free from combustible materials, gasoline, and other flammable vapors and liquids.
5. Check for and remove any obstruction to the flow of combustion or ventilation air to heater.
6. Follow pre-start-up check in the Initial Start-up section.
7. Visually inspect burner flame. Should see light blue flame. Visually inspect hot surface igniter for damage, cracking or debris build-up.
8. Check operation of safety devices. Refer to manufacturer's instructions.

9. Follow oil-lubricating instructions on circulator (if required). Over-oiling will damage circulator. Water-lubricated circulators do not need oiling.
10. To avoid potential of severe burn, DO NOT REST HANDS ON OR GRASP PIPES. Use a light touch - return piping will heat up quickly.
11. Check blower and blower motor. Clean and oil as necessary.
12. Check for piping leaks around circulators, relief valves and other fittings. Repair, if found. DO NOT use petroleum-based stop leak.
13. Check air filter and replace if necessary.

Daily:

1. Check that heater area is free from combustible materials, gasoline, and other flammable vapors and liquids.
2. Check for and remove any obstruction to the flow of combustion or ventilation air to heater.

Monthly:

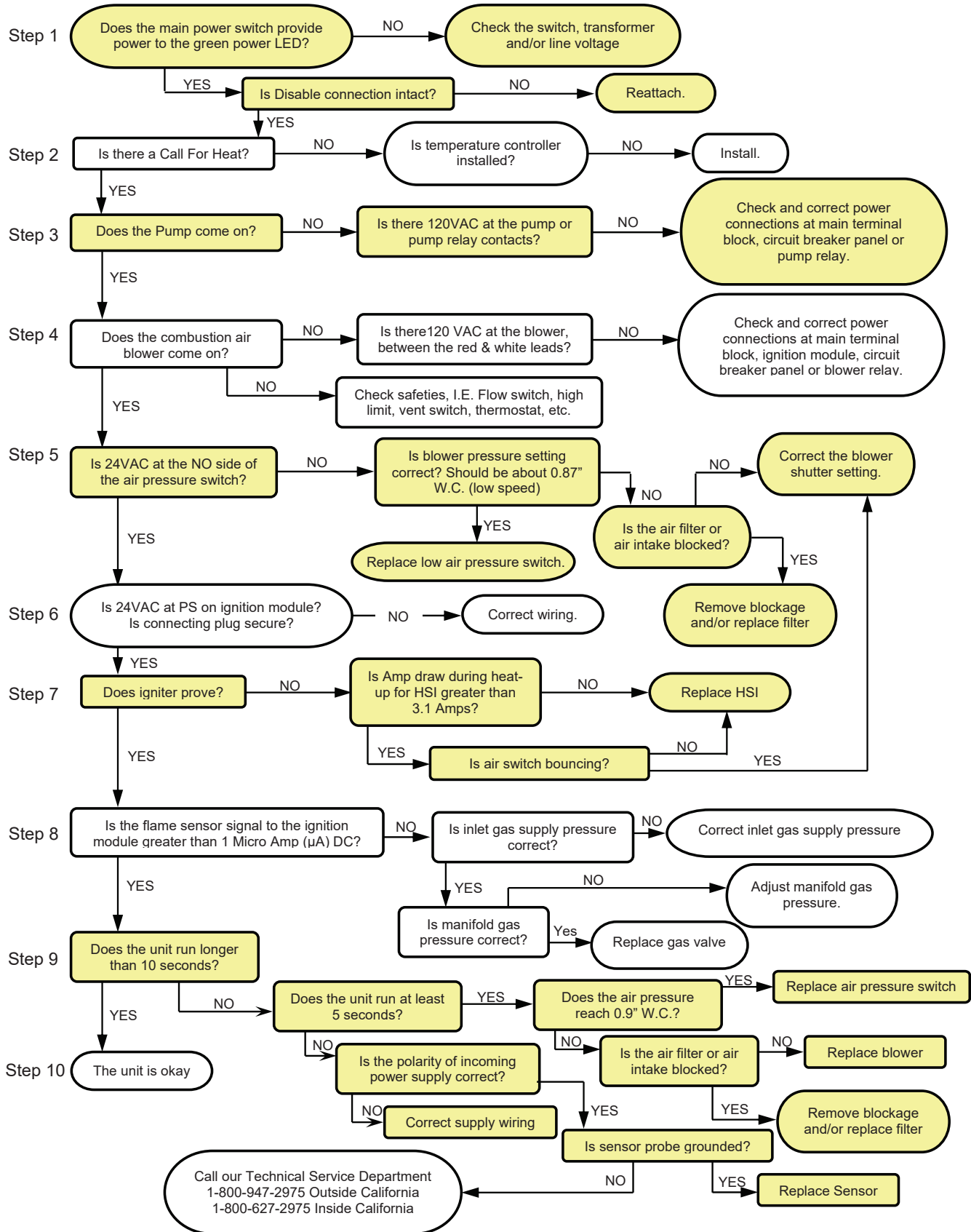
1. Check for piping leaks around circulators, mixing valves, relief valves, and other fittings. If found, repair at once. DO NOT use petroleum-based stop leak compounds.
2. Visually inspect burner flame.
3. Visually inspect venting system for proper function, deterioration or leakage.
4. Check air vents for leakage.

Quarterly:

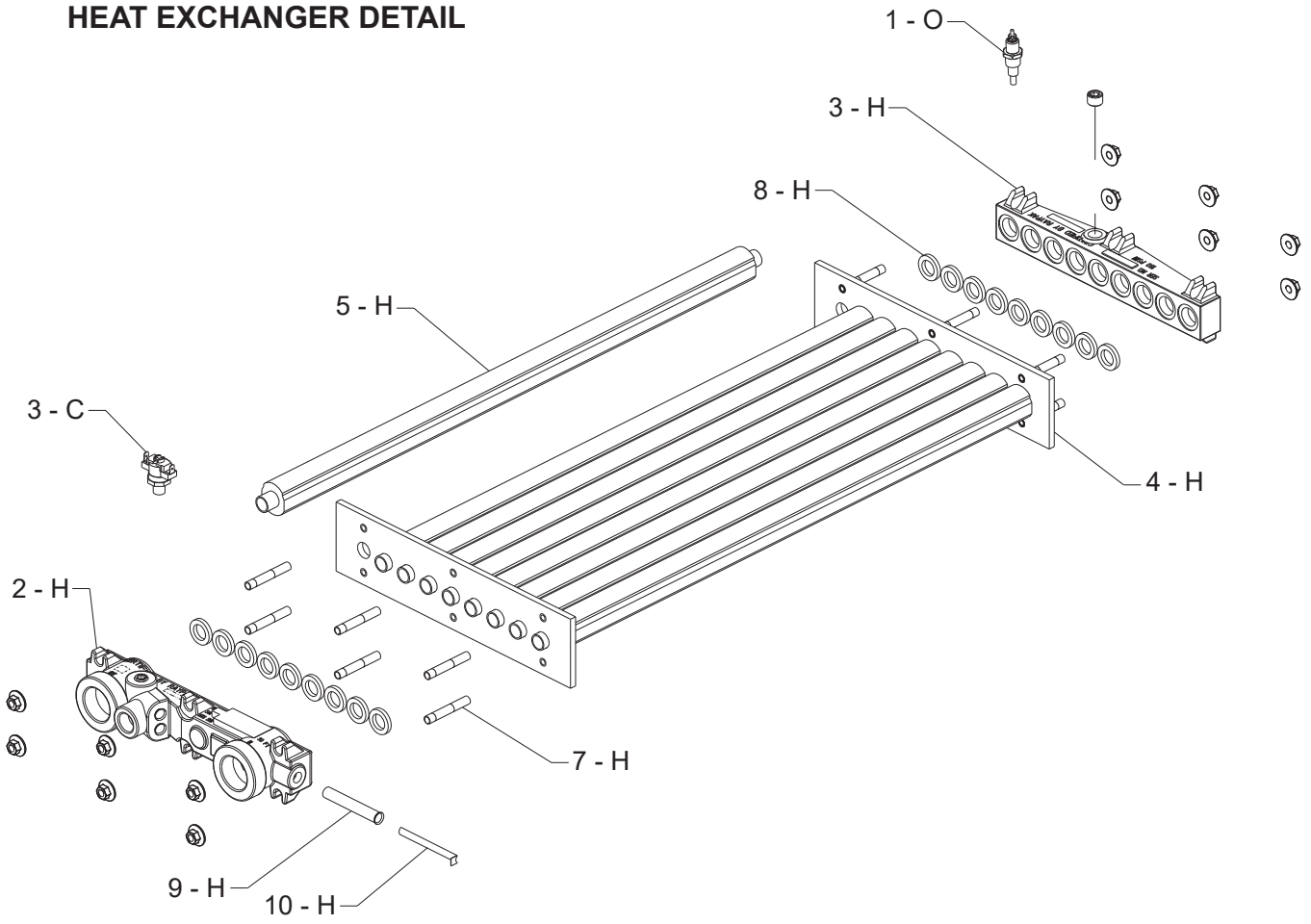
1. Check relief valve. Refer to manufacturer's instructions on valve.
2. Test low water cut-off, if used. Refer to manufacturer's instructions.
3. Check the air filter; replace if necessary.
4. Clean the screens in the vent terminal as applicable.

11. TROUBLESHOOTING

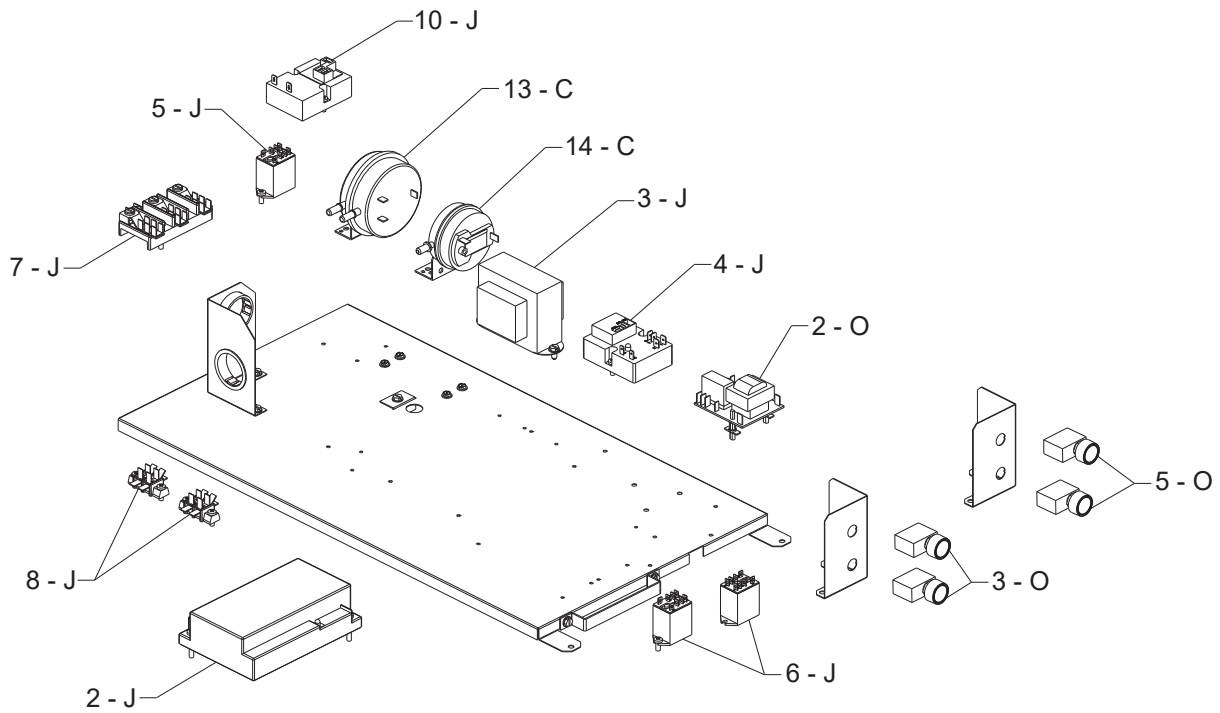
HD101-HD401 Troubleshooting



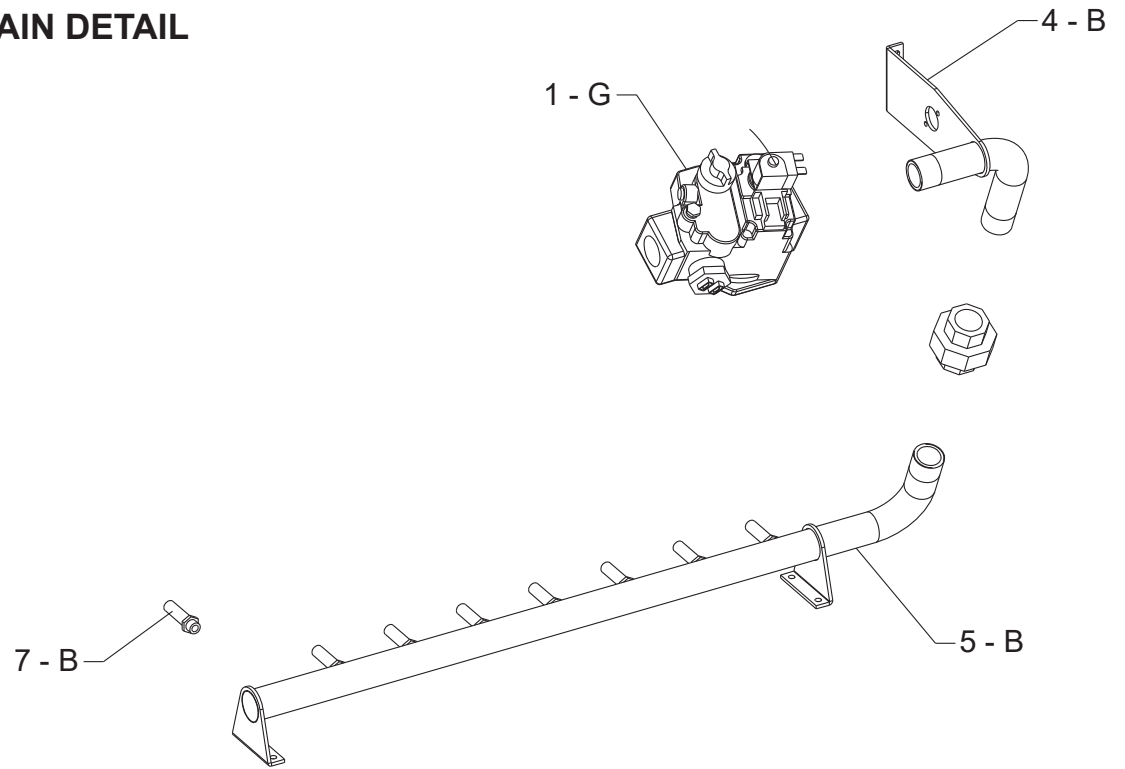
HEAT EXCHANGER DETAIL



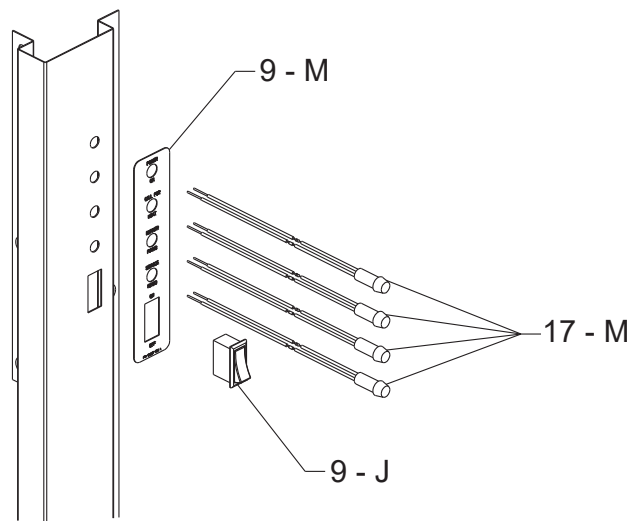
CONTROL ASSEMBLY DETAIL



GAS TRAIN DETAIL



LIGHT PANEL DETAIL



CALL OUT	DESCRIPTION	HD101	HD151	HD201	HD251	HD301	HD401
B BURNER ASSEMBLY**							
1-B	Burner Assy w/Burners (Includes Front Comb Panel)	012810F	012811F	012812F	012813F	012814F	012815F
2-B	Burner Worgas	012817F	012817F	012817F	012817F	012817F	012817F
3-B	Seal Gasket	007443F	007443F	007443F	007443F	007443F	007443F
4-B	Upper Manifold	012818F	012818F	012818F	012818F	012818F	012818F
5-B	Lower Manifold	012819F	012820F	012821F	012822F	012823F	012824F
6-B	Gas Manifold Grommet 3/4" NPT	010778F	010778F	010778F	010778F	010778F	010778F
7-B	Burner Orifice Nat.#26	351632 / 2	351632 / 3	351632 / 4	351632 / 5	351632 / 6	351632 / 8
	Burner Orifice Pro. (.084")	351671 / 2	351671 / 3	351671 / 4	351671 / 5	351671 / 6	351671 / 8
C CONTROLS							
1-C	Auto-Reset Adjustable High-Limit 240F Max	007141F	007141F	007141F	007141F	007141F	007141F
	Auto-Reset Adjustable High-Limit 180F Max	006445F	006445F	006445F	006445F	006445F	006445F
	Auto-Reset Adjustable High-Limit 200F Max	012546F	012546F	012546F	012546F	012546F	012546F
2-C	Manual-Reset Adjustable High-Limit 240F	007144F	007144F	007144F	007144F	007144F	007144F
	Manual-Reset Adjustable High-Limit 200F	008081F	008081F	008081F	008081F	008081F	008081F
3-C	Manual-Reset Fixed High-Limit 240F	008520F	008520F	008520F	008520F	008520F	008520F
	Manual-Reset Fixed High-Limit 200F	008093F	008093F	008093F	008093F	008093F	008093F
4-C	Remote Aquastat (Tankstat) (B-2)	007148F	007148F	007148F	007148F	007148F	007148F
	Remote Aquastat (Tankstat) 2-Stage (B-3)	007392F	007392F	007392F	007392F	007392F	007392F
5-C	Controller 2-Stage (B-6)	007392F	007392F	007392F	007392F	007392F	007392F
	Controller On/Off (B-20)	006445F	006445F	006445F	006445F	006445F	006445F
6-C	Controller 4-Stage B-21 / B-23 Digital Optiona	012691F	012691F	012691F	012691F	012691F	012691F
	Controller 2-Stage B-26 / B-27 Digital Optiona	012692F	012692F	012692F	012692F	012692F	012692F
	Controller On/Off (B-28) Digital	009729F	009729F	009729F	009729F	009729F	009729F
7-C	Controller RayTemp (B-25)	010252F	010252F	010252F	010252F	010252F	010252F
15-C	Controller 2-Stage w/Outdoor Reset B-42 Digital	014279F	014279F	014279F	014279F	014279F	014279F
8-C	Sensor Outdoor Air B-23 / B-27 / B-42	010786F	010786F	010786F	010786F	010786F	010786F
9-C	Sensor Water B-21 thru B-27 and B-42	010787F	010787F	010787F	010787F	010787F	010787F
10-C	Flow Switch	007142F	007142F	007142F	007142F	007142F	007142F
11-C	Flow Switch Paddle (Taco)	010026F	010026F	010026F	010026F	010026F	010026F
12-C	Switch Air Pressure N.C. (Vent)	007158F	007158F	012838F	012838F	012838F	012838F
13-C	Switch Air Pressure Low N.O. (Blower)	012838F	012838F	012838F	012838F	012838F	012838F
14-C	Switch Air Pressure High N.O. (Blower)	012837F	012837F	012837F	012837F	012837F	012837F
F FAN							
1-F	Blower Combustion Air (H3 & WH3)	100-10000758	100-10000758	015767F	015767F	015767F	015767F
	Units manufactured prior to 1/1/16	100-10000758	100-10000758	012840F	012840F	012840F	012840F
	Units manufactured from 1/1/16	100-10000758	100-10000758	012840F	012840F	012840F	012840F
	Blower Combustion Air (WH1)	100-10000758	100-10000758	012840F	012840F	012840F	012840F
2-F	Blower Gasket	012841F	012841F	012841F	012841F	012841F	012841F
3-F	Air Shutter	012842F	012842F	012825F	012825F	012825F	012825F
4-F	Hose Duct 4"	007417F	007417F	007417F	007417F	007417F	007417F
5-F	Filter Media Pleated 6 x 6	N/A	N/A	N/A	N/A	N/A	N/A
	Filter Media Polyester Mesh 6 x 6	012843F	012843F	012843F	012843F	012843F	012843F
6-F	Intake Air Vent Cap w/Screen	012844F	012844F	012844F	012844F	012844F	012844F
G GAS TRAIN							
1-G	Combination Gas Valve 2-Stage Nat Honeywell (H3 WH3)	012845F	012845F	012845F	012845F	012845F	N/A
	Combination Gas Valve 2-Stage Pro Honeywell (H3 WH3)	012846F	012846F	012846F	012846F	012846F	012846F
	Combination Gas Valve 2-Stage Pro White Rodgers (H3 WH3)	012848F	012848F	012848F	012848F	012848F	012848F
	Combination Gas Valve 2-Stage Nat Robershaw / Invensys (H3 WH3)	N/A	N/A	N/A	N/A	N/A	012849F
	Combination Gas Valve On/Off Nat Honeywell (WH1)	007424F	007424F	007424F	007424F	007424F	N/A
	Combination Gas Valve On/Off Pro Honeywell (WH1)	007425F	007425F	007425F	007425F	007425F	007425F
	Combination Gas Valve On/Off Nat Robershaw / Invensys (WH1)	N/A	N/A	N/A	N/A	N/A	007666F
2-G	Switch Low Gas Pressure (Optional)	007187F	007187F	007187F	007187F	007187F	007187F
3-G	Switch High Gas Pressure (Optional)	007188F	007188F	007188F	007188F	007188F	007188F
H HEAT EXCHANGER							
1-H	Heat Exch Cast Iron	012850F	012851F	012852F	012853F	012854F	012855F
	Heat Exch Brass Copper						
	H Boilers	012856F	012857F	012858F	012859F	012860F	012861F
	WH1/WH3 Water Heaters (Units manufactured to 3/31/17)	012856F	012857F	012858F	012859F	012860F	012861F
	WH1 Water Heaters (Units manufactured from 4/1/17)	016520F	016521F	016522F	016523F	016524F	016525F
	WH3 Water Heaters (Units manufactured from 11/1/17)	012856F	012857F	012858F	012859F	012860F	012861F
	Heat Exch Cast Iron Cupronickel	012862F	012863F	012864F	012865F	012866F	012867F
	Heat Exch Brass Cupronickel						
	H Boilers	012868F	012869F	012870F	012871F	012872F	012873F
	WH Water Heaters (Units manufactured to 3/31/17)	012868F	012869F	012870F	012871F	012872F	012873F
	WH1 Water Heaters (Units manufactured from 4/1/17)	016526F	016527F	016528F	016529F	016530F	016531F
2-H	Inlet/Outlet Header Cast Iron	012874F	012874F	012874F	012874F	012874F	012874F
	Inlet/Outlet Header Brass	012875F	012875F	012875F	012875F	012875F	012875F
3-H	Return Header Cast Iron	002042F	002042F	002042F	002042F	002042F	002042F
	Return Header Brass	002043F	002043F	002043F	002043F	002043F	002043F
4-H	Tube Bundle Copper						
	H Boilers	012876F	012877F	012878F	012879F	012880F	012881F
	WH1/WH3 Water Heaters (Units manufactured to 3/31/17)	012876F	012877F	012878F	012879F	012880F	012881F
	WH1 Water Heaters (Units manufactured from 4/1/17)	016532F	016533F	016534F	016535F	016536F	016537F
	WH3 Water Heaters (Units manufactured from 11/1/17)	012876F	012877F	012878F	012879F	012880F	012881F
	Tube Bundle Cupronickel						
	H Boilers	012882F	012883F	012884F	012885F	012886F	012887F
	WH Water Heaters (Units manufactured to 3/31/17)	012882F	012883F	012884F	012885F	012886F	012887F
	WH1 Water Heaters (Units manufactured from 4/1/17)	016538F	016539F	016540F	016541F	016542F	016543F
5-H	Heat Exchange Tube Copper Heat	012888F	012889F	012890F	012891F	012892F	012893F
	Exchange Tube Cupronickel	012894F	012895F	012896F	012897F	012898F	012899F
6-H	Baffle Kit						
	H Boilers	012900F	012901F	012902F	012903F	012904F	012905F
	WH1/WH3 Water Heaters (Units manufactured to 3/31/17)	012900F	012901F	012902F	012903F	012904F	012905F
	WH1 Water Heaters (Units manufactured from 4/1/17)	016544F	016545F	016546F	016547F	016548F	016549F
	WH3 Water Heaters (Units manufactured from 11/1/17)	012900F	012901F	012902F	012903F	012904F	012905F
7-H	Stud Bolt Kit	007870F	007870F	007870F	007870F	007870F	007870F
8-H	Header Gasket	800203B	800203B	800203B	800203B	800203B	800203B
9-H	Sensor Well	007211F	007211F	007211F	007211F	007211F	007211F
10-H	Well Retaining Clip	300203	300203	300203	300203	300203	300203

*FOR ALTITUDES ABOVE 4,500 FEET, CONSULT THE FACTORY

CALL OUT	DESCRIPTION	HD101	HD151	HD201	HD251	HD301	HD401
J	CONTROL BOX						
1-J	Control Assy	N/A	N/A	N/A	N/A	N/A	N/A
2-J	Ignition Control	008472F	008472F	008472F	008472F	008472F	008472F
3-J	Transformer 100VA	007494F	007494F	007494F	007494F	007494F	007494F
4-J	Pump Delay 5 or 10 Minutes	012551F	012551F	012551F	012551F	012551F	012551F
5-J	Blower Relay	011720F	011720F	011720F	011720F	011720F	011720F
6-J	Alarm Relay	011720F	011720F	011720F	011720F	011720F	011720F
7-J	Terminal Block (3-Space)	008523F	008523F	008523F	008523F	008523F	008523F
8-J	Terminal Block (2-Space)	011763F	011763F	011763F	011763F	011763F	011763F
10-J	Time Delay Relay	008921F	008921F	008921F	008921F	008921F	008921F
9-J	On/Off Switch	006872F	006872F	006872F	006872F	006872F	006872F
M	MISCELLANEOUS						
2-M	PRV 30 PSI	007470F	007470F	007470F	007470F	007470F	007470F
	PRV 45 PSI	007220F	007220F	007220F	007220F	007220F	007220F
	PRV 60 PSI	007222F	007222F	007222F	007222F	007222F	007222F
	PRV 75 PSI	007223F	007223F	007223F	007223F	007223F	007223F
	PRV 125 PSI	008091F	008091F	007224F	007224F	007224F	007224F
	PRV 150 PSI	007225F	007225F	007225F	007225F	007225F	007225F
3-M	Delimiting Kit	052871F	052871F	052871F	052871F	052871F	052871F
4-M	T & P Gauge 0-90 PSI	007205F	007205F	007205F	007205F	007205F	007205F
	T & P Gauge 0-200 PSI	007399F	007399F	007399F	007399F	007399F	007399F
	T & P Gauge 0-230 PSI	014221F	014221F	014221F	014221F	014221F	014221F
5-M	Sight Window Plug	008474F	008474F	008474F	008474F	008474F	008474F
6-M	Window Combustion Chamber	006947F	006947F	006947F	006947F	006947F	006947F
7-M	Ignitor	007400F	007400F	007400F	007400F	007400F	007400F
8-M	Flame Sensor	006535F	006535F	006535F	006535F	006535F	006535F
9-M	Status Light Decal	012906F	012906F	012906F	012906F	012906F	012906F
10-M	RTV Sealant 2.8 oz	008924F	008924F	008924F	008924F	008924F	008924F
	RTV Sealant 10 oz	005755F	005755F	005755F	005755F	005755F	005755F
11-M	FiberFrax Strip Insulation 1" Wide	008473F	008473F	008473F	008473F	008473F	008473F
12-M	Flue Exhaust Flange Seal Gasket	012907F	012907F	009734F	009734F	009734F	009734F
13-M	Flue Exhaust Adapter Seal Gasket	012908F	012908F	009737F	009737F	009737F	009737F
14-M	Gas Manifold Grommet 3/4" NPT	010778F	010778F	010778F	010778F	010778F	010778F
15-M	Touch-up Paint						
	Green	750125	750125	750125	750125	750125	750125
	Dark Gray	750126	750126	750126	750126	750126	750126
	Cool Dark Gray	750256	750256	750256	750256	750256	750256
	Warm Dark Gray	750258	750258	750258	750258	750258	750258
16-M	Wire Harness Cabinet						
	Units manufactured prior to 9/1/12	012909F	012909F	012909F	012909F	012909F	012909F
	Units manufactured from 9/1/12	014294F	014294F	014294F	014294F	014294F	012909F
	Units manufactured from 9/1/12 On/Off Units	016164F	016164F	016164F	016164F	016164F	016165F
	Wire Harness Control Box 2-Stage Controls						
	Units manufactured prior to 9/1/12	012910F	012910F	012910F	012910F	012910F	012910F
	Units manufactured from 9/1/12	014295F	014295F	014295F	014295F	014295F	012910F
	Wire Harness Control Box On/Off Controls	015044F	015044F	015044F	015044F	015044F	015044F
17-M	Indicator Lamp	011848F	011848F	011848F	011848F	011848F	011848F
18-M	Plastic Handle	012681F	012681F	012681F	012681F	012681F	012681F
O	OPTIONS						
1-O	Remote Sensor for Low Water Cut-Off	008063F	008063F	008063F	008063F	008063F	008063F
2-O	Low Water Cut Off PC Board	007157F	007157F	007157F	007157F	007157F	007157F
3-O	Reset/Test Switch for Low Water Cut Off	005641F	005641F	005641F	005641F	005641F	005641F
4-O	Alarm Bell 3"	005642F	005642F	005642F	005642F	005642F	005642F
	Alarm Bell 4"	005643F	005643F	005643F	005643F	005643F	005643F
5-O	Silencer/Reset Switch (Alarm)	005641F	005641F	005641F	005641F	005641F	005641F
P	PUMPS*						
1-P	Pump Inline BR Soft 0010	012911F	012911F	012911F	012911F	012911F	012911F
	Pump Inline SS/BR Medium 0012	012912F	012912F	012912F	012912F	012912F	012912F
	Pump Inline BR Hard 1611	007226F	007226F	007226F	007226F	007226F	007226F
	Pump Inline CIBF Soft 0010	012913F	012913F	012913F	012913F	012913F	012913F
	Pump Inline CIBF Medium 0012	013426F	013426F	013426F	013426F	013426F	013426F
	Pump Inline CIBF Hard 1611	007232F	007232F	007232F	007232F	007232F	007232F
	Pump Inline SS Medium 0012	013425F	013425F	013425F	013425F	013425F	013425F
2-P	Pump Cartridge 0010	015272F	015272F	015272F	015272F	015272F	015272F
	Pump Cartridge 0012	016480F	016480F	016480F	016480F	016480F	016480F
3-P	Pump Flange Gasket 0012	008747F	008747F	008747F	008747F	008747F	008747F
	Pump Flange Gasket 1611	008749F	008749F	008749F	008749F	008749F	008749F
R	REFRACTORY						
1-R	Refractory Kit (All Panels)	012993F	012994F	012995F	012996F	012997F	012998F
2-R	Refractory Front Panel	012914F	012915F	012916F	012917F	012918F	012919F
3-R	Refractory Blanket	012920F	012921F	012922F	012923F	012924F	012925F

* For individual pump parts see separate pump parts IPL 9300.100

CALL OUT	DESCRIPTION	HD101	HD151	HD201	HD251	HD301	HD401
S	SHEETMETAL						
1-S	Jacket Top	012926F	012927F	012928F	012929F	012930F	012931F
2-S	Vertical Cabinet Supports	012932F	012932F	012932F	012932F	012932F	012932F
3-S	Cabinet Supports	012933F	012934F	012935F	012936F	012937F	012938F
4-S	Jacket Front Panel						
	Green	012939F	012940F	012941F	012942F	012943F	012944F
	Warm Dark Gray	014262F	014263F	014264F	014265F	014266F	014267F
5-S	Jacket Rear Panel						
	Green	012945F	012946F	012947F	012948F	012949F	012950F
	Cool Dark Gray	014268F	014269F	014270F	014271F	014272F	014273F
6-S	Jacket Left Side Panel Front						
	Green	012951F	012951F	012951F	012951F	012951F	012951F
	Cool Dark Gray	014274F	014274F	014274F	014274F	014274F	014274F
7-S	Jacket Right Side Panel front						
	Green	012952F	012952F	012952F	012952F	012952F	012952F
	Cool Dark Gray	014275F	014275F	014275F	014275F	014275F	014275F
8-S	Jacket Side Panel Rear						
	Green	012953F	012953F	012953F	012953F	012953F	012953F
	Cool Dark Gray	014276F	014276F	014276F	014276F	014276F	014276F
9-S	Base Panel	012954F	012955F	012956F	012957F	012958F	012959F
10-S	Front Combustion Chamber Panel	012960F	012961F	012962F	012963F	012964F	012965F
11-S	Rear/Bottom Combustion Chamber Panel	012966F	012967F	012968F	012969F	012970F	012971F
12-S	Combustion Chamber Top	012972F	012973F	012974F	012975F	012976F	012977F
13-S	Filter Box	012978F	012978F	012978F	012978F	012978F	012978F
14-S	Controller Mounting Bracket						
	B-26 thru B-28	012979F	012979F	012979F	012979F	012979F	012979F
	B-42	014293F	014293F	014293F	014293F	014293F	014293F
15-S	Access Panel Water Connections (All Panels)						
	Green	012980F	012980F	012980F	012980F	012980F	012980F
	Cool Dark Gray	014277F	014277F	014277F	014277F	014277F	014277F
16-S	Access Panel Filter						
	Green	012981F	012981F	012981F	012981F	012981F	012981F
	Cool Dark Gray	014278F	014278F	014278F	014278F	014278F	014278F
17-S	Access Panel Wiring Box						
	Green	012982F	012982F	012982F	012982F	012982F	012982F
	Cool Dark Gray	014214F	014214F	014214F	014214F	014214F	014214F
18-S	Flue Exhaust Gasket Retainer	012983F	012983F	010029F	010029F	010029F	010030F
19-S	Pump Cover (Taco 0010)	013355F	013355F	013355F	013355F	013355F	013355F
	Pump Cover (Taco 0012)	013371F	013371F	013371F	013371F	013371F	013371F
	Pump Cover (Taco 1610)	012987F	012987F	012987F	012987F	012987F	012987F
20-S	Intake Air Collar (Outside)	012988F	012988F	012988F	012988F	012988F	012988F
21-S	Intake Air Collar (Inside)	012989F	012989F	012989F	012989F	012989F	012989F
22-S	Intake Air Vent Hood						
	Green	012772	012772	012772	012772	012772	012772
	Cool Dark Gray	014246F	014246F	014246F	014246F	014246F	014246F
24-S	Manifold Plenum Cover Panels	016518F	016519F	016621F	016622F	016623F	016624F
23-S	Access Panel Igniter/Flame Sensor	N/A	N/A	013345F	013345F	013345F	013345F
V	VENTING						
1-V	Outdoor Stack	015445F	015445F	015446F	015446F	015446F	014622F
2-V	D15 Vent Cap Horizontal Thru-the-Wall for Indoor Units	011712	011712	007000	007000	007000	006644
3-V	D20 Vent Cap Vertical (Roof top only) for Indoor Units	010800	010800	010801	010801	010801	010802
4-V	Flue Exhaust Adapter	012990F	012990F	012991F	012991F	012991F	012992F
5-V	D16 Intake Air Elbow	006996	006996	006996	006996	006996	006996
Gas Conversions*		HD101	HD151	HD201	HD251	HD301	HD401
Natural to Propane (H3 WH3)		013066F	013066F	013066F	013066F	013066F	013067F
Decal		100-10001010	100-10001010	100-10001010	100-10001010	100-10001010	100-10001010

*FOR GAS CONVERSIONS, PLEASE CONSULT THE FACTORY.

13. IMPORTANT INSTRUCTIONS FOR THE COMMONWEALTH OF MASSACHUSETTS

The Commonwealth of Massachusetts requires compliance with regulation 248 CMR 4.00 and 5.00 for installation of through-the-wall vented gas appliances as follows:

(a) For all sidewall horizontally-vented gas-fueled equipment installed in every dwelling, building or structure used in whole or in part for residential purposes, including those owned or operated by the Commonwealth and where the sidewall exhaust vent termination is less than seven (7) feet above finished grade in the area of the venting, including but not limited to decks and porches, the following requirements shall be satisfied:

1. **INSTALLATION OF CARBON MONOXIDE DETECTORS.** At the time of installation of the sidewall horizontally-vented gas-fueled equipment, the installing plumber or gasfitter shall observe that a hardwired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery-operated or hardwired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the sidewall horizontally-vented gas-fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hardwired carbon monoxide detectors

a. In the event that the sidewall horizontally-vented gas-fueled equipment is installed in a crawl space or an attic, the hard-wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.

b. In the event that the requirements of this subdivision cannot be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery-operated carbon monoxide detector with an alarm shall be installed.

2. **APPROVED CARBON MONOXIDE DETECTORS.** Each carbon monoxide detector as required in accordance with the above provisions shall comply with NFPA 720 and be ANSI/UL 2034 listed and IAS certified.

3. **SIGNAGE.** A metal or plastic identification plate shall be permanently mounted to the exterior of the building at a minimum height of eight (8) feet above grade directly in line with the exhaust vent terminal for the horizontally-vented gas-fueled heating appliance or equipment. The sign shall read, in print size no less than one-half (1/2) inch in size, "GAS VENT DIRECTLY BELOW. KEEP CLEAR OF ALL OBSTRUCTIONS".

4. **INSPECTION.** The state or local gas inspector of the sidewall horizontally-vented gas-fueled equipment shall not approve the installation unless, upon inspection, the inspector observes carbon monoxide detectors and signage installed in accordance with the provisions of 248 CMR 5.08(2)(a)1 through 4.

(b) **EXEMPTIONS:** The following equipment is exempt from 248 CMR 5.08(2)(a)1 through 4:

1. The equipment listed in Chapter 10 entitled "Equipment Not Required To Be Vented" in the most current edition of NFPA 54 as adopted by the Board; and
2. Product Approved sidewall horizontally-vented gas-fueled equipment installed in a room or structure separate from the dwelling, building or structure used in whole or in part for residential purposes.

(c) **MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM PROVIDED.** When the manufacturer of Product Approved sidewall horizontally-vented gas equipment provides a venting system design or venting system components with the equipment, the instructions provided by the manufacturer for installation of the equipment and the venting system shall include:

1. Detailed instructions for the installation of the venting system design or the venting system components; and
2. A complete parts list for the venting system design or venting system.

(d) **MANUFACTURER REQUIREMENTS - GAS EQUIPMENT VENTING SYSTEM NOT PROVIDED.** When the manufacturer of a Product Approved sidewall horizontally-vented gas-fueled equipment does not provide the parts for venting the flue gases, but identifies "special venting systems", the following requirements shall be satisfied by the manufacturer:

1. The referenced "special venting system" instructions shall be included with the appliance or equipment installation instructions; and
2. The "special venting systems" shall be Product Approved by the Board, and the instructions for that system shall include a parts list and detailed installation instructions.

(e) A copy of all installation instructions for all Product Approved sidewall horizontally-vented gas-fueled equipment, all venting instructions, all parts lists for venting instructions, and/or all venting design instructions shall remain with the appliance or equipment at the completion of the installation.

GAS PRESSURE SUPERVISION

The Commonwealth of Massachusetts requires listed high and low gas pressure switches (manual reset) for any model with a maximum firing input greater than 1,000,000 Btu/Hr in accordance with 248 CMR 7.04(11)(d).

A gas pressure regulator (field-supplied) is required in the gas train ahead of the heater, for heaters having input rates greater than 1,000,000 Btu/Hr, in accordance with 248 CMR 7.04 Figure 3B requirements.

14. QR CODES

View this Installation Manual and corresponding manuals on your smart device.

This QR Code will take you to the most current version of the manual. Previous versions of manuals can be found in the document library at Raypak.com.

P/N: 241356 Hi Delta H WH HD101-HD401



P/N: 241275 Cold Water Start & Cold Water Run Installation and Operation Instructions



P/N: 241177 2 & 4-Stage Temperature Controllers Installation and Operation Instructions



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