

INSTALLATION INSTRUCTIONS

Variable Speed Motor, Two-Stage ECM Motor and Single-Stage 35" Tall, High Efficiency Condensing Gas Furnace (F/G)9MVT, (F/G)9MXT, (F/G)9MXE

These instructions must be read and understood completely before attempting installation.

Safety Labeling and Signal Words

DANGER, WARNING, CAUTION, and NOTE

The signal words **DANGER**, **WARNING**, **CAUTION**, and **NOTE** are used to identify levels of hazard seriousness. The signal word **DANGER** is only used on product labels to signify an immediate hazard. The signal words **WARNING**, **CAUTION**, and **NOTE** will be used on product labels and throughout this manual and other manual that may apply to the product.

DANGER – Immediate hazards which will result in severe personal injury or death.

WARNING – Hazards or unsafe practices which could result in severe personal injury or death.

CAUTION – Hazards or unsafe practices which may result in minor personal injury or product or property damage.

NOTE – Used to highlight suggestions which will result in enhanced installation, reliability, or operation.

Signal Words in Manuals

The signal word **WARNING** is used throughout this manual in the following manner:

 **WARNING**

The signal word **CAUTION** is used throughout this manual in the following manner:

 **CAUTION**

Signal Words on Product Labeling

Signal words are used in combination with colors and/or pictures or product labels.

 Safety-alert symbol

When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury.

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Use of the AHRI Certified TM Mark indicates a manufacturer's participation in the program. For verification of certification for individual products, go to www.ahridirectory.org.

INSTALLER: Affix these instructions on or adjacent to the furnace.

CONSUMER: Retain these instructions for future reference.

Required Notice for Massachusetts Installations

Important

The Commonwealth of Massachusetts requires compliance with regulation 248 CMR as follows:

5.08: Modifications to NFPA-54, Chapter 10

2) Revise 10.8.3 by adding the following additional requirements:

- (a) For all side wall 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 side wall 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 side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired 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 hard wired carbon monoxide detector with an alarm is installed on each additional level of the dwelling, building or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified license professionals for the installation of hard wired carbon monoxide detectors.
 - a. In the event that the side wall 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 can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirement; 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 of local gas inspector of the side wall 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 side wall 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 side wall 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 side wall 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 side wall 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.

For questions regarding these requirements, please contact the Commonwealth of Massachusetts Board of State Examiners of Plumbers and Gas Fitters, 239 Causeway Street, Boston, MA 02114. 617-727-9952

Safety Considerations



WARNING

FIRE, EXPLOSION, ELECTRICAL SHOCK, AND CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in dangerous operation, personal injury, death, or property damage.

Improper installation, adjustment, alteration, service, maintenance, or use can cause carbon monoxide poisoning, explosion, fire, electrical shock, or other conditions which may cause personal injury or property damage. Consult a qualified service agency, local gas supplier, or your distributor or branch for information or assistance. The qualified service agency must use only factory-authorized and listed kits or accessories when modifying this product.



CAUTION

FURNACE RELIABILITY HAZARD

Failure to follow this caution may result in unit component damage.

Application of this furnace should be indoors with special attention given to vent sizing and material, gas input rate, air temperature rise, unit leveling, and unit sizing.

Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause personal injury or property damage. Consult a qualified service agency, local gas supplier, or your distributor or branch for information or assistance. The qualified installer or agency must use only factory-authorized and listed kits or accessories when modifying this product. Refer to the individual instructions packaged with the kits or accessories when installing.

Installing and servicing heating equipment can be hazardous due to gas and electrical components. **Only trained and qualified personnel should install, repair, or service heating equipment.** Untrained personnel can perform basic maintenance functions such as cleaning and replacing air filters. All other operations must be performed by trained service personnel. When working on heating equipment, observe precautions in literature, on tags, and on labels attached to or shipped with furnace and other safety precautions that may apply.

These instructions cover minimum requirements and conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances, especially those that may not have kept up with changing residential construction practices. We require these instructions as a minimum for a safe installation.

Follow all safety codes. Wear safety glasses, protective clothing, and work gloves. Have a fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit.



CAUTION

CUT HAZARD

Failure to follow this caution may result in personal injury.

Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts, and servicing furnaces.

This is the safety-alert symbol . When you see this symbol on the furnace and in instructions or manuals, be alert to the potential for personal injury.

Understand the signal words DANGER, WARNING, and CAUTION. These words are used with the safety-alert symbol. DANGER identifies the most serious hazards which **will** result in severe personal injury or death. WARNING signifies a hazard which **could** result in personal injury or death. CAUTION is used to identify hazards which **may** result in minor personal injury or product and property damage. NOTE is used to highlight suggestions which will result in enhanced installation, reliability, or operation.

1. Use only with type of gas approved for this furnace. Refer to the furnace rating plate.
2. Install this furnace only in a location and position as specified in the "Location" section of these instructions.
3. Provide adequate combustion and ventilation air to the furnace space as specified in "Air for Combustion and Ventilation" section.
4. Combustion products must be discharged outdoors. Connect this furnace to an approved vent system only, as specified in the "Venting" section of these instructions.
5. Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections, as specified in the "Gas Piping" section.
6. Always install furnace to operate within the furnace's intended temperature-rise range with a duct system which has an external static pressure within the allowable range, as specified in the "Start-Up, Adjustments, and Safety Check" section. See furnace rating plate.
7. When a furnace is installed so that supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by duct(s) sealed to the furnace casing and terminating outside the space containing the furnace. See "Air Ducts" section.
8. A gas-fired furnace for installation in a residential garage must be installed as specified in the warning box in the "Location" section. (See **Figure 4**)
9. The furnace may be used for construction heat provided that the furnace installation and operation complies with the first CAUTION in the LOCATION section on page 7 of these instructions.
10. These Multipoise Gas-Fired Furnaces are CSA design-certified for use with natural and propane gases (see furnace rating plate) and for installation in alcoves, attics, basements, closets, utility rooms, crawlspaces, and garages. The furnace is factory-shipped for use with natural gas. A CSA (A.G.A. and C.G.A.) listed accessory gas conversion kit is required to convert furnace for use with propane gas.
11. See **Table 1** for required clearances to combustible construction.

- Maintain a 1-in. (25 mm) clearance from combustible materials to supply air ductwork for a distance of 36-in. (914 mm) horizontally from the furnace. See NFPA 90B or local code for further requirements.

Table 1	Minimum Clearances to Combustible Materials for All Units	
POSITION	CLEARANCE In(mm)	
REAR	0	
FRONT (Combustion air openings in furnace and in structure)	1 (25)	
Required for service	24 (610)	
All Sides of Supply Plenum	1 (25)	
Sides	0	
Vent	0	
Top of Furnace	1 (25)	

- These furnaces SHALL NOT be installed directly on carpeting, tile, or any other combustible material other than wood flooring. In downflow installations, factory accessory floor base MUST be used when installed on combustible materials and wood flooring. Special base is not required when this furnace is installed on manufacturer's Coil Assembly or when Coil Box is used. See **Table 1** for clearance to combustible construction information.

Introduction

The 4-way multipoise Category IV condensing furnace is CSA design-certified as a direct (2-pipe) or non-direct vent (1-pipe) furnace. (See **Figure 3**) The furnace is factory-shipped for use with natural gas. The furnace can be converted in the field for use with propane gas when a factory-supplied conversion kit is used. Refer to the furnace rating plate for conversion kit information.

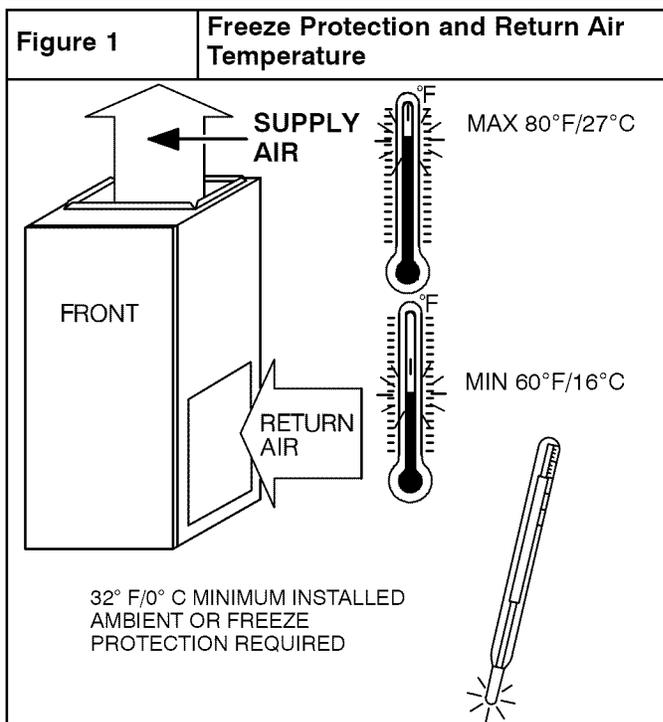
Single Stage furnace is approved for installation in a mobile home when a factory-supplied accessory mobile home conversion kit is used. The conversion kit is required for use with both natural and propane gas. The furnace must also be installed on a factory-supplied accessory combustible floor base or evaporator coil casing.

This furnace is designed for minimum continuous return-air temperature of 60°F (15°C) db or intermittent operation down to 55°F (15°C) db such as when used with a night setback thermostat. Return-air temperature must not exceed 80°F (27°C) db. Failure to follow these return-air temperature limits may affect reliability of heat exchangers, motors, and controls (See **Figure 1**)

The furnace should be sized to provide 100 percent of the design heating load requirement plus any margin that occurs because of furnace model size capacity increments. Heating load estimates can be made using approved methods available from Air Conditioning Contractors of America (Manual J); American Society of Heating, Refrigerating, and Air-Conditioning Engineers; or other approved engineering methods. Excessive oversizing of the furnace could cause the furnace and/or vent to fail prematurely.

For accessory installation details, refer to the applicable instruction literature.

NOTE: Remove all shipping materials, parts assemblies and literature before operating the furnace.



Codes and Standards

Follow all national and local codes and standards in addition to these instructions. The installation must comply with regulations of the serving gas supplier, local building, heating, plumbing, and other codes. In absence of local codes, the installation must comply with the national codes listed below and all authorities having jurisdiction.

In the United States and Canada, follow all codes and standards for the following:

Safety

- US: National Fuel Gas Code (NFGC) NFPA 54-2009/ANSI Z223.1-2009 and the Installation Standards, Warm Air Heating and Air Conditioning Systems ANSI/NFPA 90B
- A manufactured (Mobile) home installation must conform with the Manufactured Home Construction and Safety Standard, Title 24 CFR, Part 3280, or when this standard is not applicable, the Standard for Manufactured Home Installation (Manufactured Home Sites, Communities, and Set-Ups), ANSI/NCS A225.1, and/or CAN/CSA-Z240, MH Series Mobile Homes
- CANADA: National Standard of Canada, Natural Gas and Propane Installation Code (NSCNGPIC) CAN/CSA B149.1-2010

General Installation

- US: NFGC and the NFPA 90B. For copies, contact the National Fire Protection Association Inc., Batterymarch Park, Quincy, MA 02269; or for only the NFGC contact the American Gas Association, 400 N. Capitol, N.W., Washington DC 20001.
- CANADA: NSCNGPIC. For a copy, contact Standard Sales, CSA International, 178 Rexdale Boulevard, Etobicoke (Toronto), Ontario, M9W 1R3, Canada.

Combustion and Ventilation Air

- US: Section 9.3 of the NFPA54/ANSI Z223.1-2009, Air for Combustion and Ventilation
- CANADA: Part 8 of the CAN/CSA B149.1-2010, Venting Systems and Air Supply for Appliances

Duct Systems

- US and CANADA: Air Conditioning Contractors Association (ACCA) Manual D, Sheet Metal and Air Conditioning Contractors National Association (SMACNA), or American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 2005 Fundamentals Handbook Chapter 35.

Acoustical Lining and Fibrous Glass Duct

- US and CANADA: current edition of SMACNA, NFPA 90B as tested by UL Standard 181 for Class I Rigid Air Ducts

Gas Piping and Gas Pipe Pressure Testing

- U.S.A.: NFPA 54/ANSI Z223.1–2009, NFGC; Chapters 5, 6, 7, and 8 and national plumbing codes.
- CANADA: CAN/CSA-B149.1–2010, Parts 4, 5, 6 and 9.

In the state of Massachusetts:

- This product must be installed by a licensed plumber or gas fitter.
- When flexible connectors are used, the maximum length shall not exceed 36-in. (914 mm).
- When lever type gas shutoffs are used they shall be T-handle type.
- The use of copper tubing for gas piping is not approved by the state of Massachusetts.

Electrical Connections

- U.S.A.: National Electrical Code (NEC) ANSI/NFPA 70–2011
- CANADA: Canadian Electrical Code CSA C22.1

Electrostatic Discharge (ESD)

Precautions Procedure



CAUTION

FURNACE RELIABILITY HAZARD

Failure to follow this caution may result in unit component damage.

Electrostatic discharge can affect electronic components. Take precautions during furnace installation and servicing to protect the furnace electronic control. Precautions will prevent electrostatic discharges from personnel and hand tools which are held during the procedure. These precautions will help to avoid exposing the control to electrostatic discharge by putting the furnace, the control, and the person at the same electrostatic potential.

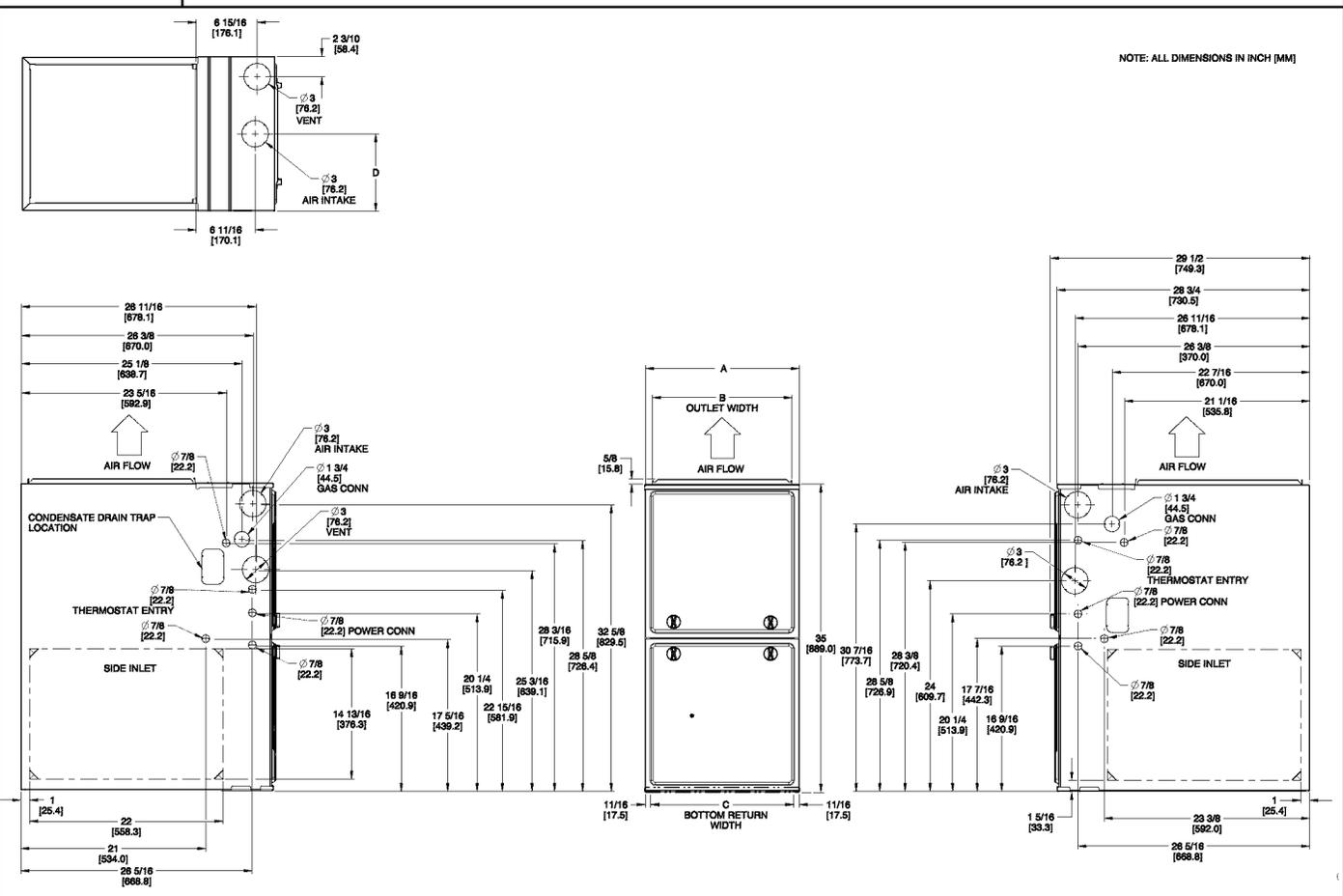
- Disconnect all power to the furnace. Multiple disconnects may be required. DO NOT TOUCH THE CONTROL OR ANY WIRE CONNECTED TO THE CONTROL PRIOR TO DISCHARGING YOUR BODY'S ELECTROSTATIC CHARGE TO GROUND.
- Firmly touch the clean, unpainted, metal surface of the furnace chassis which is close to the control. Tools held in a person's hand during grounding will be satisfactorily discharged.
- After touching the chassis, you may proceed to service the control or connecting wires as long as you do nothing to recharge your body with static electricity (for example; DO NOT move or shuffle your feet, do not touch ungrounded objects, etc.).
- If you touch ungrounded objects (and recharge your body with static electricity), firmly touch a clean, unpainted metal surface of the furnace again before touching control or wires.
- Use this procedure for installed and uninstalled (ungrounded) furnaces.
- Before removing a new control from its container, discharge your body's electrostatic charge to ground to protect the control from damage. If the control is to be installed in a furnace, follow items 1 through 4 before bringing the control or yourself in contact with the furnace. Put all used and new controls into containers before touching ungrounded objects.
- An ESD service kit (available from commercial sources) may also be used to prevent ESD damage.

Accessories

See Specification Sheets for a list of accessories for this product.

Table 2	Loose Parts Bag Contents (shipped in blower compartment)
QUANTITY	COMPONENT NAME
1	Air Intake Pipe Flange
1	Vent Pipe Flange
2	Coupling Flange Gaskets
10	Sharp Tip Screws (Vent and Inlet Flanges)
1	Vent Pipe Coupling
2	Vent Pipe Coupling Clamps
1	Pressure Switch Tube
1	Outlet Choke Plate (used with 40k BTUH furnaces, only)
1	Drain Tube Elbow
1	Drain Extension Tube
2	Drain Tube Clamps
1	Drain Line Grommet
1	Gas Line Grommet
1	Gas Line Knockout Plug
1	Junction Box Cover
1	Junction Box Base
1	Green Ground Screw
3	Blunt Tip Screws (Junction Box)
1	Thermostat Wire Grommet

Figure 2 Dimensions



(F/G)9MVT FURNACE SIZE	A	B	C	D	SHIP WT. LB (KG)
	CABINET WIDTH	OUTLET WIDTH	BOTTOM INLET WIDTH	AIR INTAKE	
40,000	14-3/16 (361)	12-1/2 (319)	12-9/16 (322)	7-1/8 (181)	121 (54)
60,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	142 (63)
80,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	152 (68)
100,000	21 (533)	19-3/8 (492)	19-1/2 (495)	10-1/2 (267)	166 (75)
120,000	24-1/2 (622)	22-7/8 (581)	23 (584)	12-1/4 (311)	190 (86)
(F/G)9MXT FURNACE SIZE	A	B	C	D	SHIP WT. LB (KG)
	CABINET WIDTH	OUTLET WIDTH	BOTTOM INLET WIDTH	AIR INTAKE	
40,000	14-3/16 (361)	12-1/2 (319)	12-9/16 (322)	7-1/8 (181)	125 (56)
60,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	146 (66)
80,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	156 (70)
100,000	21 (533)	19-3/8 (492)	19-1/2 (495)	10-1/2 (267)	171 (77)
120,000	24-1/2 (622)	22-7/8 (581)	23 (584)	12-1/4 (311)	195 (88)
(F/G)9MXE FURNACE SIZE	A	B	C	D	SHIP WT. LB (KG)
	CABINET WIDTH	OUTLET WIDTH	BOTTOM INLET WIDTH	AIR INTAKE	
40,000	14-3/16 (361)	12-1/2 (319)	12-9/16 (322)	7-1/8 (181)	120 (54)
60,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	141 (63)
80,000	17-1/2 (445)	15-7/8 (403)	16 (406)	8-3/4 (222)	151 (68)
100,000	21 (533)	19-3/8 (492)	19-1/2 (495)	10-1/2 (267)	179 (80)
120,000	24-1/2 (622)	22-7/8 (581)	23 (584)	12-1/4 (311)	203 (91)

NOTE: Doors may vary by model.

- a. For 800 CFM 16-in. (406 mm) round or 14 1/2 x 12-in. (368 x 305 mm) rectangle.
- b. For 1200 CFM 20-in. (508 mm) round or 14 1/2 x 19 1/2-in. (368 x 495 mm) rectangle.
- c. For 1600 CFM 22-in. (559 mm) round or 14 1/2 x 22 1/16-in. (368 x 560 mm) rectangle.
- d. For airflow requirements above 1800 CFM, see Air Delivery table in Installation Instructions for specific use of single side inlets. The use of both side inlets, a combination of 1 side and the bottom, or the bottom only return air openings may be required for airflow requirements above 1800 CFM at 0.5 in. w.c. ESP

Location



CAUTION

PERSONAL INJURY AND/OR PROPERTY DAMAGE HAZARD

Improper use or installation of this furnace may result in premature furnace component failure. This gas furnace may be used for heating buildings under construction provided that:

–The furnace is permanently installed with all electrical wiring, piping, venting and ducting installed according to these installation instructions. A return air duct is provided, sealed to the furnace casing, and terminated outside the space containing the furnace. This prevents a negative pressure condition as created by the circulating air blower, causing a flame rollout and/or drawing combustion products into the structure.

–The furnace is controlled by a thermostat. It may not be “hot wired” to provide heat continuously to the structure without thermostatic control.

–Clean outside air is provided for combustion. This is to minimize the corrosive effects of adhesives, sealers and other construction materials. It also prevents the entrainment of drywall dust into combustion air, which can cause fouling and plugging of furnace components.

–The temperature of the return air to the furnace is maintained between 55°F (13°C) and 80°F (27°C), with no evening setback or shutdown. The use of the furnace while the structure is under construction is deemed to be intermittent operation per our installation instructions.

–The air temperature rise is within the rated rise range on the furnace rating plate, and the gas input rate has been set to the nameplate value.

–The filters used to clean the circulating air during the construction process must be either changed or thoroughly cleaned prior to occupancy.

–The furnace, ductwork and filters are cleaned as necessary to remove drywall dust and construction debris from all HVAC system components after construction is completed.

–Verify proper furnace operating conditions including ignition, gas input rate, air temperature rise, and venting according to these installation instructions.

General

These furnaces are shipped with the following materials to assist in proper furnace installation. These materials are shipped in the main blower compartment.

See **Table 2** for loose parts bag contents.

This furnace must:

- be installed so the electrical components are protected from water.
- not be installed directly on any combustible material other than wood flooring (refer to SAFETY CONSIDERATIONS).

- be located close to the chimney or vent and attached to an air distribution system. Refer to Air Ducts section.
- be provided ample space for servicing and cleaning. Always comply with minimum fire protection clearances shown in **Table 1** or on the furnace clearance to combustible construction label.



WARNING

CARBON MONOXIDE POISONING / COMPONENT DAMAGE HAZARD

Failure to follow this warning could result in personal injury or death and unit component damage.

Corrosive or contaminated air may cause failure of parts containing flue gas, which could leak into the living space. Air for combustion must not be contaminated by halogen compounds, which include fluoride, chloride, bromide, and iodide. These elements can corrode heat exchangers and shorten furnace life. Air contaminants are found in aerosol sprays, detergents, bleaches, cleaning solvents, salts, air fresheners, and other household products. Do not install furnace in a corrosive or contaminated atmosphere. Make sure all combustion and circulating air requirements are met, in addition to all local codes and ordinances.

The following types of furnace installations may require OUTDOOR AIR for combustion due to chemical exposures:

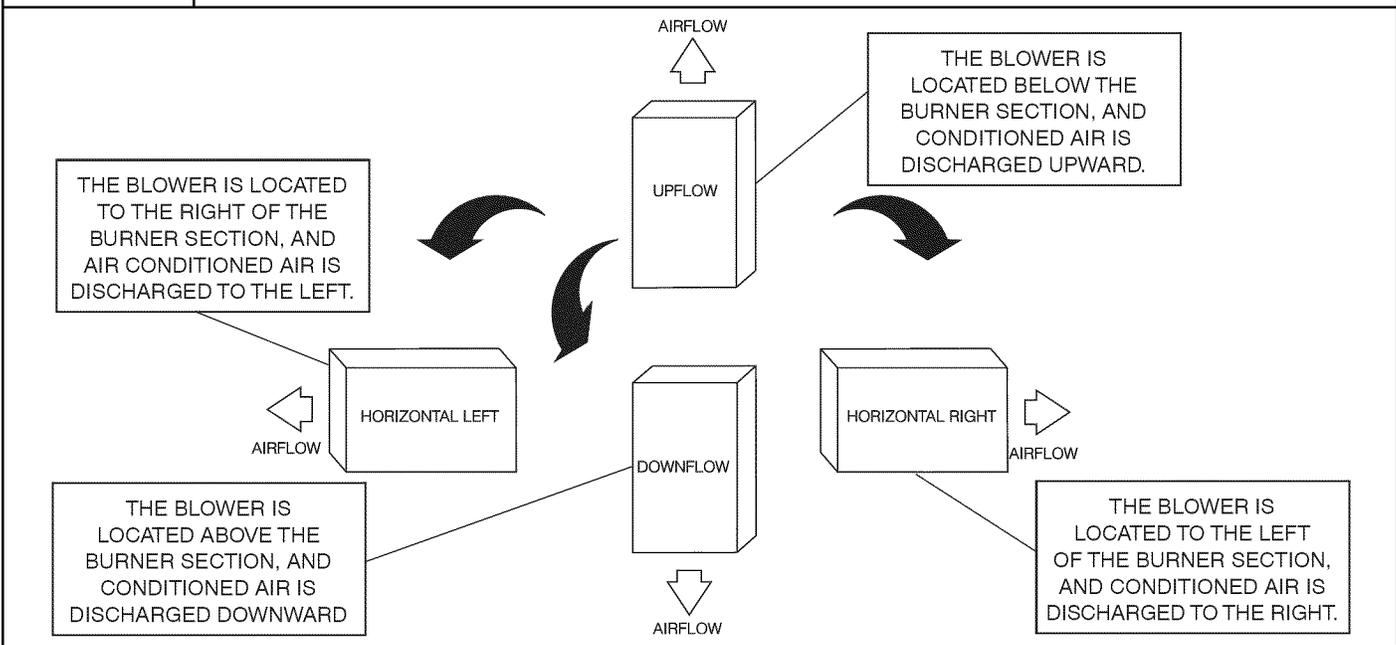
- Commercial buildings
- Buildings with indoor pools
- Laundry rooms
- Hobby or craft rooms, and
- Chemical storage areas

If air is exposed to the following substances, it should not be used for combustion air, and outdoor air may be required for combustion:

- Permanent wave solutions
- Chlorinated waxes and cleaners
- Chlorine based swimming pool chemicals
- Water softening chemicals
- De-icing salts or chemicals
- Carbon tetrachloride
- Halogen type refrigerants
- Cleaning solvents (such as perchloroethylene)
- Printing inks, paint removers, varnishes, etc.
- Hydrochloric acid
- Cements and glues
- Antistatic fabric softeners for clothes dryers
- Masonry acid washing materials

All fuel-burning equipment must be supplied with air for fuel combustion. Sufficient air must be provided to avoid negative pressure in the equipment room or space. A positive seal must be made between the furnace cabinet and the return-air duct to prevent pulling air from the burner area.

Figure 3 Multipoise Orientations



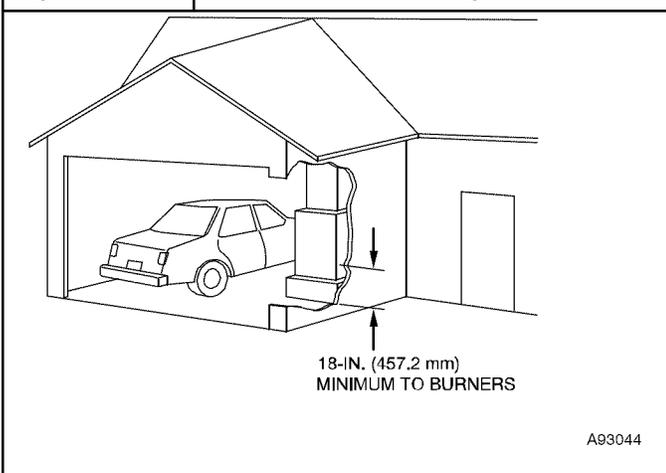
⚠ WARNING

FIRE, INJURY OR DEATH HAZARD

Failure to follow this warning could result in personal injury, death and/or property damage.

When the furnace is installed in a residential garage, the burners and ignition sources must be located at least 18-in. (457 mm) above the floor. The furnace must be located or protected to avoid damage by vehicles. When the furnace is installed in a public garage, airplane hangar, or other building having a hazardous atmosphere, the furnace must be installed in accordance with the NFPA 54/ANSI Z223.1-2009 or CAN/CSA B149.1-2010. (See **Figure 4**)

Figure 4 Installation in a Garage



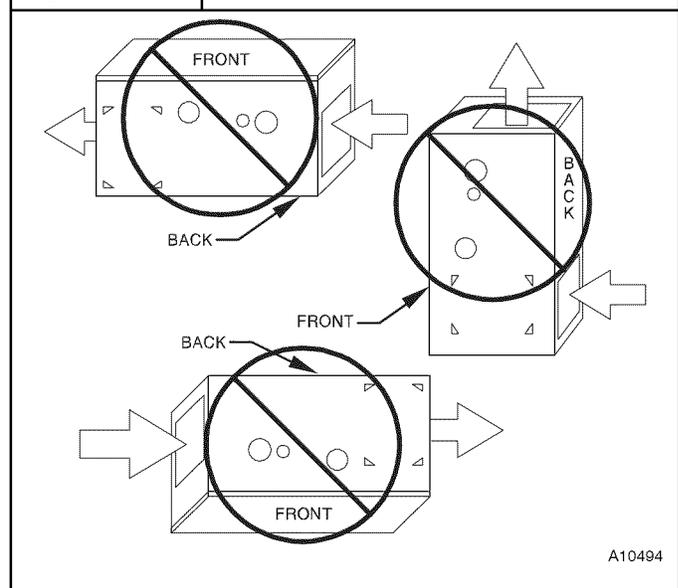
⚠ WARNING

FIRE HAZARD

Failure to follow this warning could result in personal injury, death and/or property damage.

Do not install the furnace on its back or hang furnace with control compartment facing downward. Safety control operation will be adversely affected. Never connect return-air ducts to the back of the furnace. (See **Figure 5**)

Figure 5 Prohibit Installations



Location Relative to Cooling Equipment

The cooling coil must be installed parallel with, or on the downstream side of the unit to avoid condensation in the heat exchangers. When installed parallel with the furnace, dampers or other flow control must prevent chilled air from entering the furnace. If the dampers are manually operated, they must be equipped with means to prevent operation of either unit unless the damper is in the full-heat or full-cool position.

Air for Combustion and Ventilation

Introduction

Direct Vent (2-pipe) Applications

When the furnace is installed as a direct vent (2-pipe) furnace, no special provisions for air for combustion are required. However, other gas appliances installed in the space with the furnace may require outside air for combustion. Follow the guidelines below to insure that other gas appliances have sufficient air for combustion.

Non-Direct Vent (1-pipe) Applications

When the furnace is installed as a non-direct vent (1-pipe) furnace, it will be necessary to insure there is adequate air for combustion. Other gas appliances installed with the furnace may also require air for combustion and ventilation in addition to the amount of combustion air and ventilation air required for the furnace. Follow the guidelines below to insure that the furnace and other gas appliances have sufficient air for combustion.

Ventilated Combustion Air Applications

When the furnace is installed using the ventilated combustion air option, the attic or crawlspace must freely communicate with the outdoor to provide sufficient air for combustion. The combustion air pipe cannot be terminated in attics or crawlspaces that use ventilation fans designed to operate during the heating season. If ventilation fans are present in these areas, the combustion air pipe must terminate outdoors as a Direct Vent/ 2-Pipe system.

All air for combustion is piped directly to the furnace from a space that is well ventilated with outdoor air (such as an attic or crawlspace) and the space is well isolated from the living space or garage. In addition, other gas appliances installed in the space with the furnace may require outside air for combustion. Follow the guidelines below to insure that the roof or crawlspace walls have sufficient free area to provide sufficient air for combustion and ventilation for the furnaces. The guidelines below can be used to insure that other gas appliances have sufficient air for combustion.

Provisions for adequate combustion, ventilation, and dilution air must be provided in accordance with:

- **U.S. Installations:** Section 9.3 of the NFPA 54/ANSI Z223.1-2009, Air for Combustion and Ventilation and applicable provisions of the local building codes.
- **Canadian Installations:** Part 8 of CAN/CSA-B149.1-2010, Venting Systems and Air Supply for Appliances and all authorities having jurisdiction.



CAUTION

FURNACE CORROSION HAZARD

Failure to follow this caution may result in furnace damage.

Air for combustion must not be contaminated by halogen compounds, which include fluoride, chloride, bromide, and iodide. These elements can corrode heat exchangers and shorten furnace life. Air contaminants are found in aerosol sprays, detergents, bleaches, cleaning solvents, salts, air fresheners, and other household products.



WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in personal injury or death.

The operation of exhaust fans, kitchen ventilation fans, clothes dryers, attic exhaust fans or fireplaces could create a **NEGATIVE PRESSURE CONDITION** at the furnace. Make-up air **MUST** be provided for the ventilation devices, in addition to that required by the furnace. Refer to the Carbon Monoxide Poisoning Hazard warning in the venting section of these instructions to determine if an adequate amount of make-up air is available.

The requirements for combustion and ventilation air depend upon whether or not the furnace is located in a space having a volume of at least 50 cubic feet per 1,000 Btuh (4.8 cubic meters per kW) input rating for all gas appliances installed in the space.

- Spaces having less than 50 cubic feet per 1,000 Btuh (4.8 cubic meters per kW) require the **OUTDOOR COMBUSTION AIR METHOD**.
- Spaces having at least 50 cubic feet per 1,000 Btuh (4.8 cubic meters per kW) may use the **INDOOR COMBUSTION AIR, STANDARD** or **KNOWN AIR INFILTRATION METHOD**.

Outdoor Combustion Air Method

1. Provide the space with sufficient air for proper combustion, ventilation, and dilution of flue gases using permanent horizontal or vertical duct(s) or opening(s) directly communicating with the outdoors or spaces that freely communicate with the outdoors.
2. **Figure 6** illustrates how to provide **TWO OUTDOOR OPENINGS**, one inlet and one outlet combustion and ventilation air openings to the outdoors.
 - a. One opening **MUST** commence within 12-in. (300 mm) of the ceiling and the second opening **MUST** commence within 12-in. (300 mm) of the floor.
 - b. Size openings and ducts per **Figure 6** and **Table 3**.
 - c. **TWO HORIZONTAL DUCTS** require 1 square inch (25.4 square mm) of free area per 2,000 Btuh (1,100 mm²/kW) of combined input for all gas appliances in the space per **Figure 6** and **Table 3**.
 - d. **TWO OPENINGS OR VERTICAL DUCTS** require 1 square inch (25.4 square mm) of free area per 4,000 Btuh (550 mm²/kW) for combined input of all gas appliances in the space per **Figure 6** and **Table 3**.
3. **ONE OUTDOOR OPENING** requires:
 - a. 1 sq. in. (25.4 square mm) of free area per 3,000 Btuh (734 mm²/kW) for combined input of all gas appliances in the space per **Table 3** and

- b. Not less than the sum of the areas of all vent connectors in the space.

The opening shall commence within 12-in. (300 mm) of the ceiling. Appliances in the space shall have clearances of at least 1-in. (25 mm) from the sides and back and 6-in. (150 mm) from the front. 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.

Indoor Combustion Air® NFPA & AGA Standard and Known-Air-Infiltration Rate Methods

Indoor combustion air is permitted for combustion, ventilation, and dilution, if the **Standard** or **Known-Air-Infiltration Rate Method** is used.

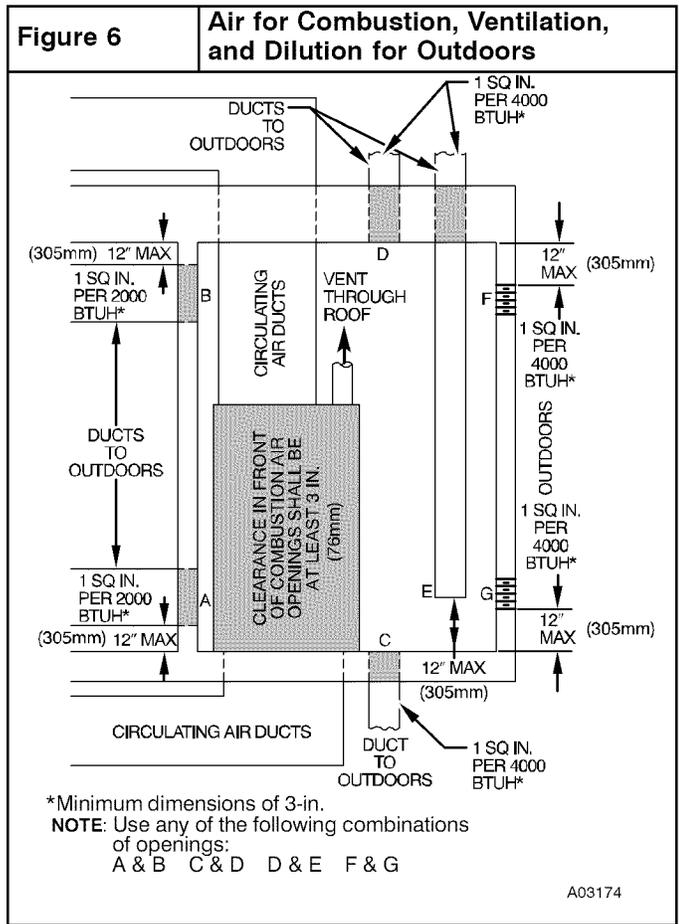
! WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in personal injury or death.

Many homes require air to be supplied from outdoors for furnace combustion, ventilation, and dilution of flue gases.

The furnace combustion air supply must be provided in accordance with this instruction manual.



The **Standard Method**:

1. The space has no less volume than 50 cubic feet per 1,000 Btuh (4.8 cubic meters per kW) of the maximum input ratings for all gas appliances installed in the space and
2. The air infiltration rate is not known to be less than 0.40 air changes per hour (ACH).

The **Known Air Infiltration Rate Method** shall be used, if the infiltration rate is known to be:

1. Less than 0.40 ACH and
2. Equal to or greater than 0.10 ACH

Infiltration rates greater than 0.60 ACH shall not be used. The minimum required volume of the space varies with the number of ACH and shall be determined per **Table 4** or Equations 1 and 2. Determine the minimum required volume for each appliance in the space and add the volumes together to get the total minimum required volume for the space.

Table 4 - Minimum Space Volumes were determined by using the following equations from the National Fuel Gas Code ANSI Z223.1/NFPA 54-2009, 9.3.2.2:

1. For **other than fan-assisted appliances**, such as a draft hood-equipped water heater

$$\text{Volume}_{\text{Other}} = \frac{21\text{ft}^3}{\text{ACH}} \left(\frac{I_{\text{other}}}{1000 \text{ Btu/hr}} \right)$$

A04002

2. For **fan-assisted appliances** such as this furnace:

$$\text{Volume}_{\text{Fan}} = \frac{15\text{ft}^3}{\text{ACH}} \left(\frac{I_{\text{fan}}}{1000 \text{ Btu/hr}} \right)$$

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If:

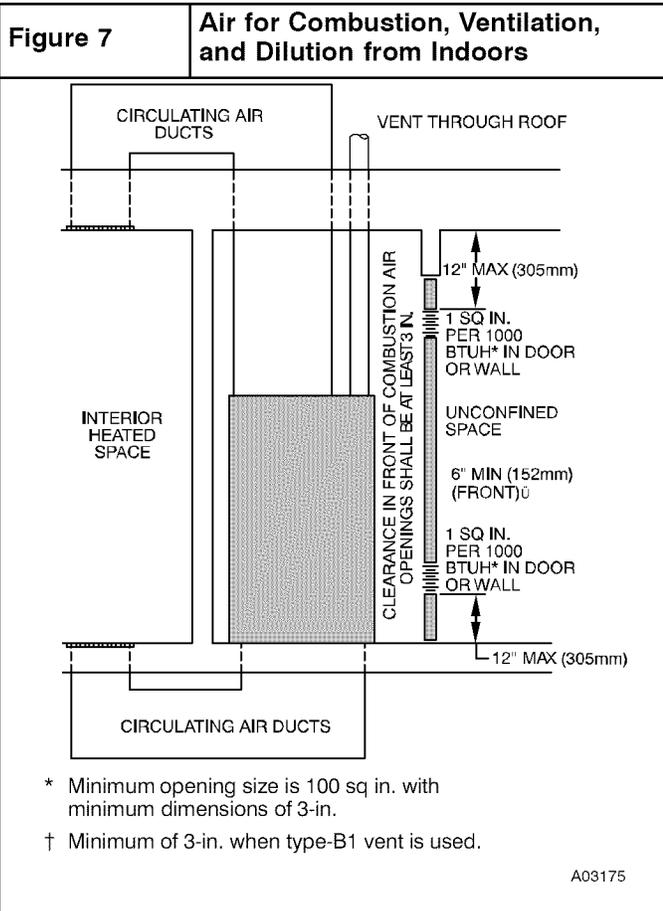
I_{other} =combined input of all **other than fan-assisted appliances** in Btuh/hr

I_{fan} =combined input of all **fan-assisted appliances** in Btuh/hr

ACH = air changes per hour (ACH shall not exceed 0.60.)

The following requirements apply to the **Standard Method** and to the **Known Air Infiltration Rate Method**.

1. Adjoining rooms can be considered part of a space if:
 - a. There are no closable doors between rooms.
 - b. Combining spaces on same floor level. Each opening shall have free area of at least 1-in.²/1,000 Btuh (2,000 mm²/kW) of the total input rating of all gas appliances in the space, but not less than 100-in.² (0.06 m²). One opening shall commence within 12-in. (300 mm) of the ceiling and the second opening shall commence within 12-in. (300 mm) of the floor. The minimum dimension of air openings shall be at least 3-in. (80 mm). (See **Figure 7**)
 - c. Combining space on different floor levels. The volumes of spaces on different floor levels shall be considered as communicating spaces if connected by one or more permanent openings in doors or floors having free area of at least 2-in.²/1,000 Btuh (4,400 mm²/kW) of total input rating of all gas appliances.
2. An attic or crawlspace may be considered a space that freely communicates with the outdoors provided there are adequate permanent ventilation openings directly to outdoors having free area of at least 1-in.²/4,000 Btuh of total input rating for all gas appliances in the space.



3. In spaces that use the **Indoor Combustion Air** Method, infiltration should be adequate to provide air for combustion, permanent ventilation and dilution of flue gases. However, in buildings with unusually tight construction, additional air **MUST** be provided using the methods described in the **Outdoor Combustion Air** Method section.
4. Unusually tight construction is defined as Construction with:
 - a. Walls and ceilings exposed to the outdoors have a continuous, sealed vapor barrier. Openings are gasketed or sealed and
 - b. Doors and openable windows are weatherstripped and
 - c. Other openings are caulked or sealed. These include joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, at penetrations for plumbing, electrical and gas lines, etc.

Combination of Indoor and Outdoor Air

1. Indoor openings shall comply with the **Indoor Combustion Air** Method below and,
2. Outdoor openings shall be located as required in the **Outdoor Combustion Air** Method mentioned previously and,
3. Outdoor openings shall be sized as follows:
 - a. Calculate the Ratio of all Indoor Space volume divided by required volume for **Indoor Combustion Air** Method.
 - b. Outdoor opening size reduction **Factor** is one minus the **Ratio** in a. above.
 - c. Minimum size of Outdoor openings shall be the size required in **Outdoor Combustion Air** Method above multiplied by reduction **Factor** in b. above. The minimum dimension of air openings shall be not less than 3-in. (80 mm).

FURNACE INPUT (BTUH)	TWO HORIZONTAL DUCTS (1 SQ. IN./2,000 BTUH) (1,100 SQ. MM/KW)		SINGLE DUCT OR OPENING (1 SQ. IN./3,000 BTUH) (734 SQ. MM/KW)		TWO OPENINGS OR VERTICAL DUCTS (1 SQ. IN./4,000 BTUH) (550 SQ. MM/KW)	
	Free Area of Opening and Duct Sq. In (Sq. mm)	Round Duct In. (mm) Dia	Free Area of Opening and Duct Sq. In (Sq. mm)	Round Duct In. (mm) Dia	Free Area of Opening and Duct Sq. In (mm)	Round Duct In. (mm) Dia.
40,000 *	20 (12904)	5 (127)	14 (8696)	5 (127)	10 (6452)	4 (102)
60,000	30 (19355)	6 (152)	20 (13043)	5 (127)	15 (9678)	5 (127)
80,000	40 (25807)	7 (178)	27 (17391)	6 (152)	20 (12904)	5 (127)
100,000	50 (32258)	8 (203)	34 (21739)	7 (178)	25 (16130)	6 (152)
120,000	60 (38709)	9 (229)	40 (26087)	7 (178)	30 (19355)	6 (152)
140,000 *	70 (45161)	10 (254)	47 (30435)	8 (203)	35 (22581)	7 (178)

* Not all families have these models.

EXAMPLE: Determining Free Area

FURNACE	+	WATER HEATER	=	TOTAL INPUT	=	Result
100,000	+	30,000	=	(130,000 divided by 4,000)	=	32.5 Sq. In. for each two Vertical Ducts or Openings
60,000	+	40,000	=	(100,000 divided by 3,000)	=	33.3 Sq. In. for each Single Duct or Opening
80,000	+	30,000	=	(110,000 divided by 2,000)	=	55.0 Sq. In. for each two Horizontal Ducts

ACH	OTHER THAN FAN-ASSISTED TOTAL (1,000'S BTUH GAS INPUT RATE)			FAN-ASSISTED TOTAL (1,000'S BTUH GAS INPUT RATE)					
	30	40	50	40	60	80	100	120	140
	Space Volume Ft ³ (M ³)								
0.60	1,050 (29.7)	1,400 (39.6)	1,750 (49.5)	1,400 (39.6)	1,500 (42.5)	2,000 (56.6)	2,500 (70.8)	3,000 (84.9)	3,500 (99.1)
0.50	1,260 (35.6)	1,680 (47.5)	2,100 (59.4)	1,680 (47.5)	1,800 (51.0)	2,400 (67.9)	3,000 (84.9)	3,600 (101.9)	4,200 (118.9)
0.40	1,575 (44.5)	2,100 (59.4)	2,625 (74.3)	2,100 (59.4)	2,250 (63.7)	3,000 (84.9)	3,750 (106.1)	4,500 (127.3)	5,250 (148.6)
0.30	2,100 (59.4)	2,800 (79.2)	3,500 (99.1)	2,800 (79.2)	3,000 (84.9)	4,000 (113.2)	5,000 (141.5)	6,000 (169.8)	7,000 (198.1)
0.20	3,150 (89.1)	4,200 (118.9)	5,250 (148.6)	4,200 (118.9)	4,500 (127.3)	6,000 (169.8)	7,500 (212.2)	9,000 (254.6)	10,500 (297.1)
0.10	6,300 (178.0)	8,400 (237.8)	10,500 (297.3)	8,400 (237.8)	9,000 (254.6)	12,000 (339.5)	15,000 (424.4)	18,000 (509.2)	21,000 (594.1)
0.00	NP	NP	NP	NP	NP	NP	NP	NP	NP

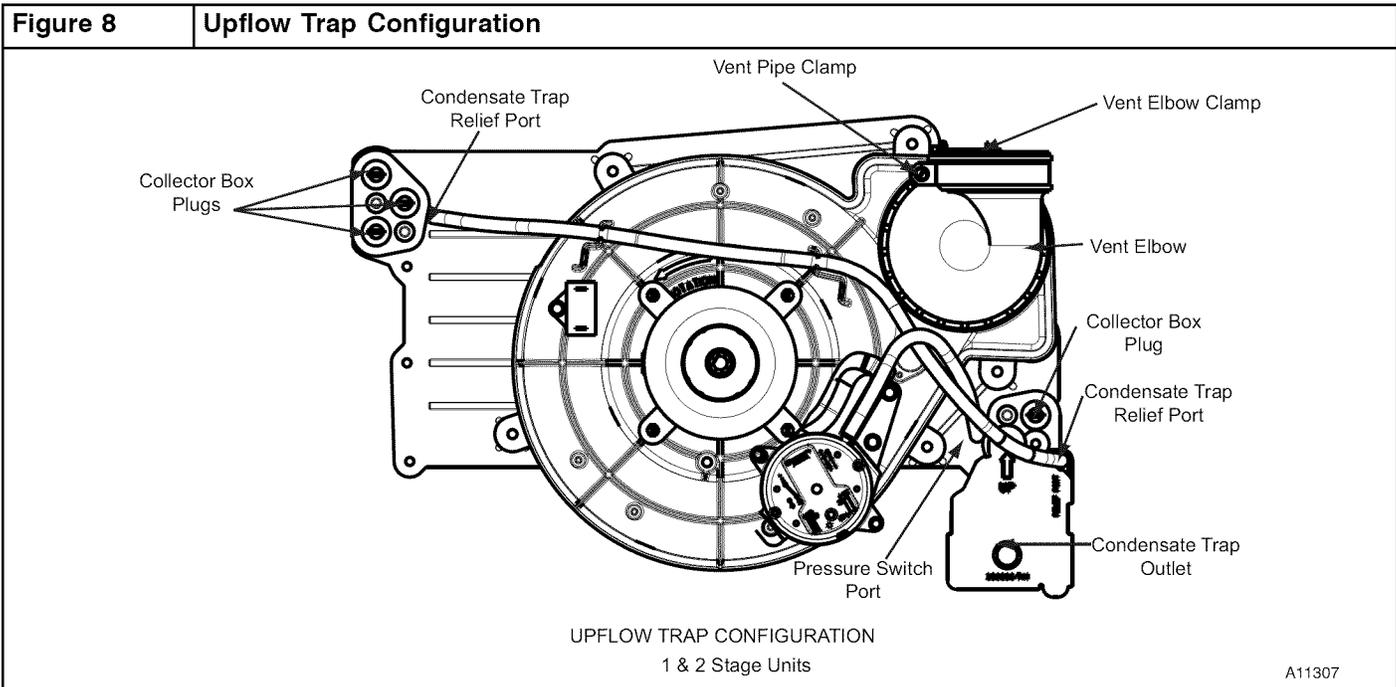
NP = Not Permitted

CONDENSATE TRAP

Condensate Trap – Upflow Orientation

When the furnace is installed in the upflow position, it is not necessary to relocate the condensate trap or associated

tubing. Refer to **Figure 8** for upflow condensate trap information. Refer to Condensate Drain section for information how to install the condensate drain.



Condensate Trap – Downflow Orientation

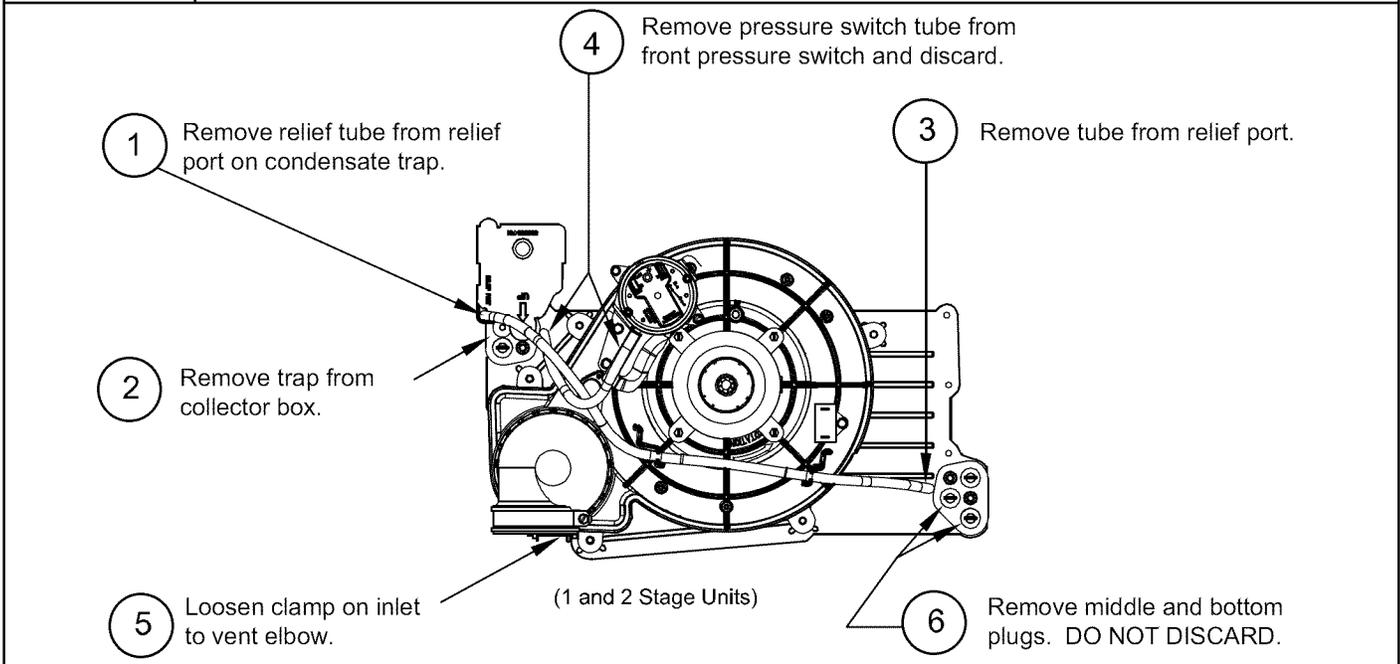
When the furnace is installed in the downflow position, the factory-installed trap will be located at the upper left corner of the collector box. When the furnace is installed in the downflow orientation, the factory-installed trap must be relocated for proper condensate drainage.

To Relocate the Condensate Trap:

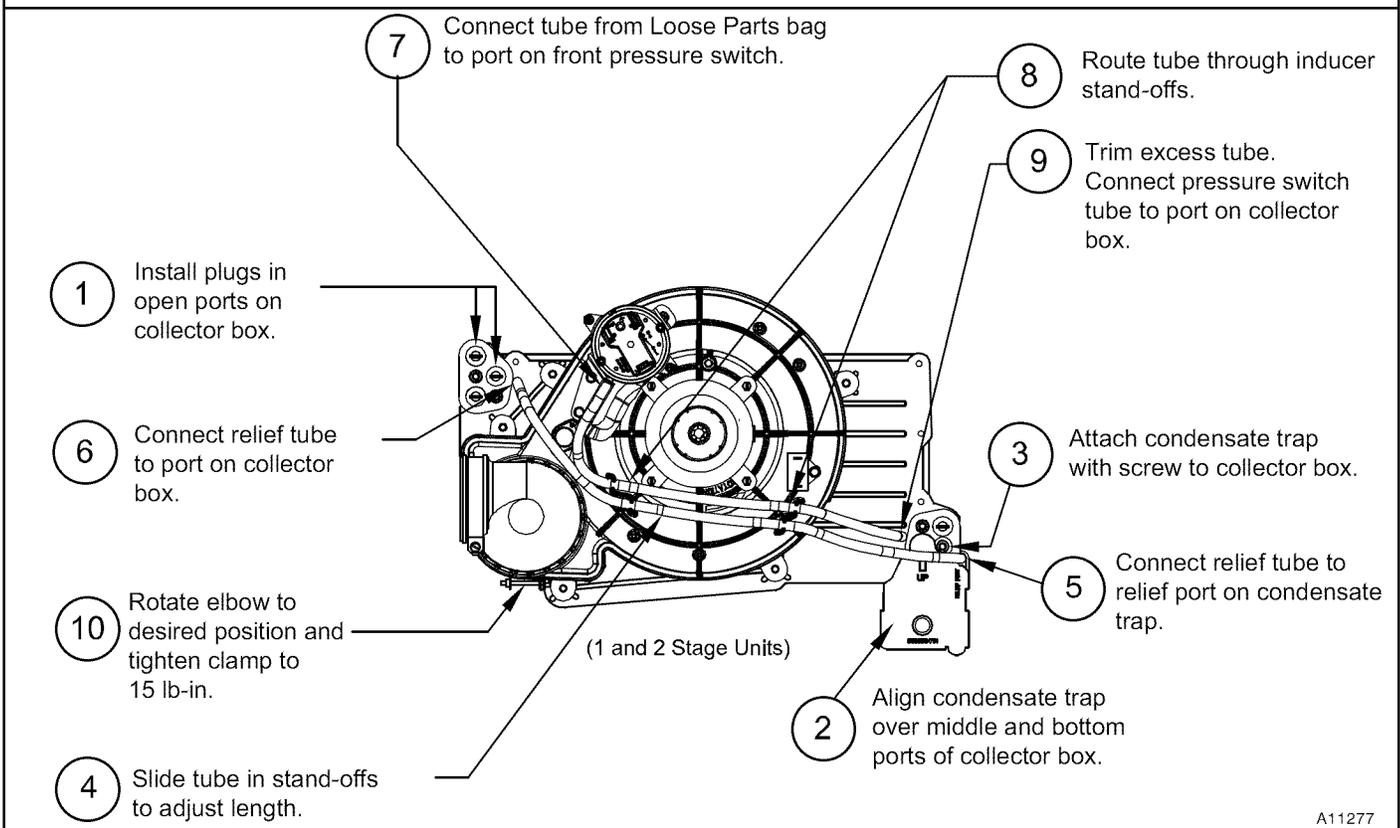
1. Orient the furnace in the desired position.
2. **Figure 9** shows the condensate trap and tubing before and after relocation.
3. Remove the relief tube from the condensate trap.
4. Remove the screw that secures the condensate trap to the collector box.
5. Remove the trap.
6. Remove the relief tube from of the port on the collector box. It is not necessary to remove the tube from the inducer assembly.
7. Remove the pressure switch tube from the front pressure switch and discard the tube. A new pressure switch tube is shipped in the loose parts bag.
8. Loosen the clamp around the inlet of the vent elbow on the inducer.
9. Remove the middle and bottom plugs from the lower right side of the collector box and set aside. **Do Not Discard Plugs.**
10. Refer to the appropriate figure to begin the trap conversion.
11. Install the two (2) plugs previously removed from the collector box in the ports where the condensate trap was removed.

12. Install the trap over the ports on the lower right side of the collector box.
13. Secure the trap to the collector box with the screw.
14. Connect the relief tube to the condensate trap to the relief port of the condensate trap.
15. If necessary, slide the relief tube in the inducer stand-offs to adjust the position of the tube.
16. Connect the relief tube to the relief port of the condensate trap.
17. Connect the new pressure switch tube to the port on the front pressure switch. Route the tube through the stand-offs on the inducer assembly and connect to the port on the collector box. Trim off any excess tube to avoid sags or kinks in the tube.
18. Rotate the vent elbow to the desired position and tighten the clamp 15 in.-lbs.
19. Refer to Condensate Drain section for information how to install the condensate drain.

Figure 9 Unconverted Factory Configuration as viewed in the Downflow orientation



Downflow Trap Configuration

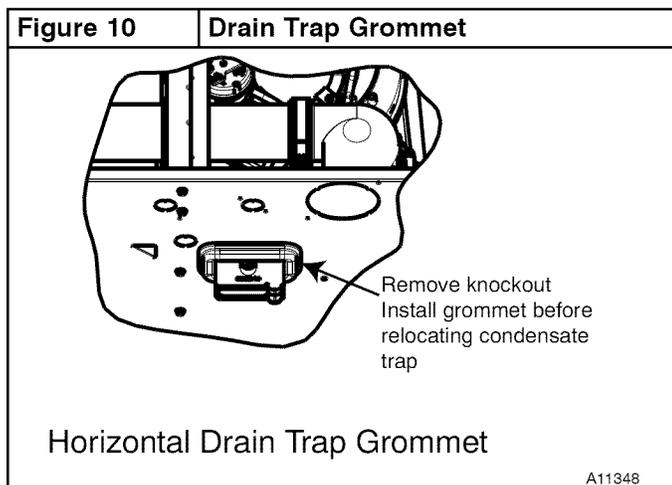


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Condensate Trap – Horizontal Orientation

When the furnace is installed in the horizontal right position, the factory-installed trap will be located at the bottom of the collector box. When the furnace is installed in the horizontal left position, the factory-installed trap will be located at the top of the collector box. The trap must be repositioned on the collector box for proper condensate drainage.

When the furnace is installed as a direct-vent furnace, a field supplied, accessory Horizontal Installation Kit is required for all horizontal installations. The kit contains a rubber casing grommet designed to seal between the furnace casing and the condensate trap. (See **Figure 10**)



NOTE: The condensate trap extends below the side of the casing in the horizontal position. A minimum of 2-in. (51 mm) of clearance is required between the casing side and the furnace platform for the trap to extend out of the casing in the horizontal position.

To Relocate the Condensate Trap:

1. Remove the knockout in the casing for the casing grommet.
2. Install the grommet in the casing.
3. Orient the furnace in the desired position.
4. Allow for 2-in. (51 mm) of clearance underneath the furnace for the condensate trap and drain line.
5. **Figure 11** shows the condensate trap and tubing before and after relocation in the horizontal right position.
6. **Figure 12** shows the condensate trap and tubing before and after relocation in the horizontal left position.
7. Refer to the appropriate figure to begin the trap conversion.

8. Remove the relief tube from the condensate trap.
9. Remove the screw that secures the condensate trap to the collector box.
10. Remove the trap.
11. Remove the relief tube from of the port on the collector box. It is not necessary to remove the tube from the inducer assembly.

For Horizontal Left only:

1. Remove the pressure switch tube from the front pressure switch and discard the tube. A new pressure switch tube is shipped in the loose parts bag.

For Horizontal Right only:

1. The pressure switch tube location is not modified.
2. Loosen the clamp around the inlet of the vent elbow on the inducer.
3. Remove the plugs from the collector box and set aside. **Do Not Discard Plugs.**

For Horizontal Left only:

1. Remove the middle and right plug from the ports at the bottom of the collector box.

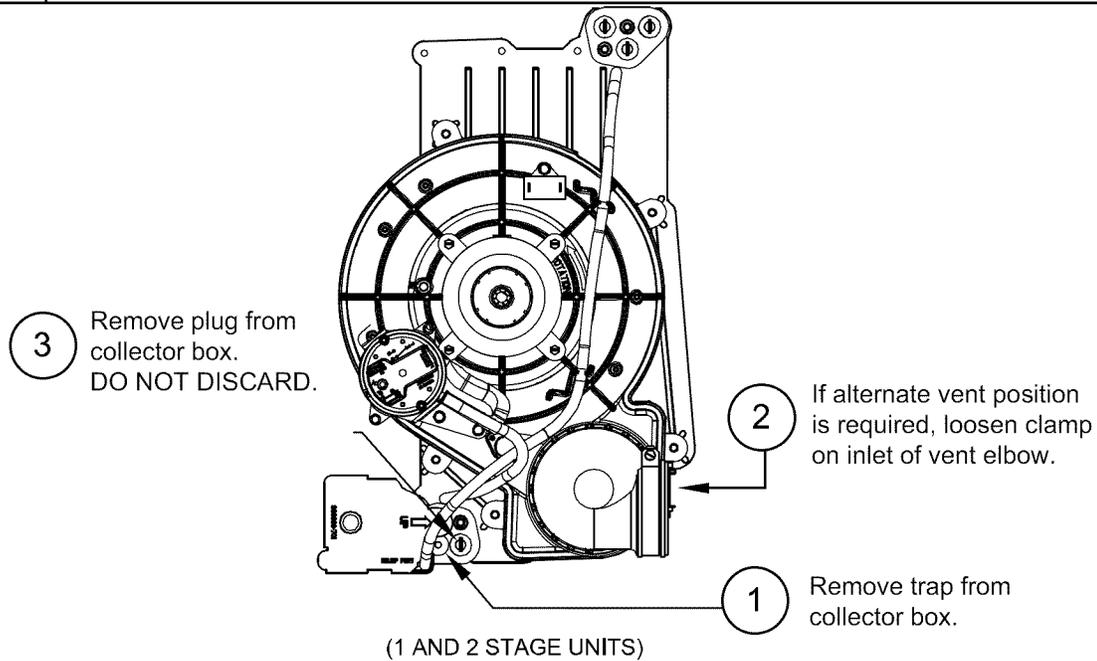
For Horizontal Right only:

1. Remove the plug to the right of the condensate trap.
2. Refer to the appropriate figure to begin the trap conversion.
3. Install the plugs previously removed from the collector box in the ports where the condensate trap was removed.
4. Install the trap over the ports on the lower side of the collector box.
5. Secure the trap to the collector box with the screw.
6. Connect the relief tube to the condensate trap to the relief port of the condensate trap.
7. If necessary, slide the relief tube in the inducer stand-offs to adjust the position of the tube.
8. Connect the relief tube to the relief port of the condensate trap.

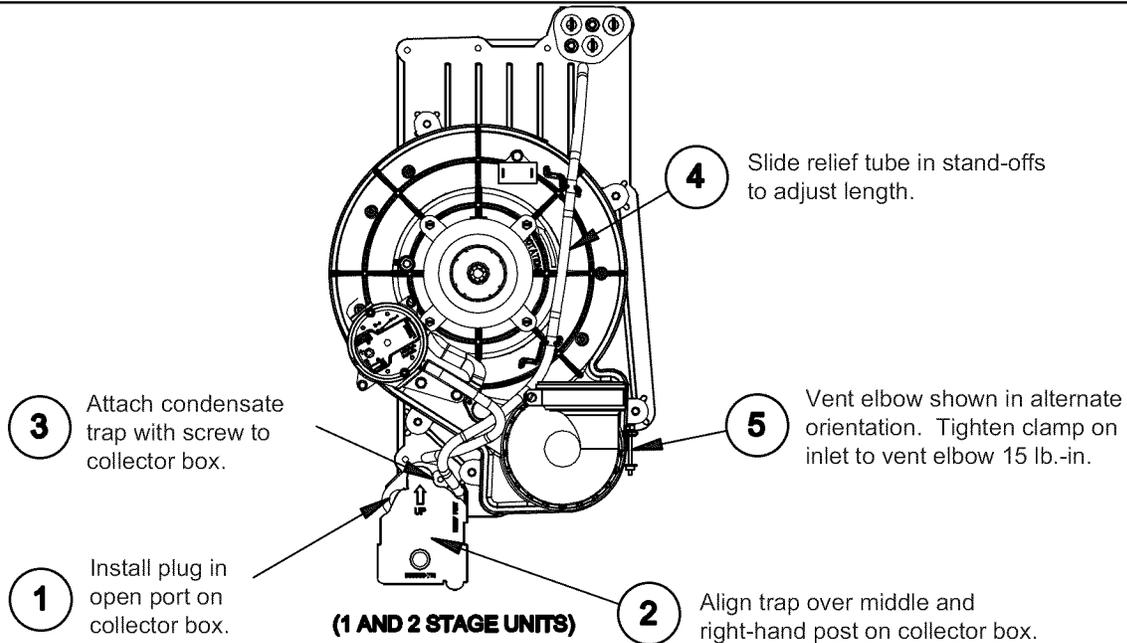
For Horizontal Left only:

1. Connect the new pressure switch tube to the port on the front pressure switch. Route the tube through the stand-offs on the inducer assembly and connect to the port on the collector box. Trim off any excess tube to avoid sags or kinks in the tube.
2. Rotate the vent elbow to the desired position and tighten the clamp 15 in.-lbs.
3. Refer to Condensate Drain section for information how to install the condensate drain.

Figure 11 Unconverted Factory Configuration as viewed in the Horizontal Right Orientation

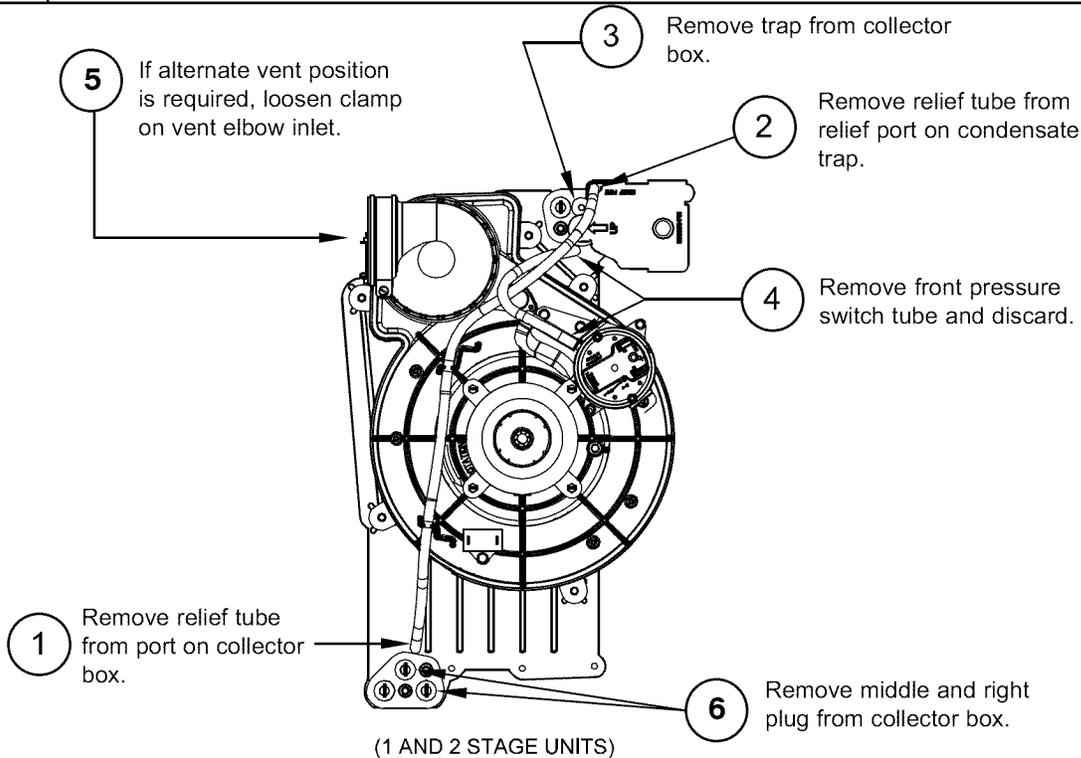


Horizontal Right Trap Configuration

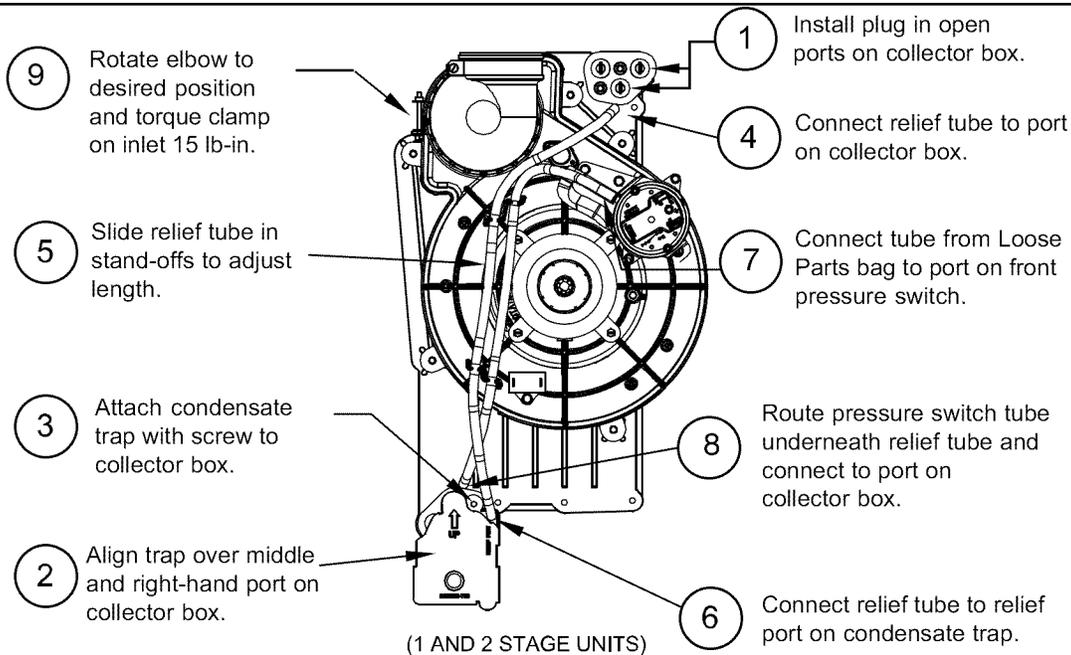


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Figure 12 Unconverted Factory Configuration as viewed in the Horizontal Left Orientation



Horizontal Left Trap Configuration



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Condensate Drain Connection

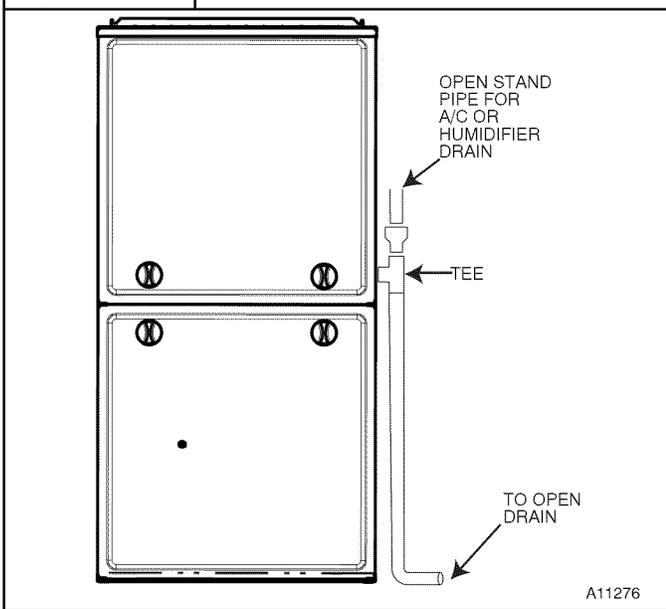
Upflow/Downflow Orientation

In the Upflow or Downflow orientation, the condensate trap is inside the furnace casing. The condensate drain must be routed from the trap through the furnace casing. The condensate drain can be routed through the left or right side of the casing. (The left or right side is as you are viewing the

furnace.) The furnace condensate drain can be connected to the Air Conditioning condensate drain as shown in **Figure 13**.

NOTE: On narrower casing, it may be easier to remove the condensate trap, connect the drain line components and re-install the condensate trap. Read the steps thoroughly to familiarize yourself with the required steps.

Figure 13 Example of Field Drain Attachment



For Right Side Condensate Drain:

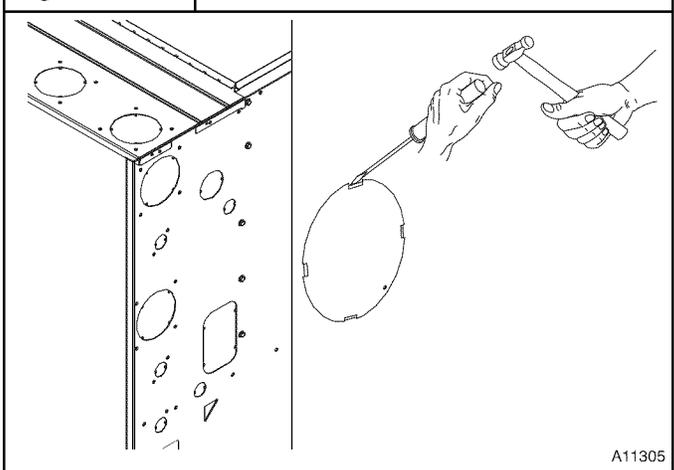
1. Remove the 7/8-in. knock-out from the right side of the casing. (See **Figure 14**)
2. Remove the pre-formed drain tube and two spring clamps from the loose parts bag.
3. Slide a spring clamp 1-in. down the plain end of the drain tube.
4. From inside the casing, insert the formed grommet end of the tube through the 7/8-in. knockout in the casing.
5. Pull the tube through the casing from the outside until it is seated in the knockout
6. Attach the plain end of the drain tube to the outlet stub on the drain trap. Secure the drain tube to the trap with the spring clamp.
7. Slide a spring clamp over the open end of the drain tube outside the casing.
8. Open the spring clamp and connect a field-supplied 1/2-in. CPVC street elbow to the open end of the drain tube.
9. Connect additional 1/2-in. CPVC piping to a condensate pump approved for use with acidic furnace condensate or to a code-approved drain.

For Left Side Condensate Drain Connection:

1. For left side condensate drainage, the drain line is routed from the condensate trap, behind the inducer and out through the left side of the casing. A pre-formed "Z" pipe is provided in the loose parts bag shipped with the furnace. The "Z" pipe is long enough to extend out of the casing on the 14 3/16-in. (360 mm) wide furnace. Larger casings will require a field supplied CPVC pipe and to extend the drain line out of the furnace.
2. The "Z" pipe is connected to the condensate trap by modifying the formed rubber drain tube. Connect the drain line as shown below:
3. Remove the knock-out from the left side of the casing. (See **Figure 14**)

4. Install the grommet for the 1/2-in. CPVC drain line in the 7/8-in. knockout in the casing.
5. Remove the pre-formed drain tube, the offset 1/2-in. CPVC pipe and two spring clamps from the loose parts bag.
6. Remove the formed grommet on the tube by cutting the tube along the vertical line located about 1-in. away from the formed grommet. (See **Figure 15**)
7. Slide a spring clamp 1-in. down the plain end of the drain tube
8. With the bend in the tube oriented horizontally and plain end of the tube pointing away from you, insert the 1/2-in. CPVC pipe into the other end of the drain tube. Rotate the tube so the offset in the tube points away from you. Slide a spring clamp over the open end of the 1/2-in. CPVC tube and secure the cut end of drain tube to the pipe.
9. Prime the bare end of the pipe with CPVC primer.
10. Route the offset pipe behind the inducer assembly and through the grommet in the casing, if the "Z" pipe is long enough. If the "Z" pipe is not long enough, continue with installation.
11. Attach the plain end of the drain tube to the outlet stub on the drain trap. Secure the drain tube to the trap with the spring clamp.
12. If the "Z" pipe does not extend through the casing, slide a piece of field supplied CPVC through the grommet in the casing, otherwise, go to Step 17.
13. Cement a 1/2-in. CPVC coupling to the end of the CPVC pipe.
14. Apply cement to the end of the "Z" pipe connected to the condensate trap.
15. Connect the field-supplied CPVC pipe to the CPVC pipe connected to the condensate trap.
16. Cut off excess CPVC pipe outside the casing.
17. Connect additional 1/2-in. CPVC piping to a condensate pump approved for use with acidic furnace condensate or to a code-approved drain.
18. When a condensate pump is not used, slope the pipe away from the furnace to allow for proper drainage.

Figure 14 Knockout Removal

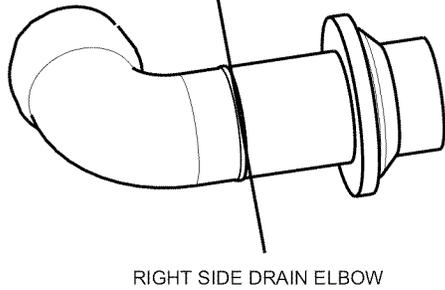


CAUTION

CUT HAZARD
 Failure to follow this caution may result in personal injury.
 Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts, and servicing furnaces.

Figure 15 Modify Drain Tube

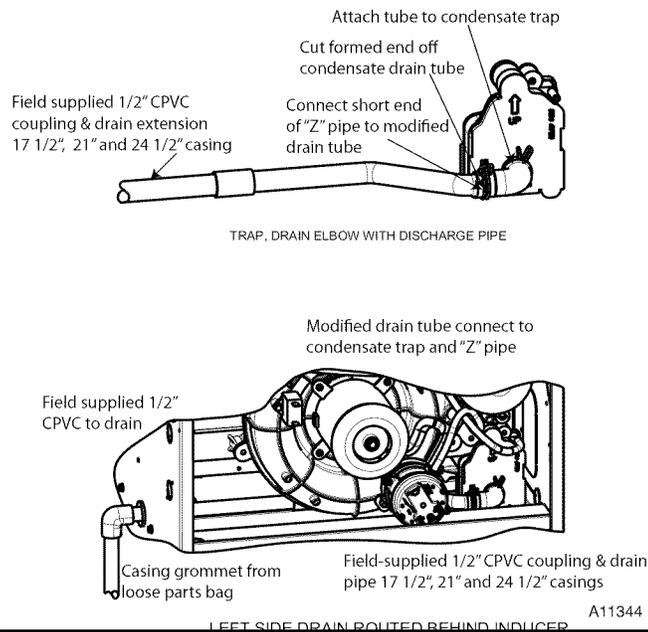
Cut and remove formed end of drain tube for left side and horizontal drain connection



RIGHT SIDE DRAIN ELBOW

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Figure 16 Drain Trap Connection and Routing



TRAP, DRAIN ELBOW WITH DISCHARGE PIPE

Modified drain tube connect to condensate trap and "Z" pipe

LEFT SIDE DRAIN ROUTED BEHIND INDUCER

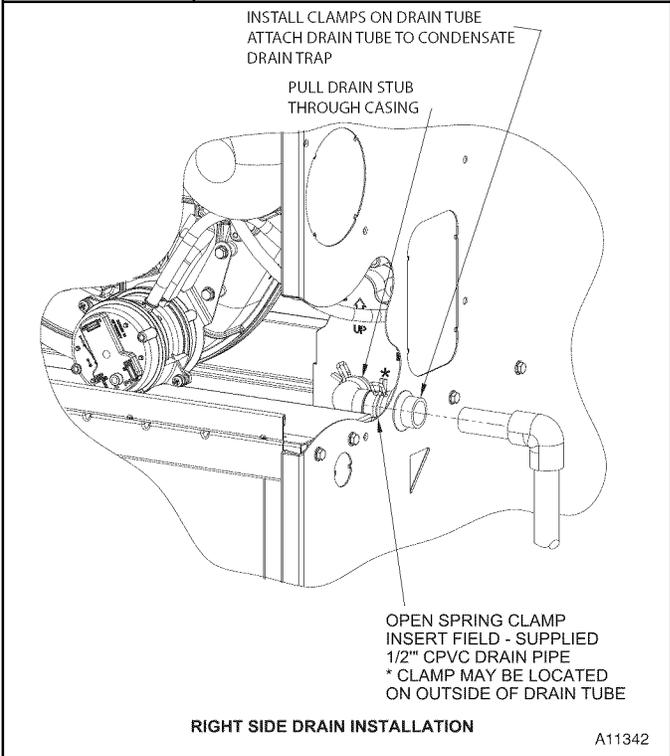
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Horizontal Orientation

1. In the Horizontal orientation, a field supplied accessory drain trap grommet is required to seal the gap between the casing and the condensate trap. The condensate trap outlet extends 2-in. (51 mm) below the furnace casing. To allow for servicing the trap, the condensate drain tube in the loose parts bag can be modified to make a coupler to allow for future service of the condensate trap and drain line.
2. Remove the knock-out for the condensate trap in the side of the casing.
3. Install the drain trap grommet in the casing. If necessary, remove the trap, install the grommet and re-install the trap.
4. Remove the pre-formed drain tube, the offset 1/2-in. CPVC pipe and two spring clamps from the loose parts bag.
5. Remove the formed grommet on the tube to create an elbow or straight connector. (See **Figure 17**)
6. Connect the cut tube to the outlet of the condensate trap with 1 spring clamp.

7. Slide the other spring clamp down the plain end of the drain tube.
8. Connect additional 1/2-in. CPVC piping to a condensate pump approved for use with acidic furnace condensate or to a code-approved drain.
9. When a condensate pump is not used, slope the pipe away from the furnace to allow for proper drainage.

Figure 17 Formed Tube Grommet



RIGHT SIDE DRAIN INSTALLATION

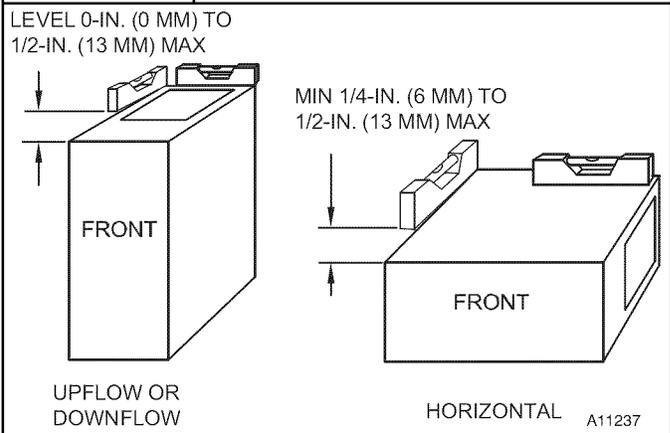
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INSTALLATION

UPFLOW INSTALLATION

NOTE: The furnace must be pitched forward as shown in **Figure 18** for proper condensate drainage.

Figure 18 Furnace Pitch Requirements



UPFLOW OR DOWNFLOW

HORIZONTAL

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Supply Air Connections

For a furnace not equipped with a cooling coil, the outlet duct shall be provided with a removable access panel. This opening shall be accessible when the furnace is installed and shall be of such a size that the heat exchanger can be viewed for possible openings using light assistance or a probe can be inserted for sampling the air stream. The cover attachment shall prevent leaks.

Connect supply-air duct to flanges on furnace supply-air outlet. Bend flange upward to 90° with wide duct pliers. (See **Figure 22**) The supply-air duct must be connected to ONLY the furnace supply-outlet-air duct flanges or air conditioning coil casing (when used). DO NOT cut main furnace casing side to attach supply air duct, humidifier, or other accessories. All accessories MUST be connected to duct external to furnace main casing.

Return Air Connections

WARNING

FIRE HAZARD

A failure to follow this warning could cause personal injury, death and/or property damage.

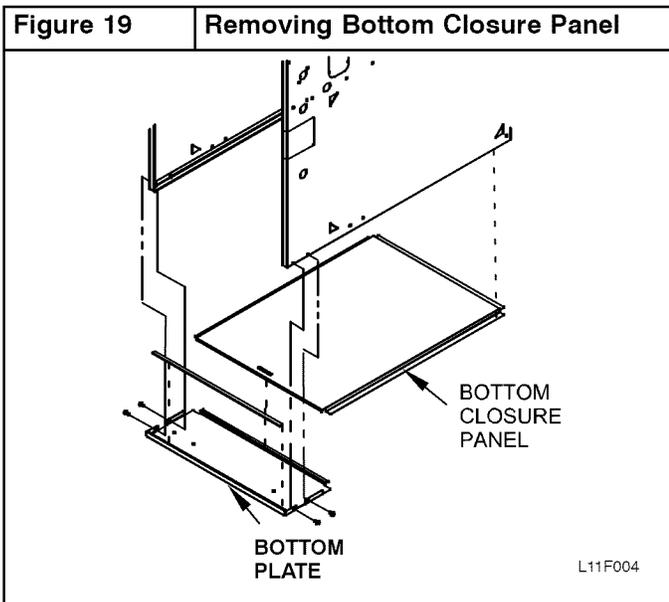
Never connect return-air ducts to the back of the furnace. Follow instructions below.

The return-air duct must be connected to bottom, sides (left or right), or a combination of bottom and side(s) of main furnace casing as shown in **Figure 27**, **Figure 28** and **Figure 29**. Bypass humidifier may be attached into unused return air side of the furnace casing.

Bottom Return Air Inlet

These furnaces are shipped with bottom closure panel installed in bottom return-air opening. Remove and discard this panel when bottom return air is used. To remove bottom closure panel, perform the following:

1. Tilt or raise furnace and remove four (4) screws holding bottom plate. (See **Figure 19**)
2. Remove bottom plate.
3. Remove bottom closure panel.
4. Reinstall bottom plate and screws.



Side Return Air Inlet

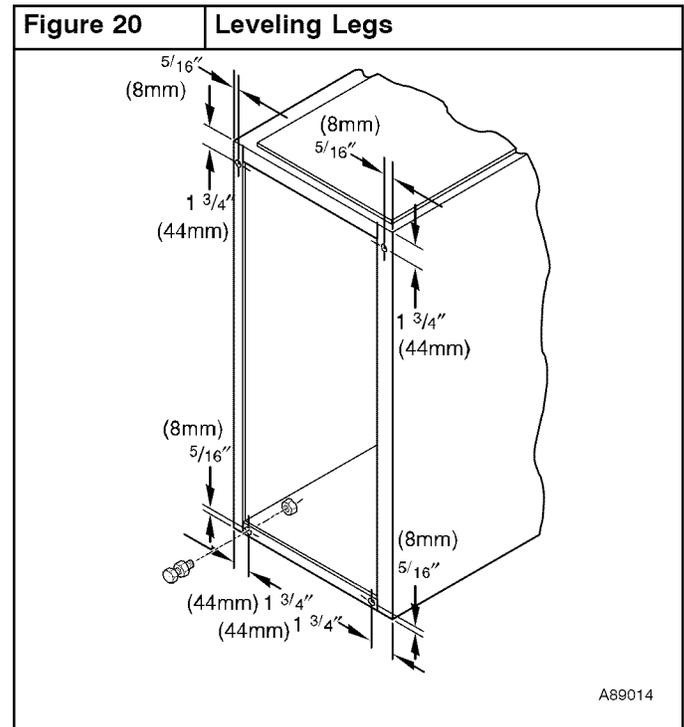
These furnaces are shipped with bottom closure panel installed in bottom return-air opening. This panel MUST be in place when only side return air is used.

NOTE: Side return-air openings can be used in UPFLOW and most HORIZONTAL configurations. Do not use side return-air

openings in DOWNFLOW configuration. (See **Figure 27**, **Figure 28** and **Figure 29**)

Leveling Legs (If Desired)

In upflow position with side return inlet(s), leveling legs may be used. (See **Figure 20**) Install field-supplied, 5/16 x 1-1/2-in. (8 x 38 mm) (max) corrosion-resistant machine bolts, washers and nuts.



NOTE: Bottom closure must be used when leveling legs are used. It may be necessary to remove and reinstall bottom closure panel to install leveling legs. To remove bottom closure panel, see Step 1 in Bottom Return Air Inlet section.

To install leveling legs:

1. Position furnace on its back. Locate and drill a hole in each bottom corner of furnace.
2. For each leg, install nut on bolt and then install bolt with nut in hole. (Install flat washer if desired.)
3. Install another nut on other side of furnace base. (Install flat washer if desired.)
4. Adjust outside nut to provide desired height, and tighten inside nut to secure arrangement.
5. Reinstall bottom closure panel if removed.

DOWNFLOW INSTALLATION

NOTE: The furnace must be pitched forward as shown in **Figure 18** for proper condensate drainage.

Supply Air Connections

NOTE: For downflow applications, this furnace is approved for use on combustible flooring when any one of the following three accessories are used (see specification sheets for list of approved accessories):

- Special Base – NAHA01101SB
 - Cased Coil Assembly – END4X, ENW4X
1. Determine application being installed from **Table 5**.
 2. Construct hole in floor per **Table 5** and **Figure 21**.
 3. Construct plenum to dimensions specified in **Table 5** and **Figure 21**.

- Install as shown in **Figure 23**. If Coil Assembly Part is used, install as shown in **Figure 24**.

CAUTION

CUT HAZARD

Failure to follow this caution may result in personal injury.

Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts, and servicing furnaces.

Connect supply-air duct to supply-air outlet on furnace. Bend flange inward past 90° with wide duct pliers (See **Table 1 Figure 22**) The supply-air duct must be connected to **ONLY** the furnace supply outlet or air conditioning coil casing (when used). When installed on combustible material, supply-air duct must be connected to **ONLY** the factory-approved accessory subbase, or a factory-approved air conditioning coil casing. **DO NOT** cut main furnace casing to attach supply side air duct, humidifier, or other accessories. All accessories **MUST** be connected to duct external to furnace casing.

Return Air Connections

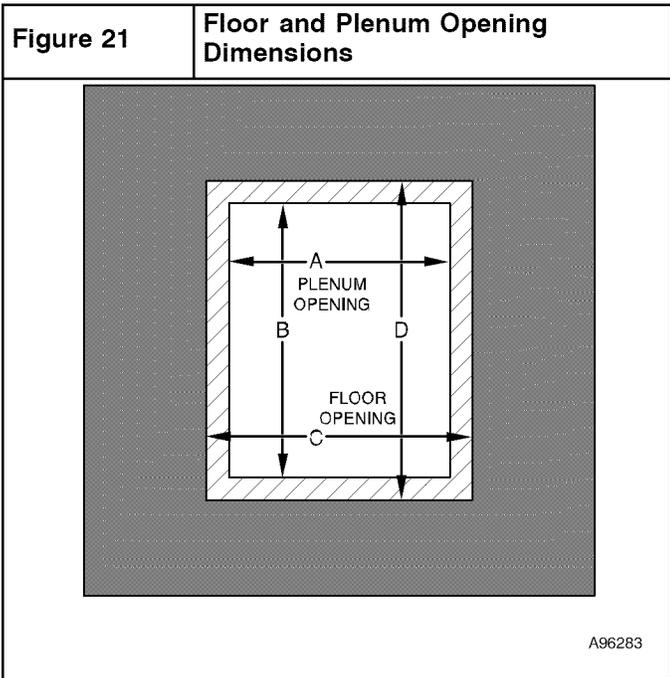
WARNING

FIRE HAZARD

A failure to follow this warning could cause personal injury, death and/or property damage.

Never connect return-air ducts to the back of the furnace. Follow instructions below.

The return-air duct must be connected to return-air opening (bottom inlet) as shown in **Figure 27**. **DO NOT** cut into casing sides (left or right). Bypass humidifier connections should be made at ductwork or coil casing sides exterior to furnace. (See **Figure 27**)



NOTE: It is recommended that the perforated supply-air duct flanges be completely removed from furnace when installing the furnace on a factory-supplied cased coil or coil box. To remove the supply-air duct flange, use wide duct pliers or hand seamers to bend flange back and forth until it breaks off. Be careful of sharp edges. (See **Figure 22**)

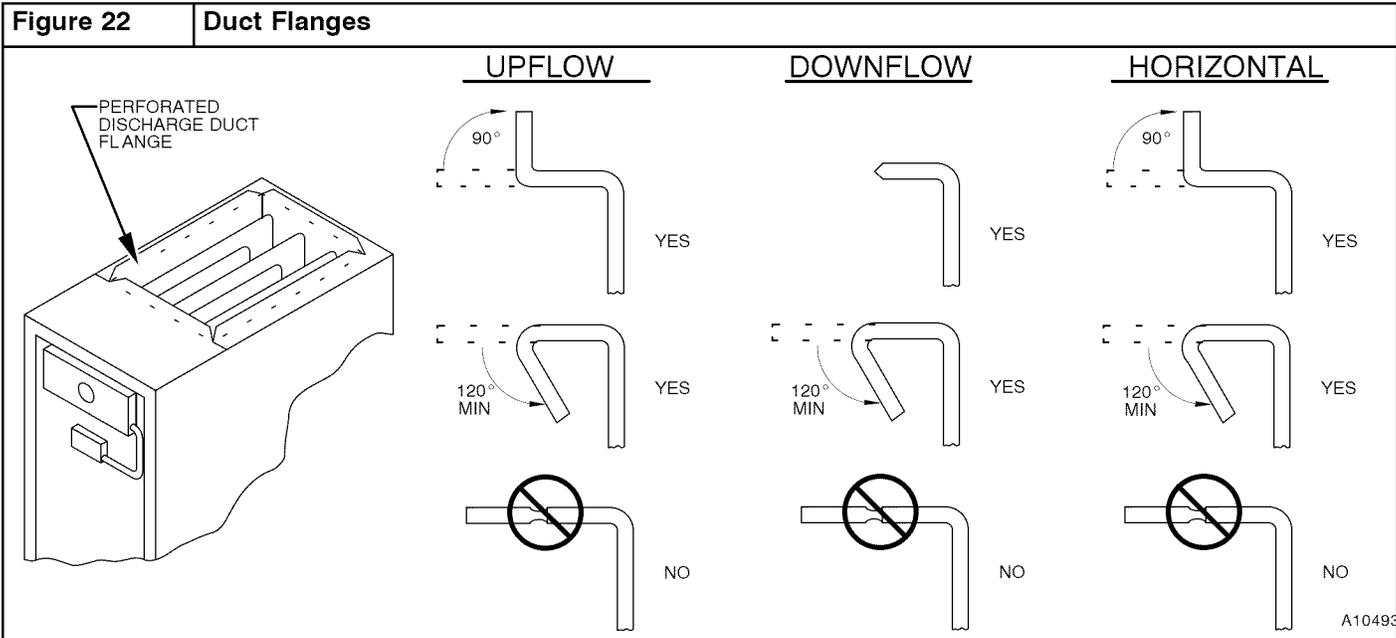
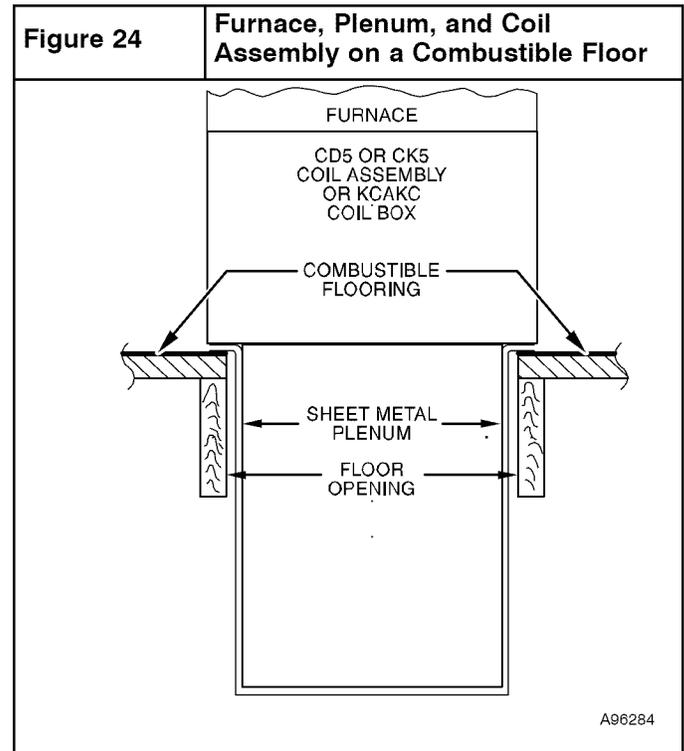
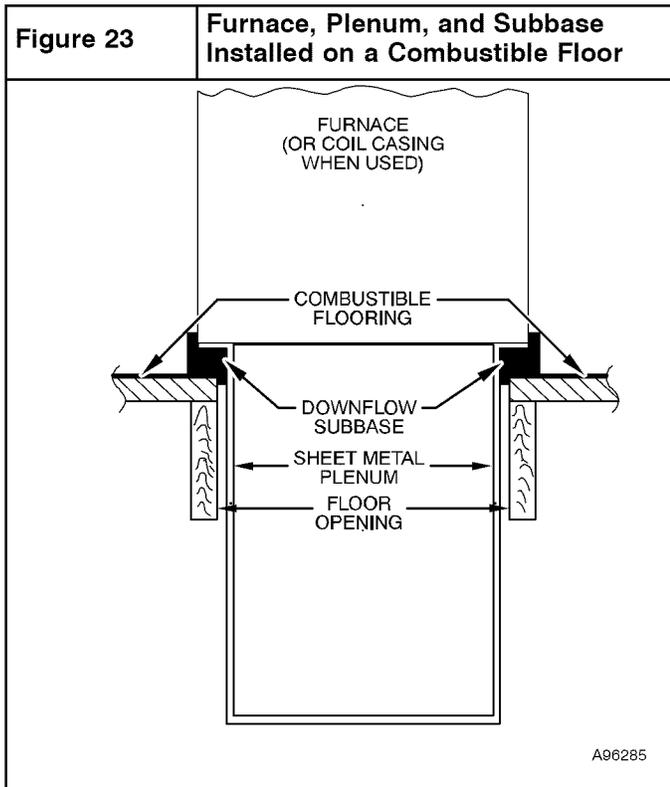


Table 5		Opening Dimensions - in. (mm)			
FURNACE CASING WIDTH IN. (mm)	APPLICATION	PLENUM OPENING		FLOOR OPENING	
		A	B	C	D
14-3/16 (360)	Upflow Applications on Combustible or Noncombustible Flooring (subbase not required)	12-11/16 (322)	21-5/8 (549)	13-5/16 (338)	22-1/4 (565)
	Downflow Applications on Noncombustible Flooring (subbase not required)	12-9/16 (319)	19 (483)	13-3/16 (335)	19-5/8 (498)
	Downflow applications on combustible flooring (subbase required)	11-13/16 (284)	19 (483)	13-7/16 (341)	20-5/8 (600)
	Downflow Applications on Combustible Flooring with Coil Assembly or coil box (subbase not required)	12-5/16 (319)	19 (483)	13-5/16 (338)	20 (508)
17-1/2 (445)	Upflow Applications on Combustible or Noncombustible Flooring (subbase not required)	16 (406)	21-5/8 (549)	16-5/8 (422)	22-1/4 (565)
	Downflow Applications on Noncombustible Flooring (subbase not required)	15-7/8 (403)	19 (483)	16-1/2 (419)	19-5/8 (498)
	Downflow applications on combustible flooring (subbase required)	15-1/8 (384)	19 (483)	16-3/4 (425)	20-5/8 (600)
	Downflow Applications on Combustible Flooring with Coil Assembly or coil box (subbase not required)	15-1/2 (394)	19 (483)	16-1/2 (419)	20 (508)
21 (533)	Upflow Applications on Combustible or Noncombustible Flooring (subbase not required)	19-1/2 (495)	21-5/8 (549)	20-1/8 (511)	22-1/4 (565)
	Downflow Applications on Noncombustible Flooring (subbase not required)	19-3/8 (492)	19 (483)	20 (508)	19-5/8 (498)
	Downflow applications on combustible flooring (subbase required)	18-5/8 (473)	19 (483)	20-1/4 (514)	20-5/8 (600)
	Downflow Applications on Combustible Flooring with Coil Assembly or coil box (subbase not required)	19 (483)	19 (483)	20 (508)	20 (508)
24-1/2 (622)	Upflow Applications on Combustible or Noncombustible Flooring (subbase not required)	23 (584)	21-1/8 (537)	23-5/8 (600)	22-1/4 (565)
	Downflow Applications on Noncombustible Flooring (subbase not required)	22-7/8 (581)	19 (483)	23-1/2 (597)	19-5/8 (498)
	Downflow applications on Combustible flooring (subbase required)	22-1/8 (562)	19 (483)	23-3/4 (603)	20-5/8 (600)
	Downflow Applications on Combustible Flooring with Coil Assembly or coil box (subbase not required)	22-1/2 (572)	19 (483)	23-1/2 (597)	20 (508)



Bottom Return Air Inlet

These furnaces are shipped with bottom closure panel installed in bottom return-air opening. Remove and discard this panel when bottom return air is used. To remove bottom closure panel, perform the following:

1. Tilt or raise furnace and remove four (4) screws holding bottom plate. (See **Figure 19**)
2. Remove bottom plate.
3. Remove bottom closure panel.
4. Reinstall bottom plate and screws.

HORIZONTAL INSTALLATION

NOTE: The furnace must be pitched forward as shown in **Figure 18** for proper condensate drainage.

⚠ WARNING

FIRE, EXPLOSION, AND CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in personal injury, death, or property damage.

Do not install the furnace on its back or hang furnace with control compartment facing downward. Safety control operation will be adversely affected. Never connect return-air ducts to the back of the furnace.

The furnace can be installed horizontally in an attic or crawlspace on either the left-hand (LH) or right-hand (RH) side. The furnace can be hung from floor joists, rafters or trusses or installed on a non-combustible platform, blocks, bricks or pad.

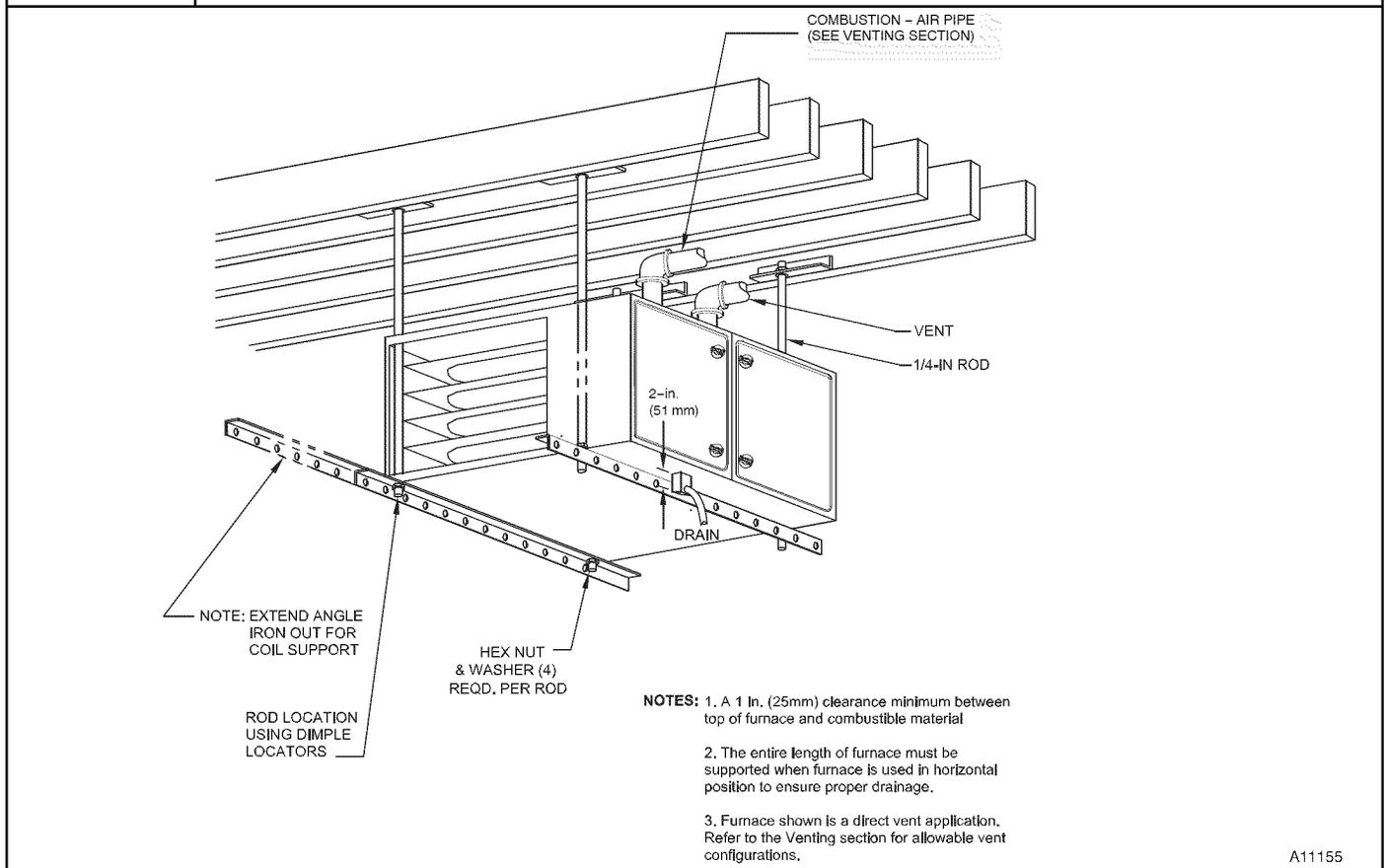
Suspended Furnace Support

The furnace may be supported under the entire length of the furnace with threaded rod and angle iron. (See **Figure 25**) Secure angle iron to bottom of furnace as shown.

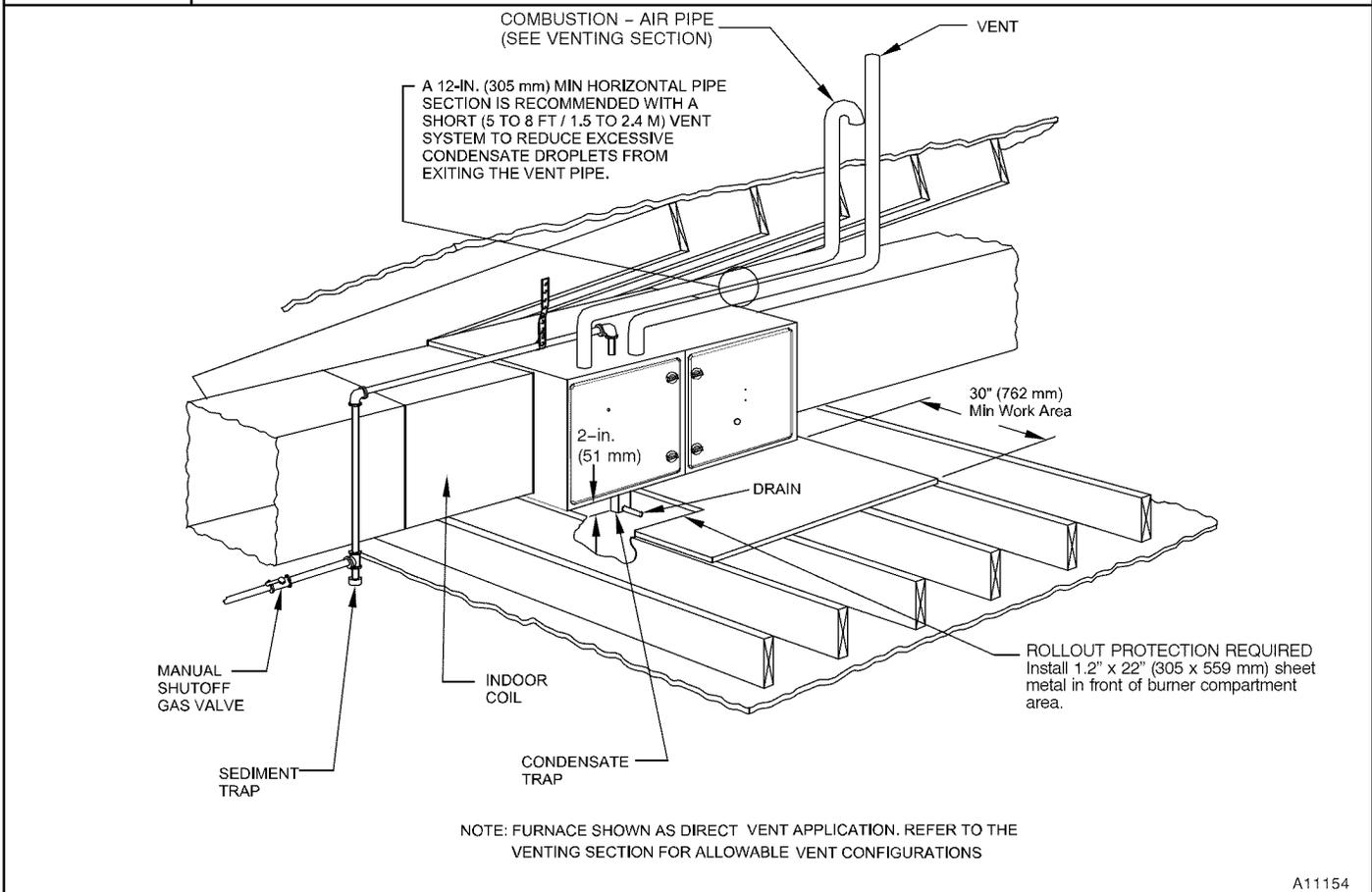
Platform Furnace Support

Construct working platform at location where all required furnace clearances are met. (See **Table 1** and **Figure 26**) For furnaces with 1-in. (25 mm) clearance requirement on side, set furnace on non-combustible blocks, bricks or angle iron. For crawlspace installations, if the furnace is not suspended from the floor joists, the ground underneath furnace must be level and the furnace set on blocks or bricks.

Figure 25 | **Suspended Furnace Installation**



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Figure 26 Working Platform for Attic Installation

Roll-Out Protection

Provide a minimum 12-in. x 22-in. (305 x 559 mm) piece of sheet metal for flame roll-out protection in front of burner area for furnaces closer than 12-in. (305 mm) above the combustible deck or suspended furnaces closer than 12-in. (305mm) to joists. The sheet metal **MUST** extend underneath the furnace casing by 1-in. (25mm) with the door removed.

The bottom closure panel may be used for flame roll-out protection when bottom of furnace is used for return air connection. See **Figure 26** for proper orientation of roll-out shield.

Supply Air Connections

For a furnace not equipped with a cooling coil, the outlet duct shall be provided with a removable access panel. This opening shall be accessible when the furnace is installed and shall be of such a size that the heat exchanger can be viewed for possible openings using light assistance or a probe can be inserted for sampling the air stream. The cover attachment shall prevent leaks.

Connect supply-air duct to flanges on furnace supply-air outlet. Bend flange upward to 90° with wide duct pliers. (See **Figure 22**) The supply-air duct must be connected to **ONLY** the furnace supply-outlet-air duct flanges or air conditioning coil casing (when used). **DO NOT** cut main furnace casing side to attach supply air duct, humidifier, or other accessories. All accessories **MUST** be connected to duct external to furnace main casing.

Return Air Connections

The return-air duct must be connected to bottom of the furnace. The side of casing that faces downward may also be used for return air connection. A combination of the bottom and downward facing side may also be used. The side of the casing cannot be used as a return air connection. Bypass humidifier may be attached into unused return air side of the furnace casing. (See **Figure 29**)

Bottom Return Air Inlet

These furnaces are shipped with bottom closure panel installed in bottom return-air opening. Remove and discard this panel when bottom return air is used. To remove bottom closure panel, perform the following:

1. Tilt or raise furnace and remove four (4) screws holding bottom plate. (See **Figure 19**)
2. Remove bottom plate.
3. Remove bottom closure panel.
4. Reinstall bottom plate and screws.

Side Return Air Inlet

These furnaces are shipped with bottom closure panel installed in bottom return-air opening. This panel **MUST** be in place when side return air inlet(s) are used without a bottom return air inlet.

Not all horizontal furnaces are approved for side return air connections (See **Figure 29**)

Filter Arrangement

⚠ WARNING

FIRE, CARBON MONOXIDE AND POISONING HAZARD

Failure to follow this warning could result in personal injury, or death.

Never operate a furnace without a filter or filtration device installed. Never operate a furnace with filter or filtration device access doors removed.

Furnaces shipped without a filter rack:

There are no provisions for an internal filter in these furnaces. An external filter rack is required and is purchased separately. A field supplied accessory air cleaner may also be used in place of the filter rack.

For upflow applications, the filter can be installed on either side of the furnace, the bottom of the furnace or any combination of side and bottom of the furnace. (See **Figure 28**, **Figure 30**, and **Figure 31**)

For downflow applications, the filter rack (or field supplied accessory air cleaner) must only be connected to the bottom opening on the furnace (See **Figure 27** and **Figure 31** and **Table 7**).

For horizontal applications, the filter rack (or field supplied accessory air cleaner) can be connected to the bottom opening on the furnace. For side return use in the horizontal position, refer to **Figure 29**. If both side and bottom openings are used in **Figure 29**, each opening used will require a filter.

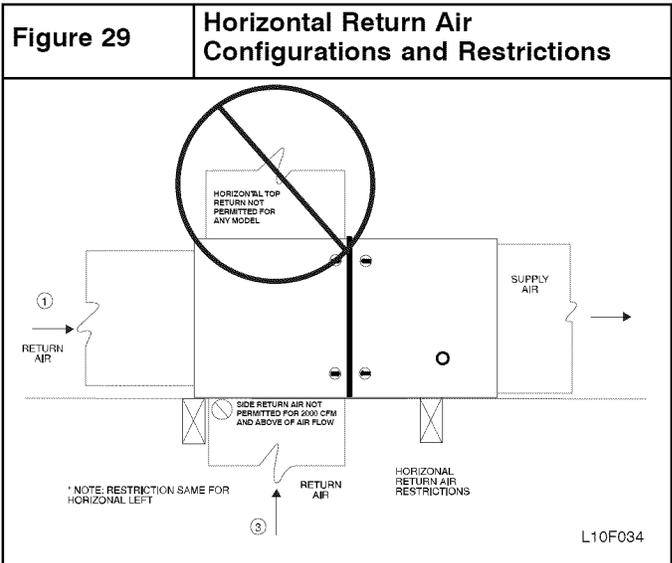
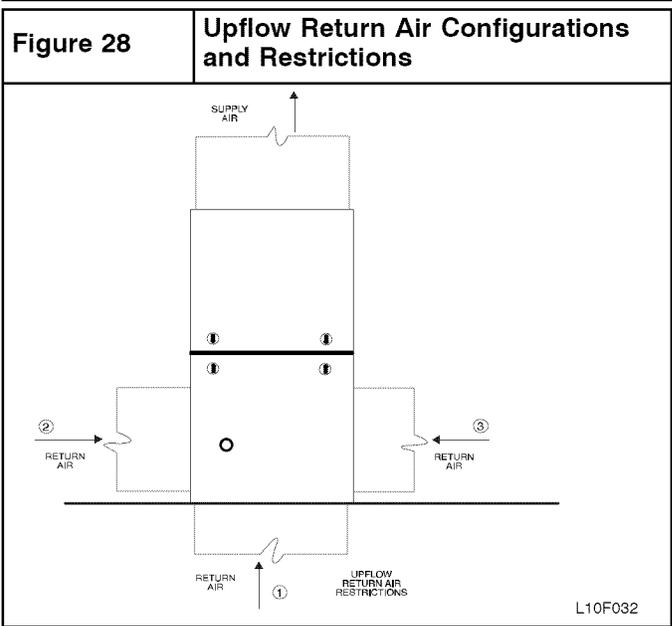
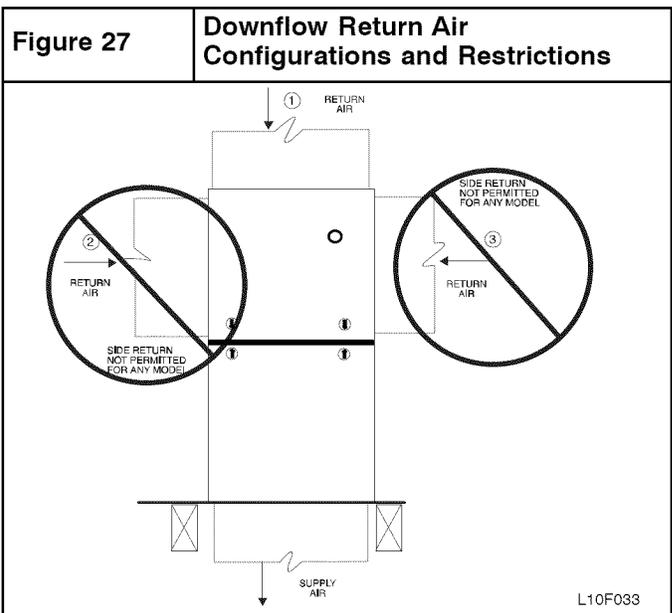
A filter rack or any field supplied accessory air cleaner can also be installed in the common return duct prior to entering the return air opening in any orientation.

See **Table 6** for recommended filter size details.

FURNACE CASING WIDTH	FILTER SIZE		FILTER TYPE
	SIDE RETURN	BOTTOM RETURN	
14-3/16 (360)	16 x 25 x 3/4 (406 x 635 x 19)	14 x 25 x 3/4 (356 x 635 x 19)	Washable*
17-1/2 (445)	16 x 25 x 3/4 (406 x 635 x 19)	16 x 25 x 3/4 (406 x 635 x 19)	Washable*
21 (533)	16 x 25 x 3/4 (406 x 635 x 19)	20 x 25 x 3/4 (508 x 635 x 19)	Washable*
24-1/2 (622)	16 x 25 x 3/4 (406 x 635 x 19)	24 x 25 x 3/4 (610 x 635 x 19)	Washable*

* Recommended to maintain air filter face velocity. See Product Data for part number.

Refer to the instructions supplied with the Filter Rack or accessory air filter for additional assembly and installation options.



External Filter Cabinet Configurations

Figure 30 Accessory Side Filter Rack

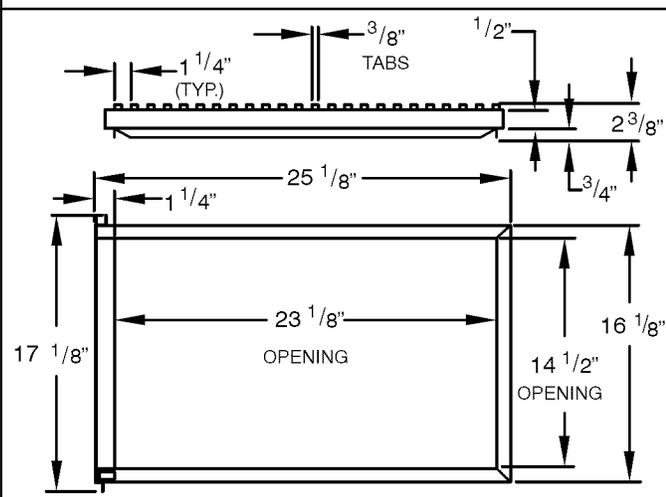
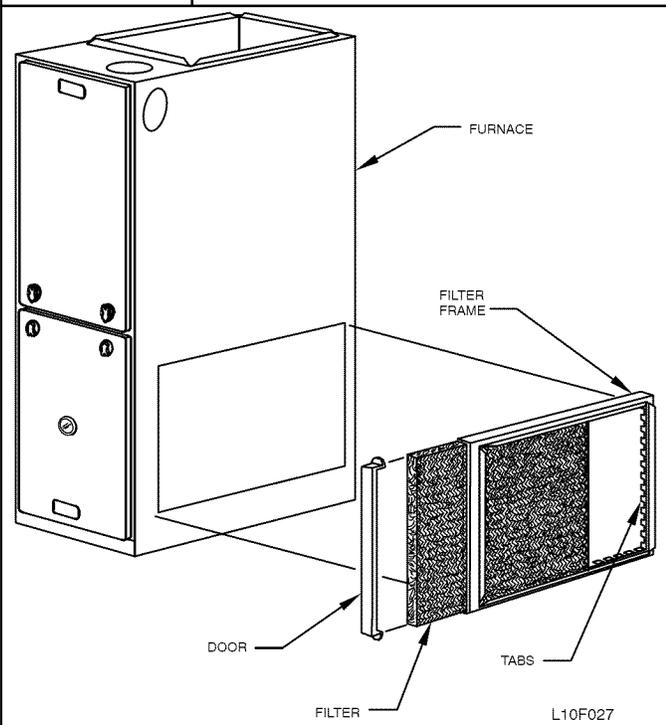
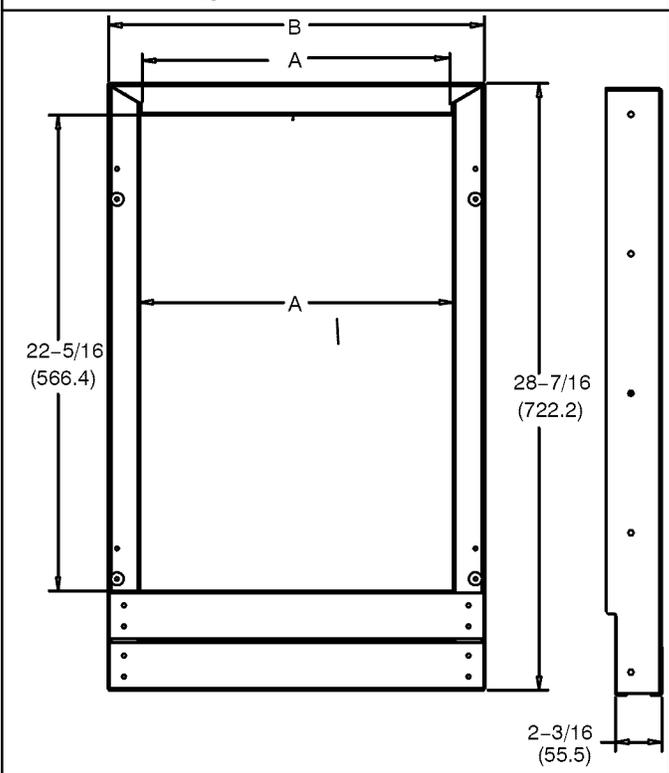
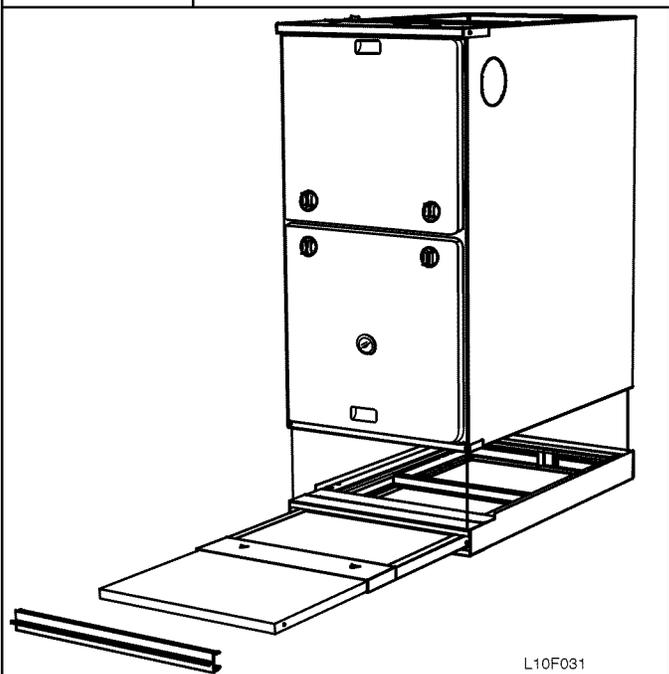


Figure 31 Accessory Bottom Filter Rack



KIT NO.	Dimensional Drawing - in. (mm)		
	FURNACE WIDTH	A	B
NAHB00501FF	14-3/16 (360.4)	11-3/8 (289)	14-1/4 (362)
NAHB00601FF	17-1/2 (444.5)	14-5/8 (371.5)	17-5/8 (447.7)
NAHB00701FF	21 (533.4)	18-1/8 (460.4)	21-1/8 (536.6)
NAHB00801FF	24-1/2 (622.3)	21-5/8 (549.3)	24-5/8 (625.5)

Air Ducts

General Requirements

The duct system should be designed and sized according to accepted national standards such as those published by: Air Conditioning Contractors Association (ACCA), Sheet Metal and Air Conditioning Contractors National Association (SMACNA) or American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) or consult *The Air Systems Design Guidelines* reference tables available from your local distributor. The duct system should be sized to handle the required system design CFM at the design external static pressure. The furnace airflow rates are provided in the **Service and Technical Support Manual**. When a furnace is installed so that the supply ducts carry air circulated by the furnace to areas outside the space containing the furnace, the return air shall also be handled by duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

Secure ductwork with proper fasteners for type of ductwork used. Seal supply- and return-duct connections to furnace with code approved tape or duct sealer.

NOTE: Flexible connections should be used between ductwork and furnace to prevent transmission of vibration.

Ductwork passing through unconditioned space should be insulated to enhance system performance. When air conditioning is used, a vapor barrier is recommended.

Maintain a 1-in. (25 mm) clearance from combustible materials to supply air ductwork for a distance of 36-in. (914 mm) horizontally from the furnace. See NFPA 90B or local code for further requirements.

Ductwork Acoustical Treatment

NOTE: Metal duct systems that do not have a 90 degree elbow and 10 ft. (3 M) of main duct to the first branch take-off may require internal acoustical lining. As an alternative, fibrous ductwork may be used if constructed and installed in accordance with the latest edition of SMACNA construction standard on fibrous glass ducts. Both acoustical lining and fibrous ductwork shall comply with NFPA 90B as tested by UL Standard 181 for Class 1 Rigid air ducts.

NOTE: For horizontal applications, the top most flange may be bent past 90° to allow the evaporator coil to hang on the flange temporarily while the remaining attachment and sealing of the coil are performed.

GAS PIPING



WARNING

FIRE OR EXPLOSION HAZARD

Failure to follow this warning could result in personal injury, death, and/or property damage.

Never purge a gas line into a combustion chamber. Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for the detection of leaks to check all connections. A fire or explosion may result causing property damage, personal injury or loss of life.



WARNING

FIRE OR EXPLOSION HAZARD

Failure to follow this warning could result in personal injury, death, and/or property damage.

Use proper length of pipe to avoid stress on gas control manifold and a gas leak.



WARNING

FIRE OR EXPLOSION HAZARD

Failure to follow this warning could result in personal injury, death, and/or property damage.

Gas valve inlet and/or inlet pipe must remain capped until gas supply line is permanently installed to protect the valve from moisture and debris. Also, install a sediment trap in the gas supply piping at the inlet to the gas valve.

Gas piping must be installed in accordance with national and local codes. Refer to current edition of NFGC in the U.S.A. Refer to current edition of CAN/CSA B149.1 in Canada.

Installations must be made in accordance with all authorities having jurisdiction. If possible, the gas supply line should be a separate line running directly from meter to furnace.

NOTE: Use a back-up wrench on the inlet of the gas valve when connecting the gas line to the gas valve.

NOTE: In the state of Massachusetts:

1. Gas supply connections MUST be performed by a licensed plumber or gas fitter.
2. When flexible connectors are used, the maximum length shall not exceed 36-in. (915 mm).
3. When lever handle type manual equipment shutoff valves are used, they shall be T-handle valves.
4. The use of copper tubing for gas piping is NOT approved by the state of Massachusetts.

Refer to **Table 8** for recommended gas pipe sizing. Risers must be used to connect to furnace and to meter. Support all gas piping with appropriate straps, hangers, etc. Use a minimum of 1 hanger every 6 ft. (1.8 M). Joint compound (pipe dope) should be applied sparingly and only to male threads of joints. Pipe dope must be resistant to the action of propane gas.



WARNING

FIRE OR EXPLOSION HAZARD

A failure to follow this warning could result in personal injury, death, and/or property damage.

If local codes allow the use of a flexible gas appliance connector, always use a new listed connector. Do not use a connector which has previously served another gas appliance. Black iron pipe shall be installed at the furnace gas control valve and extend a minimum of 2-in. (51 mm) outside the furnace.



CAUTION

FURNACE DAMAGE HAZARD

Failure to follow this caution may result in furnace damage.

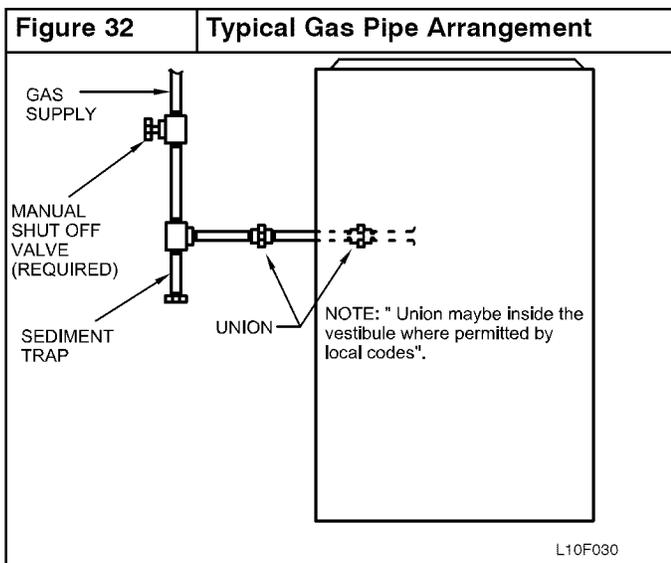
Connect gas pipe to furnace using a backup wrench to avoid damaging gas controls and burner misalignment.

Table 8	Maximum Capacity of Pipe						
	NOMINAL IRON PIPE SIZE IN. (MM)	INTERNAL DIA. IN. (MM)	LENGTH OF PIPE - FT (M)				
			10 (3.0)	20 (6.0)	30 (9.1)	40 (12.1)	50 (15.2)
1/2 (13)	0.622 (158)	175	120	97	82	73	
3/4 (19)	0.824 (20.9)	360	250	200	170	151	
1 (25)	1.049 (26.6)	680	465	375	320	285	
1-1/4 (32)	1.380 (35.0)	1400	950	770	660	580	
1-1/2 (39)	1.610 (40.9)	2100	1460	1180	990	900	

* Cubic ft of gas per hr for gas pressures of 0.5 psig (14-in. w.c.) or less and a pressure drop of 0.5-in. w.c. (based on a 0.60 specific gravity gas). Ref: **Table 8 above**, and 6.2 of NFPA54/ANSI Z223.1-2009.

An accessible manual equipment shutoff valve **MUST** be installed external to furnace casing and within 6 ft. (1.8 M) of furnace.

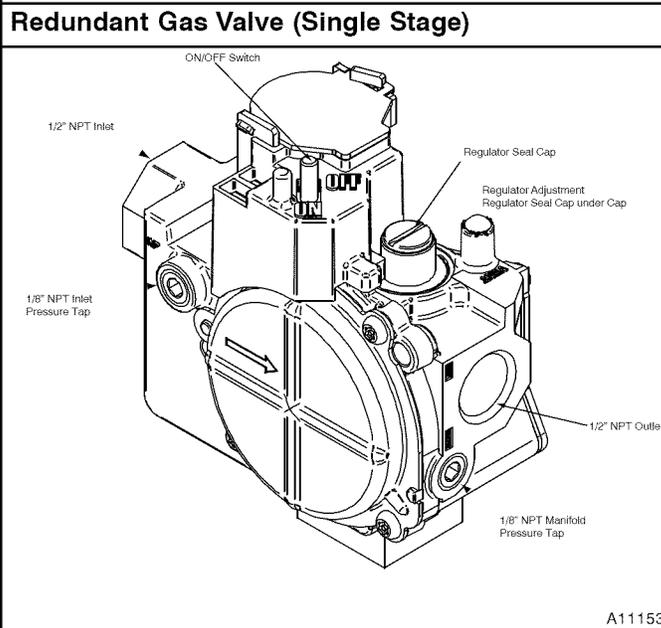
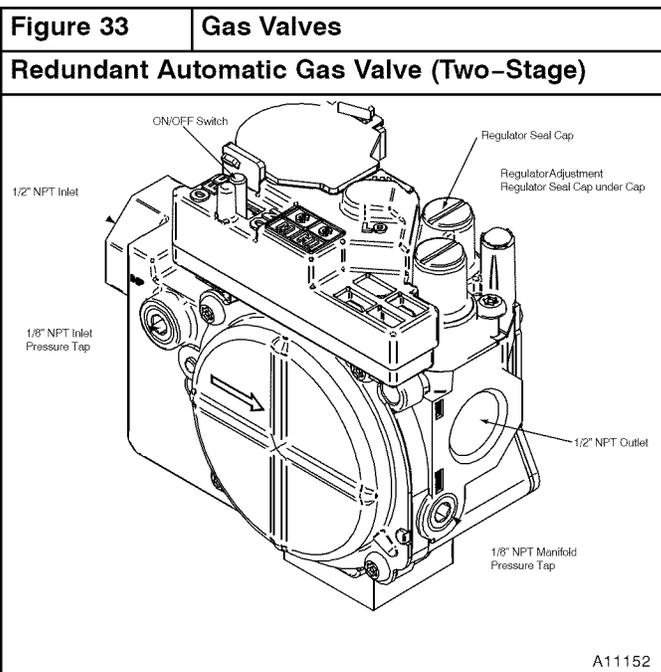
Install a sediment trap in riser leading to furnace as shown in **Figure 32**. Connect a capped nipple into lower end of tee. Capped nipple should extend below level of furnace gas controls. Place a ground joint union between furnace gas control valve and exterior manual equipment gas shutoff valve.



A 1/8-in. (3 mm) NPT plugged tapping, accessible for test gauge connection, **MUST** be installed immediately upstream of gas supply connection to furnace and downstream of manual equipment shutoff valve.

Piping should be pressure and leak tested in accordance with the current addition of the NFGC in the United States, local, and national plumbing and gas codes before the furnace has been connected. Refer to current edition of NSCPGIC in Canada. After all connections have been made, purge lines and check for leakage at furnace prior to operating furnace.

NOTE: The furnace gas control valve inlet pressure tap connection is suitable to use as test gauge connection providing test pressure **DOES NOT** exceed maximum 0.5 psig (14-in. w.c.) stated on gas control valve. (See **Figure 33**)



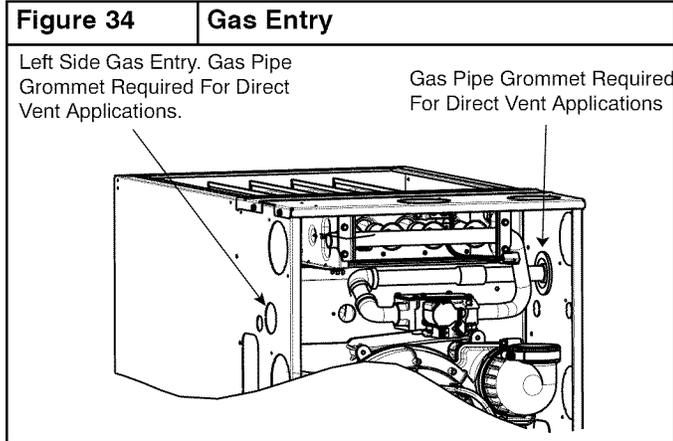
If pressure exceeds 0.5 psig (14-in. w.c.), gas supply pipe must be disconnected from furnace and capped before and during supply pipe pressure test. If test pressure is equal to or less than 0.5 psig (14-in. w.c.), turn off electric shutoff switch located on furnace gas control valve and accessible manual equipment shutoff valve before and during supply pipe pressure test. After all connections have been made, purge lines and check for leakage at furnace prior to operating furnace.

The gas supply pressure shall be within the maximum and minimum inlet supply pressures marked on the rating plate with the furnace burners ON and OFF.

Some installations require gas entry on right side of furnace (as viewed in upflow). (See **Figure 34**)

Gas Pipe Grommet

For direct vent (2-pipe) applications, the knockout for the gas pipe must be sealed to prevent air leakage. Remove the knockout, install the grommet in the knockout, then insert the gas pipe. The grommet is included in the loose parts bag. (See Figure 34)



See **Figure 35** for field wiring diagram showing typical field 115-v wiring. Check all factory and field electrical connections for tightness.

Field-supplied wiring shall conform with the limitations of 63°F (33°C) rise.

⚠ WARNING

ELECTRICAL SHOCK AND FIRE HAZARD

Failure to follow this warning could result in personal injury, death, or property damage.

The cabinet **MUST** have an uninterrupted or unbroken ground according to NEC ANSI/NFPA 70-2011 or local codes to minimize personal injury if an electrical fault should occur. In Canada, refer to Canadian Electrical Code CSA C22.1. This may consist of electrical wire, conduit approved for electrical ground or a listed, grounded power cord (where permitted by local code) when installed in accordance with existing electrical codes. Refer to the power cord manufacturer's ratings for proper wire gauge.

Do not use gas piping as an electrical ground.

ELECTRICAL CONNECTIONS

⚠ WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death.

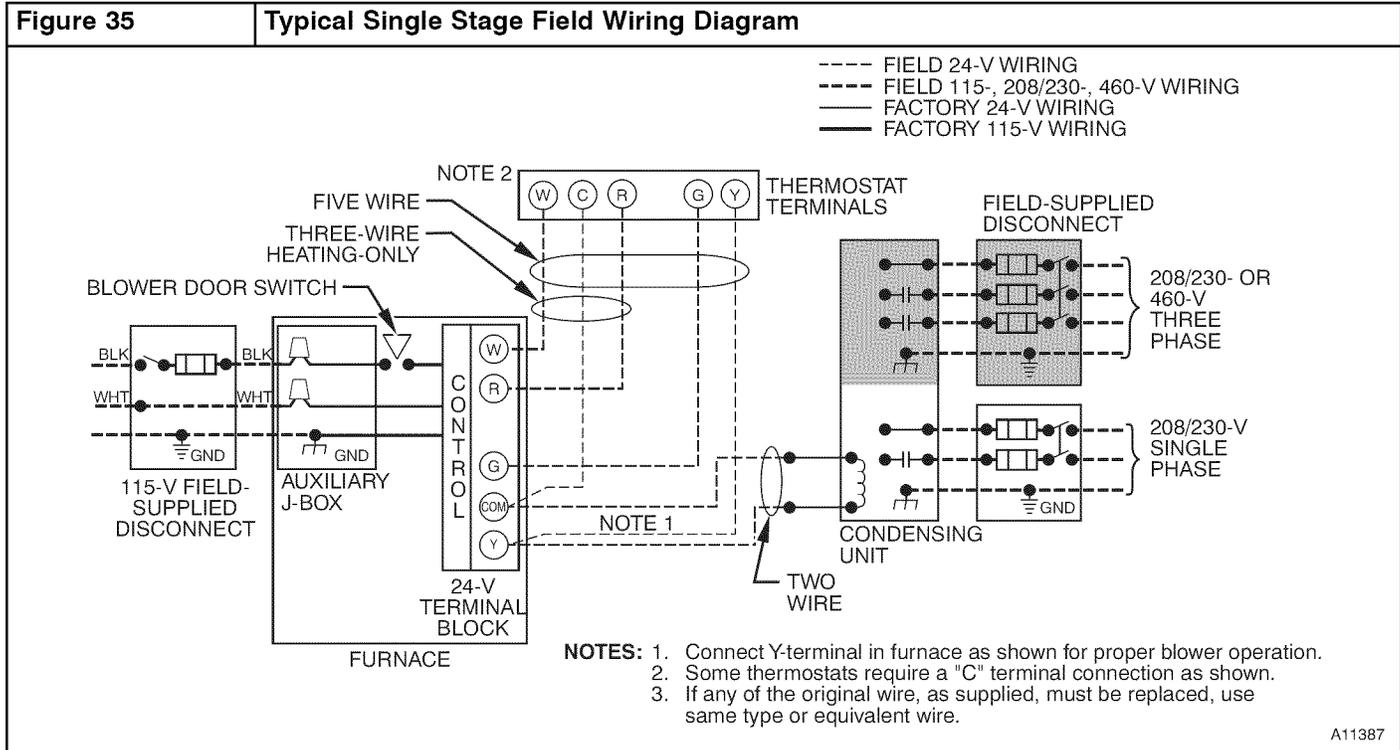
Blower door switch opens 115-v power to control. No component operation can occur. Do not bypass or close switch with blower door removed.

⚠ CAUTION

FURNACE MAY NOT OPERATE HAZARD

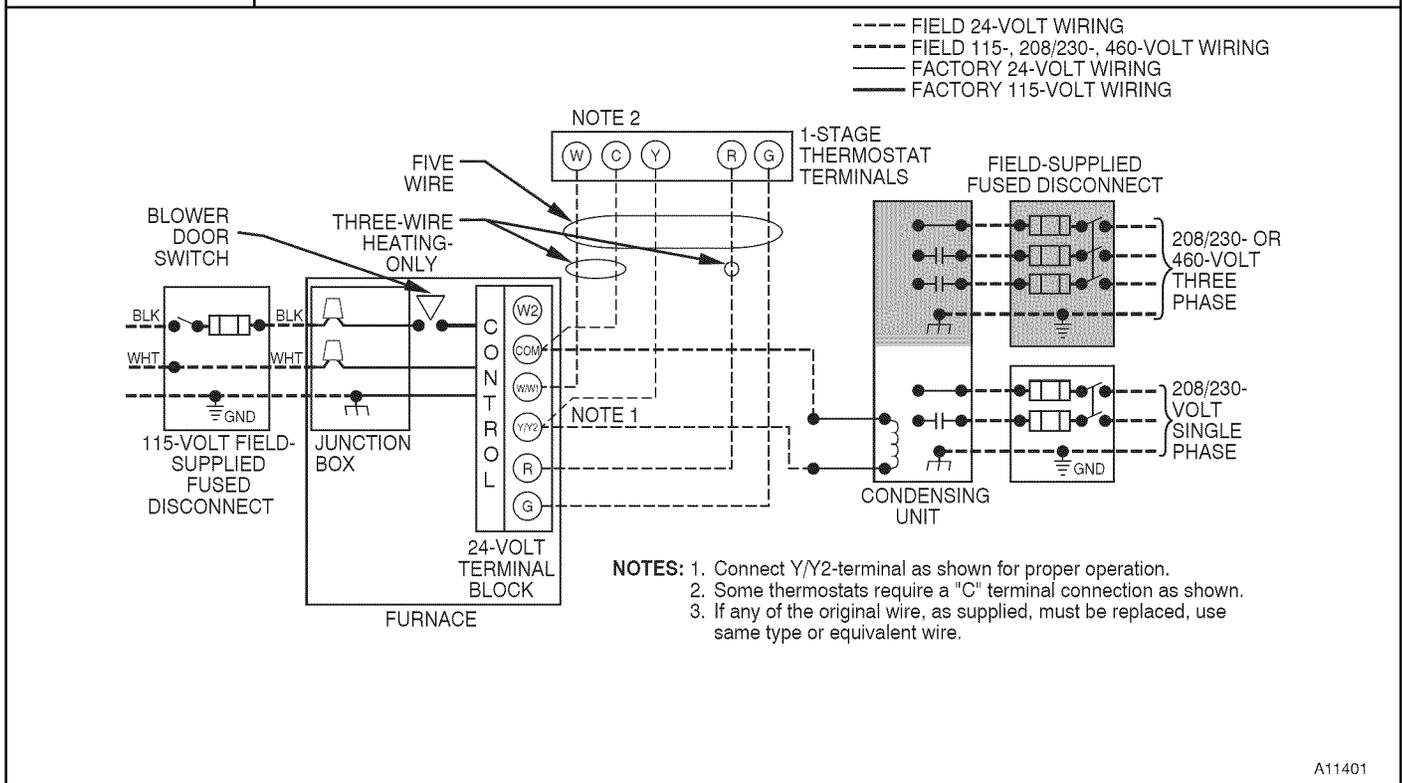
Failure to follow this caution may result in intermittent furnace operation.

Furnace control must be grounded for proper operation or else control will lock out. Control must remain grounded through green/yellow wire routed to gas valve and manifold bracket screw.



A11387

Figure 35 (CONT.) Typical Two-Stage Field Wiring Diagram



A11401

115-V Wiring

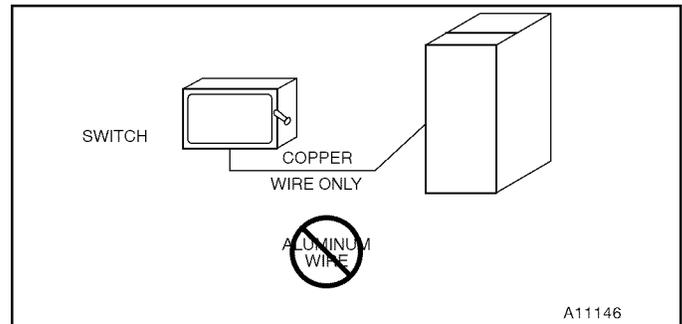
Furnace must have a 115-v power supply properly connected and grounded.

NOTE: Proper polarity must be maintained for 115-v wiring. If polarity is incorrect, control status indicator light flashes rapidly and furnace does **NOT** operate.

Verify that the voltage, frequency, and phase correspond to that specified on unit rating plate. Also, check to be sure that service provided by utility is sufficient to handle load imposed by this equipment. Refer to rating plate or **Table 9** for equipment electrical specifications.

U.S.A. Installations: Make all electrical connections in accordance with National Electrical Code (NEC) ANSI/NFPA 70 and any local codes or ordinances that might apply.

Canadian Installations: Canadian Electrical Code CSA C22.1



A1146

Use a separate, fused branch electrical circuit with a properly sized fuse or circuit breaker for this furnace. See **Table 9** for wire size and fuse specifications. A readily accessible means of electrical disconnect must be located within sight of the furnace.

J-Box Installation

⚠ WARNING

FIRE HAZARD

Failure to follow this warning could result in personal injury, death, or property damage.

Do not connect aluminum wire between disconnect switch and furnace. Use only copper wire.

⚠ WARNING

FIRE OR ELECTRICAL SHOCK HAZARD

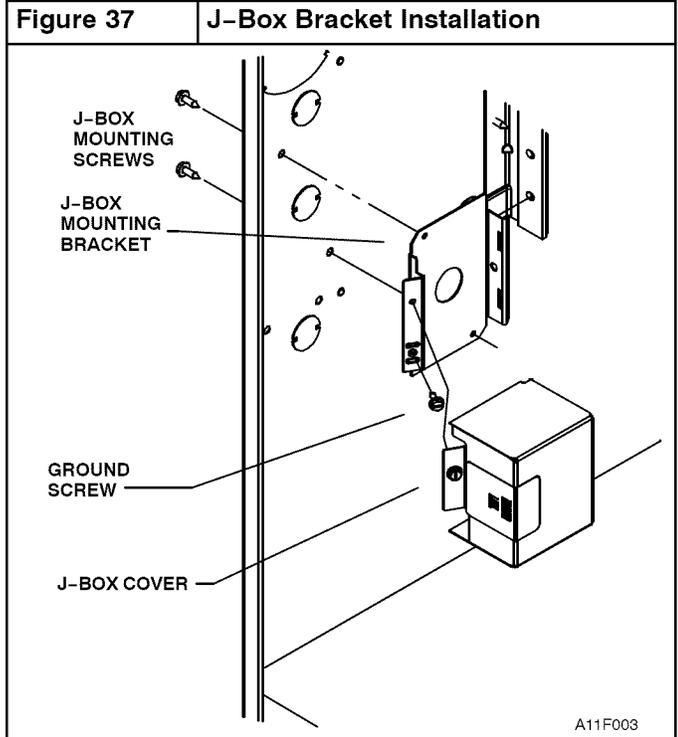
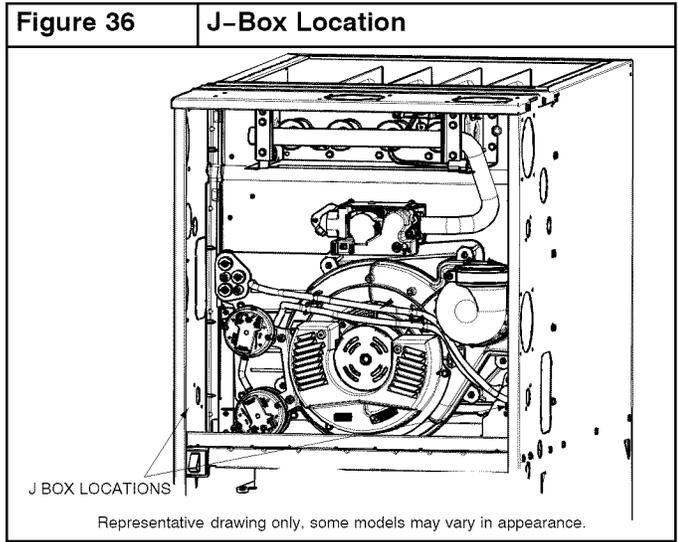
Failure to follow this warning could result in personal injury, death, or property damage.

If field-supplied manual disconnect switch is to be mounted on furnace casing side, select a location where a drill or fastener cannot damage electrical or gas components.

The J-Box is used when field line voltage electrical connections are made to the furnace wiring harness inside the furnace casing. The J-Box is not required if a field-supplied electrical

box is attached to the outside of the furnace casing and the box is grounded to the green ground wire of the main wiring harness and the earth ground of the field electrical supply.

The J-Box cover, mounting bracket and screws are shipped in the loose parts bag included with the furnace. The J-Box can be mounted on the left or right side of the casing, as viewed from the upflow position. (See **Figure 36**)



Remove the J-Box cover and mounting bracket from the loose parts bag. Select a 7/8-in. (22 mm) knock-out on the desired side of the casing. Remove the knock-out from the casing. Drill two 1/8-in. (3 mm) pilot holes in the casing dimples by the desired 7/8-in. (22 mm) knock-out.

Align the J-Box mounting bracket against the inside of the casing and secure the mounting bracket with the screws. (See **Figure 37**)

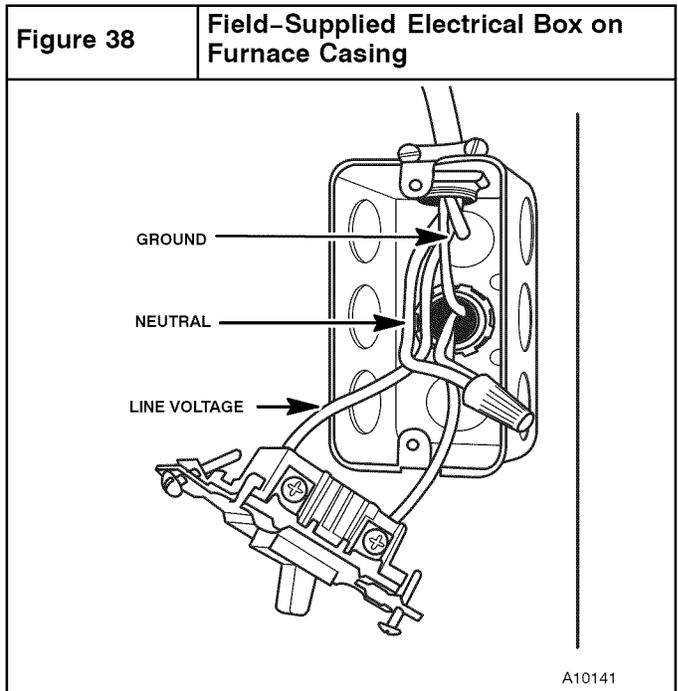
Electrical Box on Furnace Casing Side

NOTE: Check that duct on side of furnace will not interfere with installed electrical box.

1. Fasten a field-supplied external electrical box to the outside of the casing by driving two field-supplied

screws from inside electrical box into casing. (See **Figure 38**)

2. Route field power wiring into external electrical box.
3. Pull furnace power wires through 1/2-in. (12 mm) diameter hole in J-Box. If necessary, loosen power wires from strain-relief wire-tie on furnace wiring harness.
4. Connect any code required external disconnect(s) to field power wiring.
5. Route external field power wires through holes in electrical box and casing.
6. Connect field ground wire and factory ground wire to green ground screw on J-Box mounting bracket as shown in **Figure 37**.
7. Connect field power and neutral leads to furnace power leads, as shown in **Figure 35**.
8. Attach furnace J-Box cover to mounting bracket with screws supplied in loose parts bag. Do not pinch wires between cover and bracket.
9. Complete external disconnect wiring and installation. Connect line voltage leads as shown in **Figure 38**. Use best practices (NEC in U.S. for wire bushings, strain relief, etc., and Canadian Electrical Code CSA C22.1.)



Power Cord Installation in Furnace J-Box

NOTE: Power cords must be able to handle the electrical requirements listed in **Table 9**. Refer to power cord manufacturer's listings.

1. Install J-Box mounting bracket to inside of furnace casing. (See **Figure 37**)
2. Route listed power cord through 7/8-in. (22 mm) diameter hole in casing and J-Box bracket.
3. Secure power cord to J-Box bracket with a strain relief bushing or a connector approved for the type of cord used.
4. Pull furnace power wires through 1/2-in. (12 mm) diameter hole in J-Box. If necessary, loosen power wires from strain-relief wire-tie on furnace wiring harness.
5. Connect field ground wire and factory ground wire to green ground screw on J-Box mounting bracket as shown in **Figure 37**.
6. Connect power cord power and neutral leads to furnace power leads as shown in **Figure 35**.

- Attach furnace J-Box cover to mounting bracket with screws supplied in loose parts bag. Do not pinch wires between cover and bracket.

BX Cable Installation in Furnace J-Box

- Install J-Box mounting bracket to inside of furnace casing.
- Route BX connector through 7/8-in. (22 mm) diameter hole in casing and J-Box bracket.
- Secure BX cable to J-Box bracket with connectors approved for the type of cable used.
- Connect field ground wire and factory ground wire to green ground screw on J-Box mounting bracket as shown in **Figure 37**.
- Connect field power and neutral leads to furnace power leads, as shown in **Figure 35**.
- Attach furnace J-Box cover to mounting bracket with screws supplied in loose parts bag. Do not pinch wires between cover and bracket.

24-V Wiring

Make field 24-v connections at the 24-v terminal strip. (See **Figure 40**, **Figure 41**, or **Figure 42**) Connect terminal Y/Y2 as shown in **Figure 35** for proper cooling operation. Use only AWG No. 18, color-coded, copper thermostat wire.

NOTE: Use AWG No. 18 color-coded copper thermostat wire for lengths up to 100 ft. (30.5 M). For wire lengths over 100 ft., use AWG No. 16 wire.

The 24-v circuit contains an automotive-type, 3-amp. fuse located on the control. Any direct shorts during installation, service, or maintenance could cause this fuse to blow. If fuse replacement is required, use ONLY a 3-amp. fuse of identical size.

See the Service and Technical Support manual for detailed instructions on control wiring and setup.

Thermostats and Control Settings for (F/G)9MVT Variable Speed Furnaces

Communicating, single-stage and two-stage thermostats may all be used with these furnaces. Refer to typical thermostat wiring diagrams and the Sequence of Operation section of the Service and Technical Support manual for details on configuring the furnace control board. Consult the thermostat installation instructions for specific information about configuring the thermostat.

Thermostats and Control Settings for (F/G)9MXT Two-Stage Furnaces

A single-stage or two-stage heating and single-stage or two-stage cooling thermostat may be used with the furnace. Refer to typical thermostat wiring diagrams and the Sequence of Operation section of the Service and Technical Support manual for details on configuring the furnace control board. Consult the thermostat installation instructions for specific information about configuring the thermostat.

Thermostats and Control Settings for (F/G)9MXE Single-Stage Furnaces

A single stage heating and single-stage or two-stage cooling thermostat may be used with the furnace. Refer to typical thermostat wiring diagrams and the Sequence of Operation section of the Service and Technical Support manual for details on configuring the furnace control board. Consult the thermostat installation instructions for specific information about configuring the thermostat.

Accessories (See Figure 39)

- Electronic Air Cleaner (EAC)
Connect an accessory Electronic Air Cleaner (if used) using 1/4-in female quick connect terminals to the two male 1/4-in quick-connect terminals on the control board marked EAC-1 and EAC-2. The terminals are rated for 115VAC, 1.0 amps maximum and are energized during blower motor operation.

- Humidifier (HUM)

(F/G)9MVT The HUM terminal is a 24 VAC output, energized when the blower is operating during a call for heat.

(F/G)9MXT There are two humidifier outputs on the furnace control. The 115 VAC HUM terminal is energized when the Induced Draft Relay closes. The 24 VAC HUM terminal is energized when the low pressure switch closes during a call for heat. Connect an accessory 115 VAC accessory humidifier to the 115 VAC HUM terminal and L2 on the furnace control. Connect a 24 VAC humidifier to the 24 VAC HUM terminal and C screw terminal strip on the control board thermostat strip.

(F/G)9MXE The HUM terminal is a 24 VAC output energized when the gas valve relay closes during a call for heat.

Connect an accessory 24 VAC, 0.5 amp. Maximum (if used) to the 1/4-in. male quick-connect HUM terminal and C screw terminal on the control board thermostat strip.

NOTE: If the humidifier has its own 24 VAC power supply, an isolation relay may be required. Connect the 24 VAC coil of the isolation relay to the HUM and C screw terminal on the control board thermostat strip.

- (F/G)9MVT**–Communication Connector

This connection is used when the furnace is controlled by an optional communicating wall control instead of a standard thermostat. The communication plug is supplied with the communicating wall control. Refer to the instructions supplied with the communicating wall control for complete details.

- (F/G)9MVT**–Outside Air Thermistor (OAT)

The OAT connection is used in conjunction with communicating wall control. It is not required when the furnace is controlled by a standard type thermostat. Refer to the instructions supplied with the communicating wall control for complete details.

Alternate Power Supplies

This furnace is designed to operate on a utility generated power which has a smooth sinusoidal waveform. If the furnace is to be operated on a generator or other alternate power supply, the alternate power supply must produce a smooth sinusoidal waveform for compatibility with furnace electronics. The alternate power supply must generate the same voltage, phase, and frequency (Hz) as shown in **Table 9** or on the furnace rating plate.

Power from an alternate power supply that non-sinusoidal may damage the furnace or cause erratic furnace operation.

Contact the alternate power supply manufacturer for specifications and details.

Table 9 Electrical Data

(F/G)9MVT TWO-STAGE, VARIABLE SPEED FURNACES								
UNIT SIZE	VOLTS-HERTZ-PHASE	OPERATING VOLTAGE RANGE*		MAXIMUM UNIT AMPS	UNIT AMPACITY#	MINIMUM WIRE SIZE AWG	MAXIMUM WIRE LENGTH FT (M)‡	MAXIMUM FUSE OR CKT BKR AMPS†
		Maximum*	Minimum*					
40,000	115-60-1	127	104	8.2	11.0	14	33 (10.0)	15
60,000	115-60-1	127	104	9.8	13.0	14	28 (8.5)	15
80,000	115-60-1	127	104	9.8	13.0	14	28 (8.5)	15
100,000	115-60-1	127	104	12.3	16.1	12	35 (10.6)	20
120,000	115-60-1	127	104	12.3	16.1	12	35 (10.6)	20

(F/G)9MXT TWO-STAGE FURNACES								
UNIT SIZE	VOLTS-HERTZ-PHASE	OPERATING VOLTAGE RANGE*		MAXIMUM UNIT AMPS	UNIT AMPACITY#	MINIMUM WIRE SIZE AWG	MAXIMUM WIRE LENGTH FT (M)‡	MAXIMUM FUSE OR CKT BKR AMPS†
		Maximum*	Minimum*					
40,000	115-60-1	127	104	8.2	11.0	14	33 (10.0)	15
60,000	115-60-1	127	104	9.8	13.0	14	28 (8.5)	15
80,000	115-60-1	127	104	9.8	13.0	14	28 (8.5)	15
100,000	115-60-1	127	104	12.3	16.1	12	35 (10.6)	20
120,000	115-60-1	127	104	12.3	16.1	12	35 (10.6)	20

(F/G)9MXE SINGLE-STAGE FURNACES								
UNIT SIZE	VOLTS-HERTZ-PHASE	OPERATING VOLTAGE RANGE*		MAXIMUM UNIT AMPS	UNIT AMPACITY#	MINIMUM WIRE SIZE AWG	MAXIMUM WIRE LENGTH FT (M)‡	MAXIMUM FUSE OR CKT BKR AMPS†
		Maximum*	Minimum*					
40,000	115-60-1	127	104	8.1	11.0	14	33 (10.0)	15
60,000	115-60-1	127	104	9.7	13.0	14	28 (8.5)	15
80,000	115-60-1	127	104	9.7	13.0	14	28 (8.5)	15
100,000	115-60-1	127	104	12.2	16.1	12	35 (10.6)	20
120,000	115-60-1	127	104	12.2	16.1	12	35 (10.6)	20

* Permissible limits of the voltage range at which the unit operates satisfactorily.

Unit ampacity = 125 percent of largest operating component's full load amps plus 100 percent of all other potential operating components' (EAC, humidifier, etc.) full load amps.

† Time-delay type is recommended.

‡ Length shown is as measured one way along wire path between unit and service panel for maximum 2 percent voltage drop.

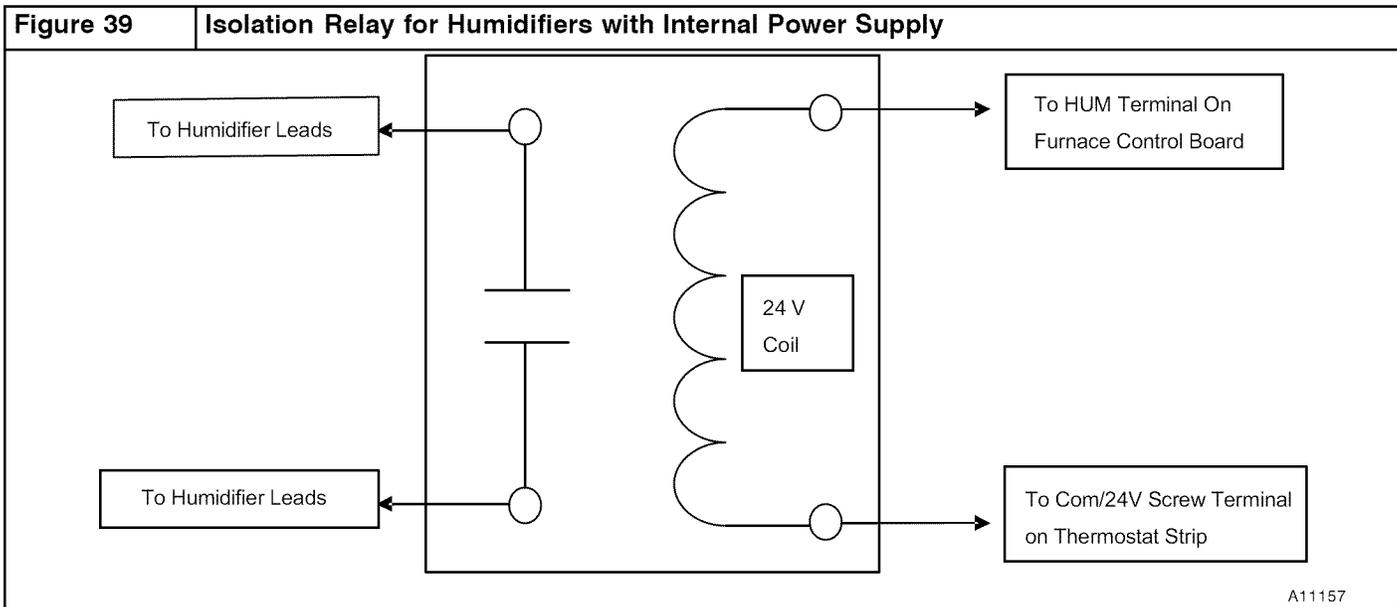


Figure 40 Variable Speed Furnace Control for ECM Blower Motor

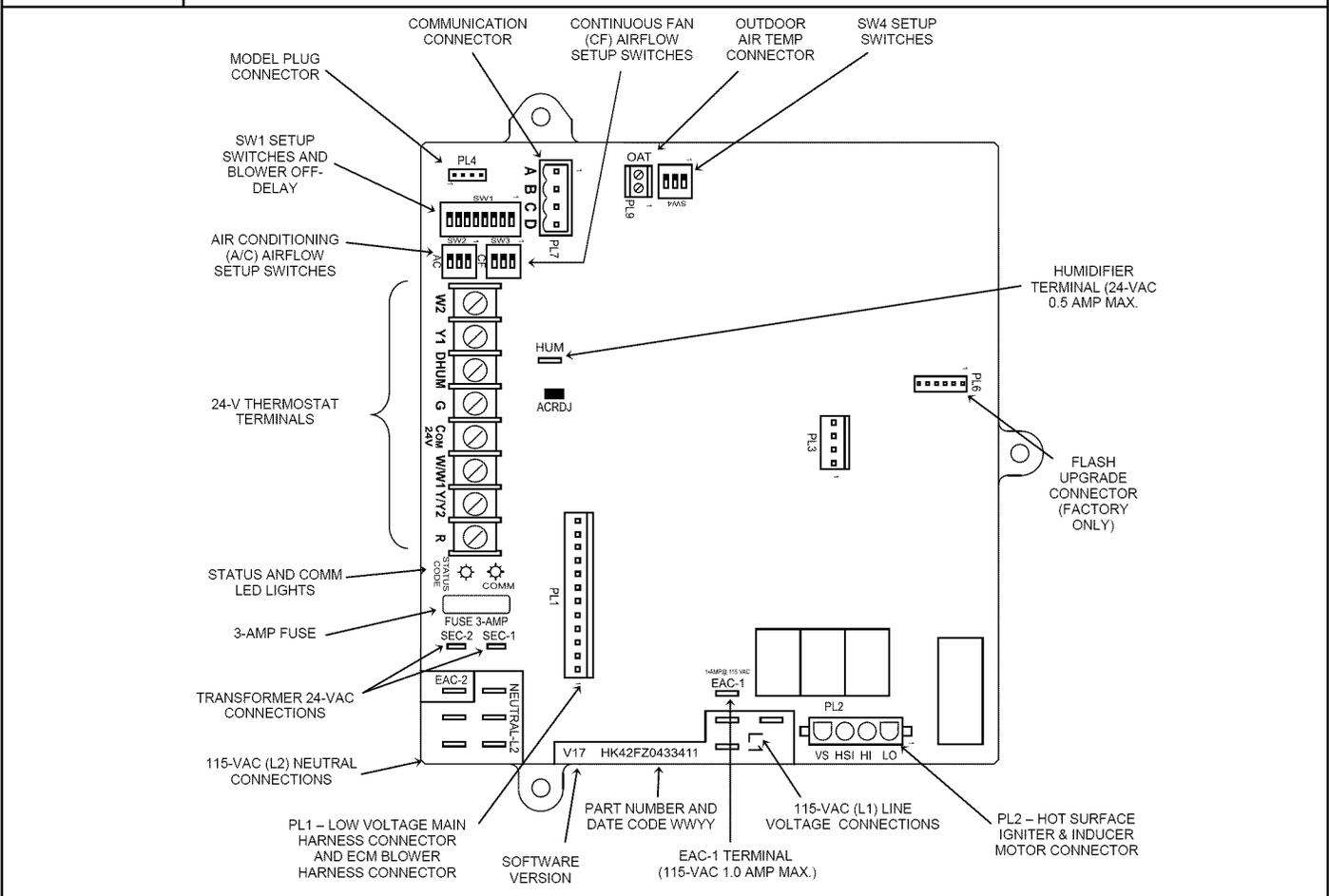


Figure 41 Two-Stage Furnace Control for ECM Blower Motor

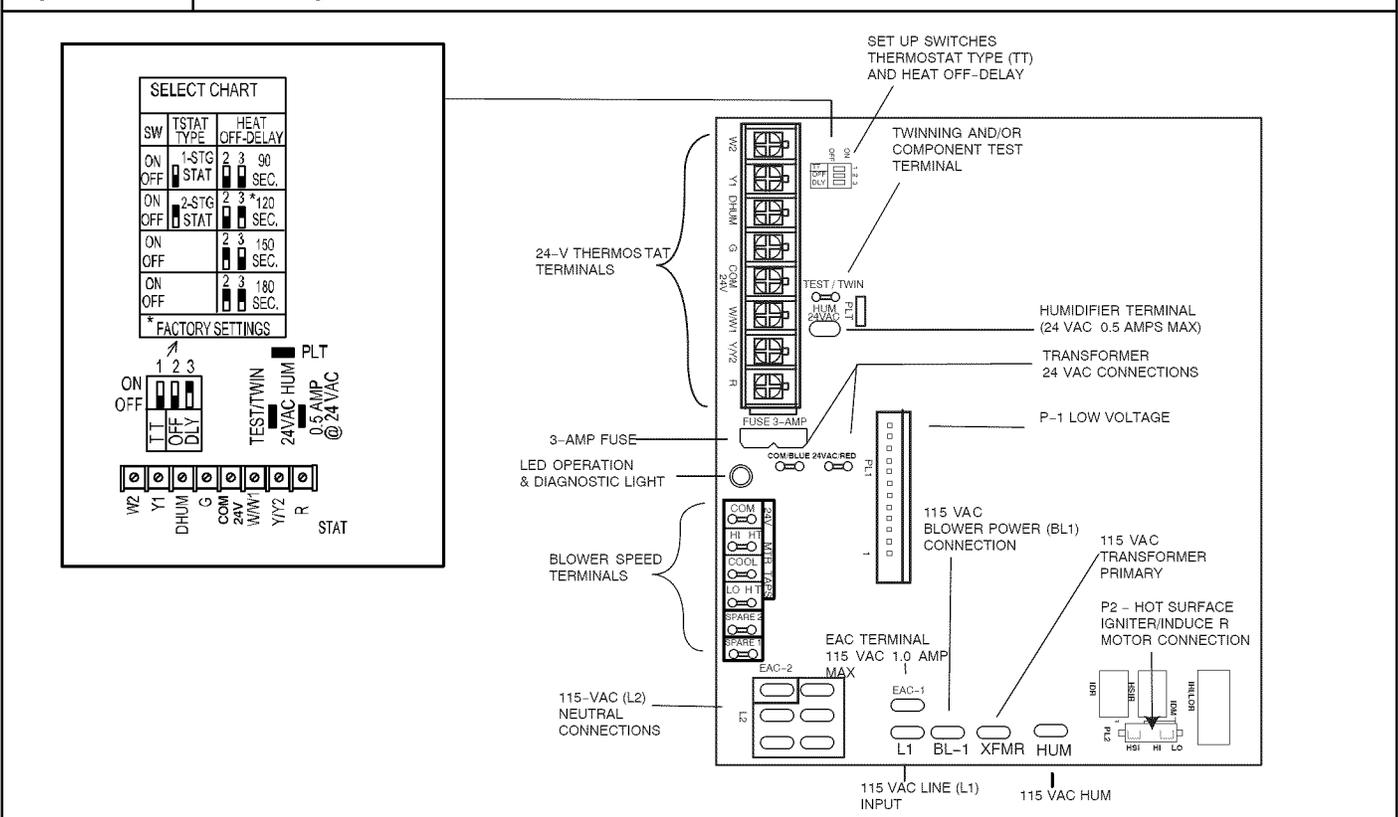
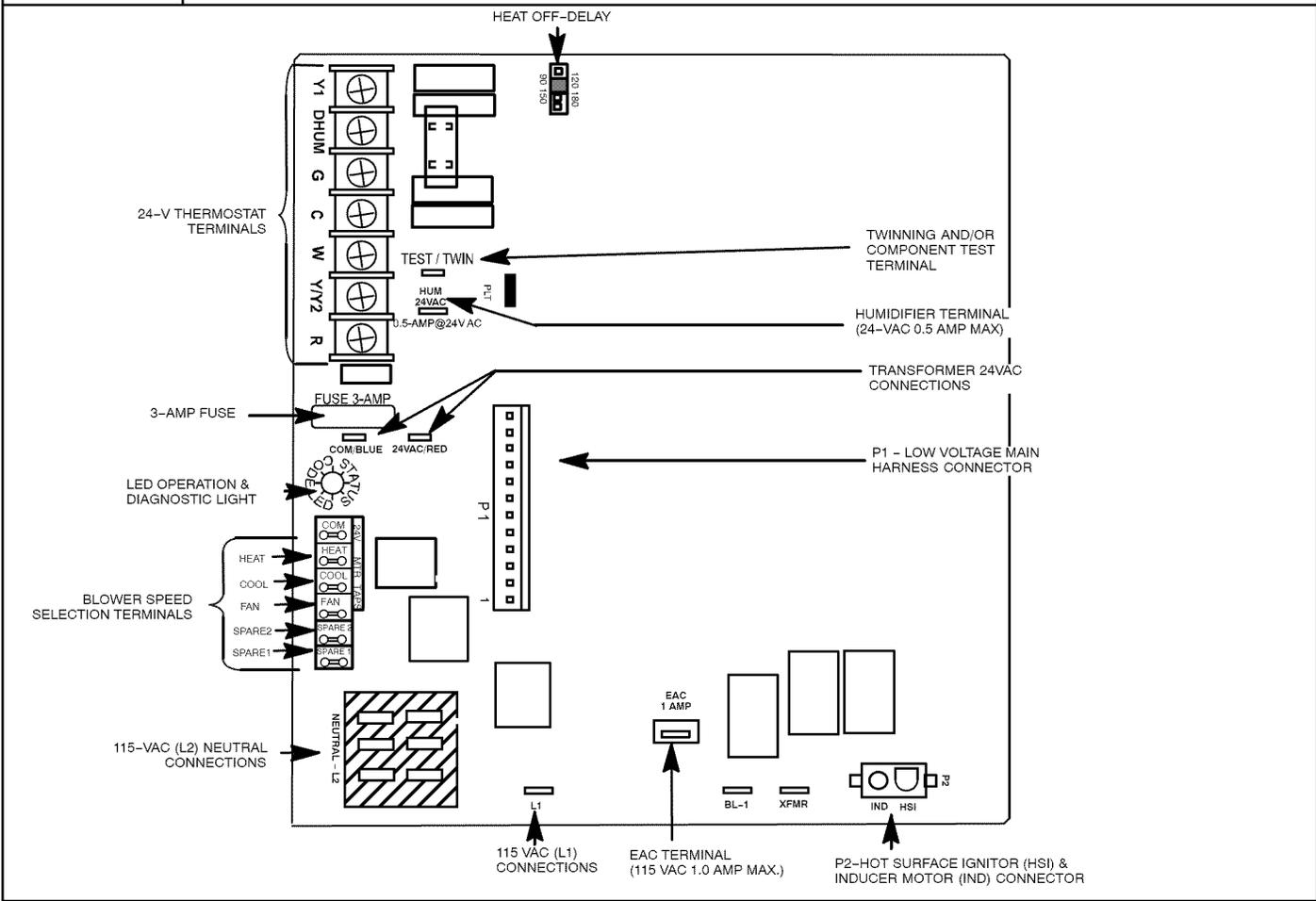


Figure 42 Single Stage Furnace Control for ECM Blower Motor



VENTING

Furnace is set in place in the required orientation.

Special Venting Requirements for Installations in Canada

Installation in Canada must conform to the requirements of CAN/CSA B149 code. Vent systems **must** be composed of pipe, fittings, cements, and primers listed to ULC S636. The special vent fittings and accessory concentric vent termination kits and accessory external drain trap have been certified to ULC S636 for use with those Royal Pipe and IPEX PVC vent components which have been certified to this standard. In Canada, the primer and cement must be of the same manufacturer as the vent system – GVS-65 Primer (Purple) for Royal Pipe or IPEX System 636, PVC/CPVC Primer, Purple Violet for Flue Gas Venting and GVS-65 PVC Solvent Cement for Royal Pipe or IPEX System 636⁽¹⁾, PVC Cement for Flue Gas Venting, rated Class IIA, 65 deg C. must be used with this venting system - do not mix primers and cements from one manufacturer with a vent system from a different manufacturer. Follow the manufacturer's instructions in the use of primer and cement and never use primer or cement beyond its expiration date.

The safe operation, as defined by ULC S636, of the vent system is based on following these installation instructions, the vent system manufacturer's installation instructions, and proper use of primer and cement. All fire stop and roof flashing used with this system must be UL listed material. Acceptability under Canadian standard CAN/CSA B149 is dependent upon full compliance with all installation instructions. Under this standard, it is recommended that the vent system be checked once a year by qualified service personnel.

The authority having jurisdiction (gas inspection authority, municipal building department, fire department, etc) should be consulted before installation to determine the need to obtain a permit.

*IPEX System 636™ is a trademark of IPEX Inc.

Consignes spéciales pour l'installation de ventilation au Canada

L'installation faite au Canada doit se conformer aux exigences du code CAN/CSA B149-2010. Ce système de ventilation **doit** se composer de tuyaux, raccords, ciments et apprêts conformes au ULC S636. La tuyauterie de ventilation des gaz, ses accessoires, le terminal concentrique mural ainsi que l'ensemble du drain de condensat extérieur ont été certifiés ULCS 636 pour l'application des composantes Royal Pipe, IPEX PVC qui sont certifiées à ce standard. Au Canada, l'apprêt et le ciment doivent être du même fabricant que le système d'évacuation. L'apprêt GVS-65 (Purple) et le ciment-solvant GVS-65 doivent être utilisés avec les Royal Pipe. Système IPEX 636, apprêt PVC/CPVC, Purple pour évacuation des gaz de combustion et système IPEX 636⁽¹⁾, ciment PVC pour évacuation des gaz de combustion, coté classe IIA, 65 deg C. doivent être utilisés avec le système d'évacuation IPEX 636 – Ne pas combiner l'apprêt et le ciment d'un fabricant avec un système d'évacuation d'un fabricant différent.

Bien suivre les indications du fabricant lors de l'utilisation de l'apprêt et du ciment et ne pas utiliser ceux-ci si la date d'expiration est atteinte.

L'opération sécuritaire, tel que définit par ULC S636, du système de ventilation est basé sur les instructions d'installation suivantes, ainsi que l'usage approprié de l'apprêt et ciment. Tout arrêt feu et solin de toit utilisés avec ce système doivent être des matériaux listés UL. L'acceptation du standard Canadien CAN/CSA B149 est directement relié à l'installation conforme aux instructions ci-haut mentionnées. Le

standard Canadien recommande l'inspection par un personnel qualifié et ce, une fois par année.

Les autorités ayant juridiction (inspecteurs de gaz, inspecteurs en bâtiments, département des incendies, etc) devraient être consultées avant l'installation afin de déterminer si un permis est requis.



WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow the steps outlined below for each appliance connected to the venting system being placed into operation could result in carbon monoxide poisoning or death.

Failure to follow the steps outlined below for each appliance connected to the venting system being placed into operation could result in carbon monoxide poisoning or death.

1. Seal any unused openings in venting system.
2. Inspect the venting system for proper size and horizontal pitch, as required in the National Fuel Gas Code, NFPA 54/ANSI Z223.1-2009 and these instructions. Determine that there is no blockage or restriction, leakage, corrosion and other deficiencies, which could cause an unsafe condition.
3. As far as practical, close all building doors and windows and all doors between the space in which the appliance(s) connected to the venting system are located and other spaces of the building.
4. Close fireplace dampers.
5. Turn on clothes dryers and any appliance not connected to the venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they are operating at maximum speed. Do not operate a summer exhaust fan.
6. Follow the lighting instructions. Place the appliance being inspected into operation. Adjust the thermostat so appliance is operating continuously.
7. Test for spillage from draft hood equipped appliances at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle.
8. If improper venting is observed during any of the above tests, the venting system must be corrected in accordance with the National Fuel Gas Code, NFPA 54/ANSI Z223.1-2009.
9. After it has been determined that each appliance connected to the venting system properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas-fired burning appliance to their previous conditions of use.

General

If this furnace replaces a furnace that was connected to a vent system or chimney, the vent or vent connectors of other remaining appliances may need to be re-sized. Vent systems or vent connectors of other appliances must be sized to the minimum size as determined using appropriate table found in the current edition of National Fuel Gas Code NFPA 54/ANSI Z-223.1. In Canada, refer to CAN/CSA-B149.1

An abandoned masonry chimney may be used as a raceway for properly insulated and supported combustion-air (when applicable) and vent pipes. Each furnace must have its own set of combustion-air and vent pipes and be terminated individually, as shown in **Figure 54** for Direct Vent (2-Pipe) system or **Figure 55** for ventilated combustion air option.

A furnace shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

Other gas appliances with their own venting system may also use the abandoned chimney as a raceway providing it is permitted by local code, the current edition of the National Fuel Gas Code and the vent or liner manufacturer's installation instructions. Care must be taken to prevent the exhaust gases from one appliance from contaminating the combustion air of other gas appliances.

Do not take combustion air from inside the chimney when using ventilated combustion air or single pipe vent option.

These furnaces can be vented as either as direct vent furnace, ventilated combustion air system or non-direct (single pipe) vent system. Each type of venting system is described below. Common venting between furnaces or other appliances prohibited.

Materials

U.S.A.

Combustion air and vent pipe, fittings, primers, and solvents must conform to American National Standards Institute (ANSI) standards and American Society for Testing and Materials (ASTM) standards. See **Table 11** for approved materials for use in the U.S.A.

Canada

Special Venting Requirements for Installations in Canada Installation in Canada must conform to the requirements of CAN/CSA B149 code. Vent systems **must** be composed of pipe, fittings, cements, and primers listed to ULC S636.

Venting Systems

A factory accessory concentric vent termination kit is available for direct vent terminations. Concentric termination kits are available for 2-in. and 3-in. pipe. See **Table 10** for available options.

Table 10		Vent Termination Kit for Direct Vent (2-Pipe) Systems	
Direct Vent (2-Pipe) Termination Kit	Termination System	Diam. Of Combustion Air and Vent Pipes in.(mm)	
2-in (51 mm) Concentric Vent Kit	Single Penetration of Wall or Roof	1, 1-1/2, 2, or 2-1/2 (25, 38, 51, 64 mm)	
3-in (76 mm) Concentric Vent Kit	Single Penetration of Wall or Roof	2-1/2, 3 or 4 (64, 76, 102 mm)	

Direct Vent / 2-Pipe System

In a direct-vent (2-pipe) system, all air for combustion is taken directly from outdoor atmosphere, and all flue products are

discharged to outdoor atmosphere. Combustion-air and vent pipes must terminate together in the same atmospheric pressure zone, either through the roof or a sidewall (roof termination preferred). See **Figure 62** for required clearances.

Ventilated Combustion Air Systems

In a ventilated combustion air option, the vent terminates and discharges the flue products directly to the outdoors similar to a direct vent system. See **Figure 63** for required clearances.

All air for combustion is piped directly to the furnace from a space that is well ventilated with outdoor air (such as an attic or crawl space) and the space is well isolated from the living space or garage. Combustion air requirements for this option are the same as the requirements for providing outside air for combustion for a single pipe vent system. Refer to the "Air For Combustion and Ventilation Section."

Provisions for adequate combustion, ventilation, and dilution air must be provided in accordance with:

U.S.A. Installations: Section 9.3 NFPA 54/ANSI Z223.1-2009, Air for Combustion and Ventilation and applicable provisions of the local building codes.

Canadian Installations: Part 8 of CAN/CSA-B149.1-2010. Venting Systems and Air Supply for Appliances and all authorities having jurisdiction.

Non-Direct Vent (1-pipe) System

In a non direct-vent (1-pipe) system, all air for combustion is taken from the area adjacent to furnace, and all flue products are discharged to outdoor atmosphere. Air for combustion must be supplied as described in the Air For Combustion and Ventilation Section. Do not use an abandoned chimney to supply outside air to the furnace.

Provisions for adequate combustion, ventilation, and dilution air must be provided in accordance with:

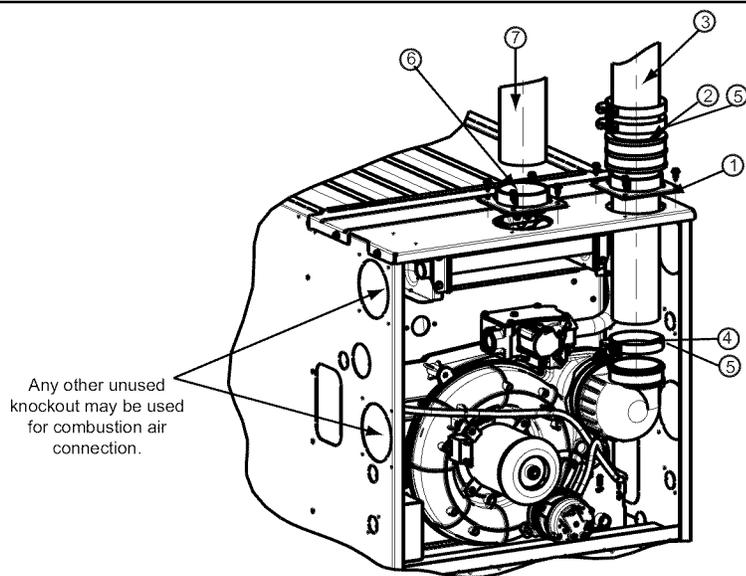
U.S.A. Installations: Section 9.3 NFPA 54/ANSI Z223.1-2009, Air for Combustion and Ventilation and applicable provisions of the local building codes.

Canadian Installations: Part 8 of CAN/CSA-B149.1-2010. Venting Systems and Air Supply for Appliances and all authorities having jurisdiction.

A combustion air pipe to the outdoors is not required for a single pipe vent system. A 12-in. (304 mm) long pipe with a 2-in. (51 mm) tight radius 90 degree elbow is required to be attached to the combustion air pipe adapter on the furnace. (See **Figure 59**)

Table 11		Approved Combustion-Air and Vent Pipe, Fitting and Cement Materials (U.S.A. Installation)			
ASTM SPECIFICATION (MARKED ON MATERIAL)	MATERIAL	PIPE	FITTINGS	SOLVENT CEMENT AND PRIMERS	DESCRIPTION
D1527	ABS	Pipe	-	-	Schedule-40
D1785	PVC	Pipe	-	-	Schedule-40
D2235	For ABS	-	-	Solvent Cement	For ABS
D2241	PVC	Pipe	-	-	SDR-21 & SDR-26
D2466	PVC	-	Fittings	-	Schedule-40
D2468	ABS	-	Fittings	-	Schedule-40
D2564	For PVC	-	-	Solvent Cement	For PVC
D2661	ABS	Pipe	Fittings	-	DWV at Schedule-40 IPS sizes
D2665	PVC	Pipe	Fittings	-	DWV
F438	CPVC	-	Fittings	-	Schedule-40
F441	CPVC	Pipe	-	-	Schedule-40
F442	CPVC	Pipe	-	-	SDR
F493	For CPVC	-	-	Solvent Cement	For CPVC
F628	ABS	Pipe	-	-	Cellular Core DWV at Schedule-40 IPS sizes
F656	For PVC	-	-	Primer	For PVC
F891	PVC	Pipe	-	-	Cellular Core Schedule-40 & DWV

Figure 43 Upflow Vertical Vent



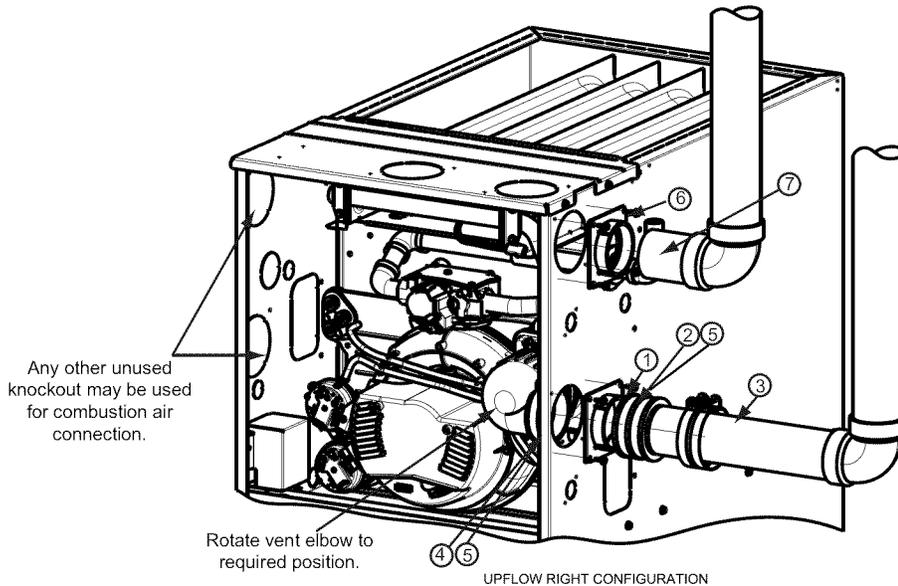
UPFLOW VERTICAL VENT

- ① Attach vent pipe adapter with gasket to furnace casing.
- ② Align notches in rubber coupling over standoffs on adapter. Slide clamps over the coupling.
- ③ Slide vent pipe through adapter and coupling into vent elbow.
- ④ Insert vent pipe into vent elbow.
- ⑤ Torque all clamps 15 lb.-in.
- ⑥ Attach combustion air pipe adapter with gasket to furnace.
- ⑦ Attach combustion air pipe to adapter with silicone. Pilot drill a 1/8-in. hole in adapter and secure with a #7 x 1/2-in sheet metal screw.

Representative drawing only, some models may vary in appearance.

A11310

Figure 44 | **Upflow Right Vent**

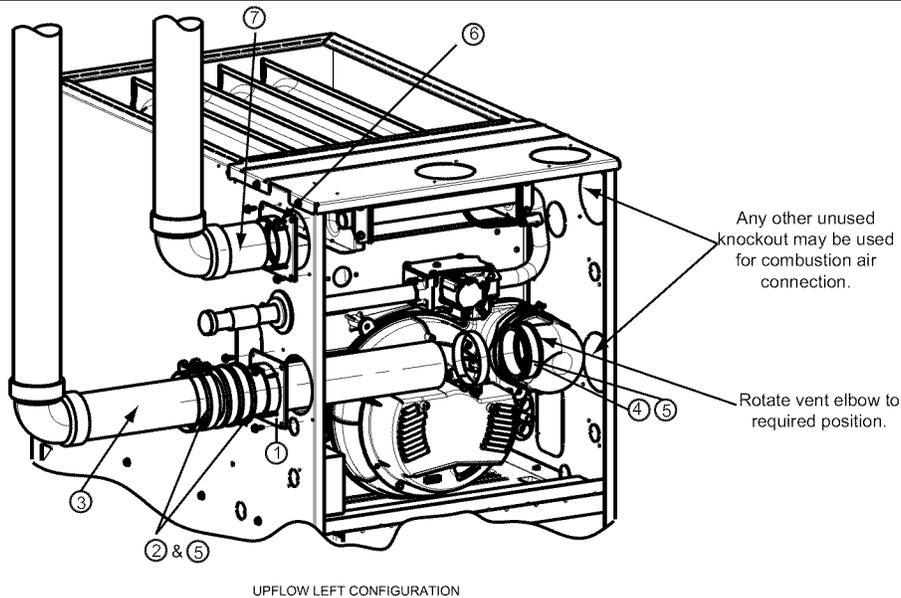


- ① Attach vent pipe adapter with gasket to furnace casing.
- ② Align notches in rubber coupling over standoffs on adapter. Slide clamps over the coupling.
- ③ Slide vent pipe through adapter and coupling into vent elbow.
- ④ Insert vent pipe into vent elbow.
- ⑤ Torque all clamps 15 lb.-in.
- ⑥ Attach combustion air pipe adapter with gasket to furnace casing.
- ⑦ Attach combustion air pipe to adapter with silicone. Pilot drill a 1/8-in. hole in adapter and secure with a #7 x 1/2-in. sheet metal screw.

Representative drawing only, some models may vary in appearance.

A11308

Figure 45 | **Upflow Left Vent**



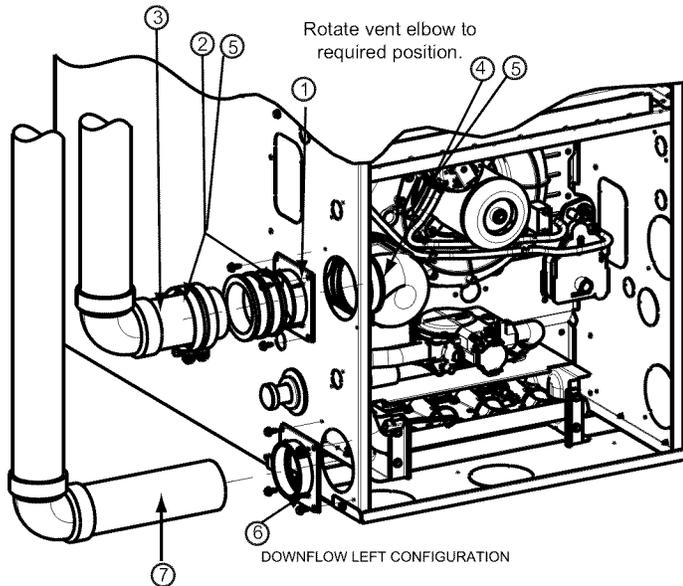
- ① Attach vent pipe adapter with gasket to furnace casing.
- ② Align notches in rubber coupling over standoffs on adapter. Slide clamps over the coupling.
- ③ Slide vent pipe through adapter and coupling into vent elbow.
- ④ Insert vent pipe into vent elbow.
- ⑤ Torque all clamps 15 lb.-in.
- ⑥ Attach combustion air pipe adapter with gasket to furnace.
- ⑦ Attach combustion air pipe to adapter with silicone. Pilot drill a 1/8-in. hole in adapter and secure with a #7 x 1/2-in sheet metal screw.

Representative drawing only, some models may vary in appearance.

A11309

Figure 46

Downflow Left Vent



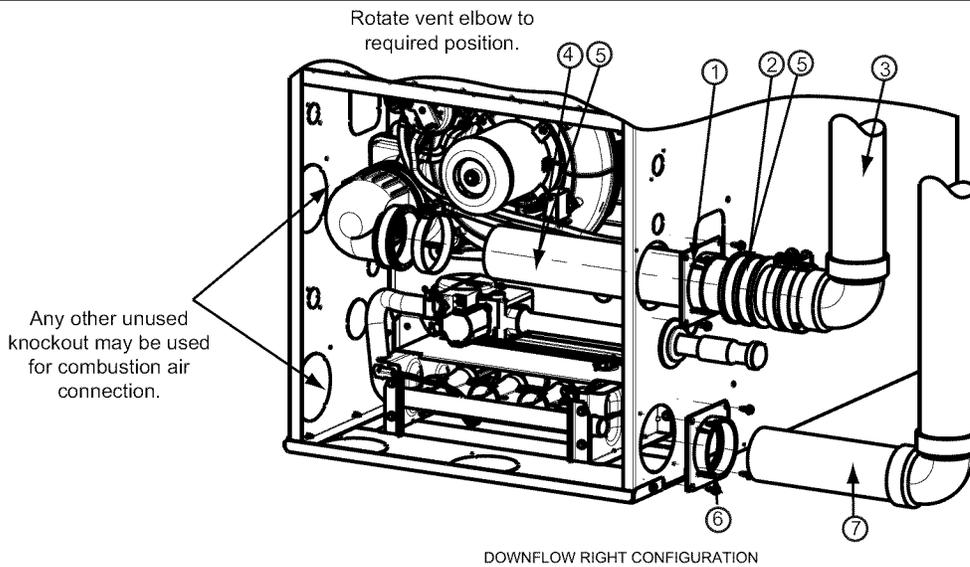
- ① Attach vent pipe adapter with gasket to furnace casing.
- ② Align notches in rubber coupling over standoffs on adapter. Slide clamps over the coupling.
- ③ Slide vent pipe through adapter and coupling into vent elbow.
- ④ Insert vent pipe into vent elbow.
- ⑤ Torque all clamps 15 lb.-in.
- ⑥ Attach combustion air pipe adapter with gasket to furnace.
- ⑦ Attach combustion air pipe to adapter with silicone. Pilot drill a 1/8-in. hole in adapter and secure with a #7 x 1/2-in sheet metal screw.

Representative drawing only, some models may vary in appearance.

A11311

Figure 47

Downflow Right Vent

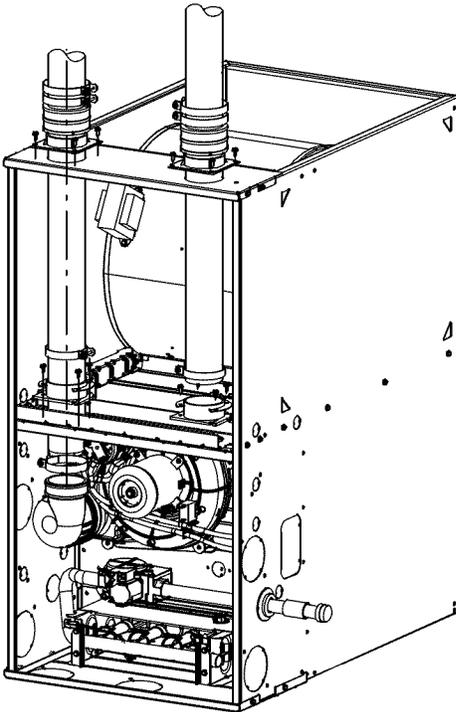


- ① Attach vent pipe adapter with gasket to furnace casing.
- ② Align notches in rubber coupling over standoffs on adapter. Slide clamps over the coupling.
- ③ Slide vent pipe through adapter and coupling into vent elbow.
- ④ Insert vent pipe into vent elbow.
- ⑤ Torque all clamps 15 lb.-in.
- ⑥ Attach combustion air pipe adapter with gasket to furnace.
- ⑦ Attach combustion air pipe to adapter with silicone. Pilot drill a 1/8-in. hole in adapter and secure with a #7 x 1/2-in sheet metal screw.

Representative drawing only, some models may vary in appearance.

A11312

Figure 48 Downflow Vertical Vent

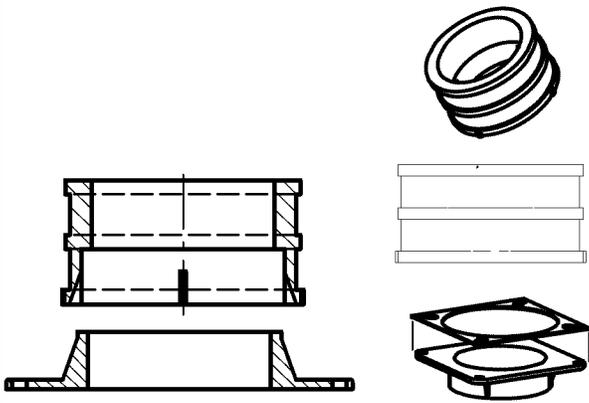


Requires Accessory Internal Vent Kit
See Specification Sheets for current kit number

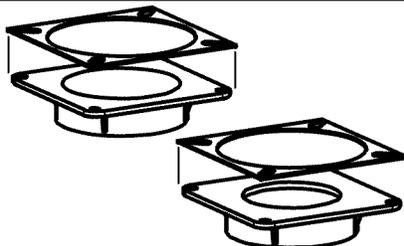
Representative drawing only, some models may vary in appearance.

L11F063

Figure 49 Vent Coupling and Adapter with Gaskets



Vent Coupling and Adapter



Attach gaskets to vent pipe and combustion air adapters

Figure 50 Vent Pipe Flush with Adaptor

VENT PIPE ADAPTER WITH GASKET
INSTALLED ON FURNACE VENT
PIPE IS CUT FLUSH WITH TOP OF
ADAPTER.

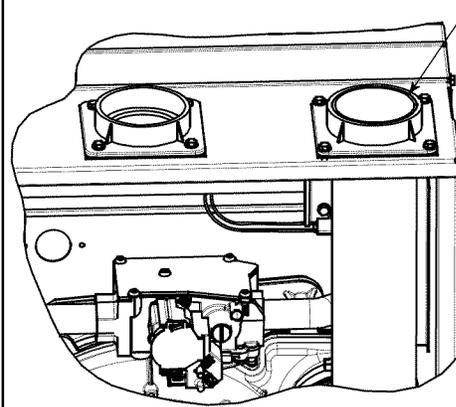
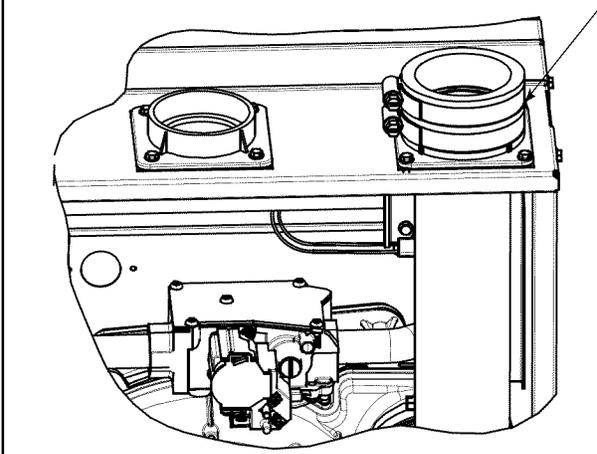


Figure 51 Vent Pipe Flush Showing Coupling

ALIGN NOTCHES IN VENT PIPE
COUPLING OVER STAND-OFF
ON ADAPTER. TORQUE LOWER
CLAMP 15 LB-IN. WHEN REMAINING
VENT PIPE IS INSTALLED, TORQUE
UPPER CLAMP TO 15 LB-IN.



Locating the Vent Termination

General

NOTE: Termination Requirements for the Provinces of Alberta and Saskatchewan are located at the end of this section.

Combustion-air (direct vent/2-pipe system only) and vent pipe must terminate outside structure, either through sidewall or roof.

For vent termination clearance, refer to **Figure 62** for Direct Vent/2-Pipe system and **Figure 63** for Non-direct Vent/1-Pipe system. For exterior termination arrangements, refer to **Figure 62** for Direct Vent/2-Pipe system and **Figure 63** for Non-Direct/1-Pipe system.

Roof termination is preferred since it is less susceptible to damage or contamination, and it has less visible vent vapors. Sidewall terminations require sealing or shielding of building surfaces with a corrosive resistance material due to corrosive combustion products of vent system.

NOTE: (Direct Vent/2-Pipe system ONLY) A factory accessory termination kit MUST be used.

When determining appropriate location for termination, consider the following guidelines:

1. Comply with all clearance requirements stated in **Figure 62** or **Figure 63** per application.
2. Termination or termination kit should be positioned where vent vapors will not damage plants/shrubs or air conditioning equipment.
3. Termination or termination kit should be positioned so that it will not be affected by wind eddy, such as inside building corners, nor by recirculation of flue gases, airborne leaves, or light snow.
4. Termination or termination kit should be positioned where it will not be damaged by or subjected to foreign objects such as stones, balls, etc.
5. Termination or termination kit should be positioned where vent vapors are not objectionable.

Direct Vent / 2-Pipe System

Direct vent (2-pipe) vent and combustion air pipes must terminate outside the structure. Follow all clearances as shown **Figure 62**. Allowable vent and combustion air terminations are shown in **Figure 54**.

Ventilated Combustion Air

The vent pipe for a Ventilated Combustion Air System must terminate outdoors. Follow all vent termination clearances shown in **Figure 63**. Allowable vent terminations are shown in **Figure 55**. The combustion air pipe terminates in a well-ventilated attic or crawl space. Follow the clearances as shown in **Figure 60** and **Figure 61**.

The combustion air pipe cannot terminate in attics or crawl spaces that use ventilation fans designed to operate in the heating season. If ventilation fans are present in these areas, the combustion air pipe must terminate outdoors as a Direct Vent System.

Non-Direct Vent / 1-Pipe System

The vent pipe for a Non Direct Vent (1-pipe) system must terminate outdoors. Follow all vent termination clearances shown in **Figure 63**. Allowable vent terminations are shown in **Figure 55**

A combustion air pipe to the outdoors is not required for a Non-Direct Vent System. A 12-in. long section of pipe with a tight radius 2-in. (51 mm) 90 degree elbow is required to be attached to the furnace.

Termination Requirements for the Provinces of Alberta and Saskatchewan

The Provinces of Alberta and Saskatchewan require a minimum unobstructed distance of 4 ft. (1.2m) from the foundation to the property line of the adjacent lot for vent termination of any appliance with an input over 35,000 btuh. If there is less than 4 ft. (1.2m) of unobstructed distance to the property line of the adjacent lot, no type of vent termination is permitted for appliances with inputs greater than 35,000 btuh.

There are no additional restrictions on unobstructed distances greater than 8 ft. (2.4m). All single, two-pipe and concentric vents may be used, providing all other Code and manufacturer's requirements in these instructions are adhered to. Refer to the appropriate **Vent Termination** section above for locating the vent termination .

If the unobstructed distance from the foundation to the property line of the adjacent lot is no less than 4 ft. (1.2m) and no greater than 8 ft. (2.4m), it will be necessary to re-direct the flue gas plume. In this situation, a concentric vent kit cannot be used. A 2-pipe termination (or single pipe termination when permitted) that re-directs the flue gas away by use of an elbow or tee, certified to ULC S636 from the adjacent property line must be used. (See **Figure 52** and **Figure 53**)

The concentric vent kit currently cannot be modified to attach an elbow to the vent portion of the rain cap. A tee attached to the rain cap could potentially direct the flue gas plume toward the intake air stream and contaminate the incoming combustion air for the furnace.

Refer to **Figure 52** and **Figure 53** for terminations approved for use in Alberta and Saskatchewan.

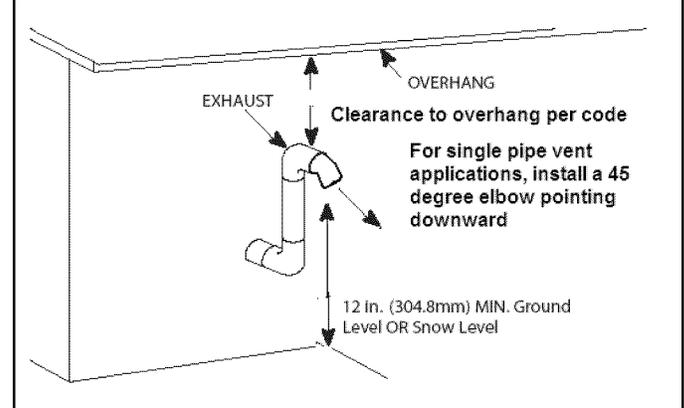
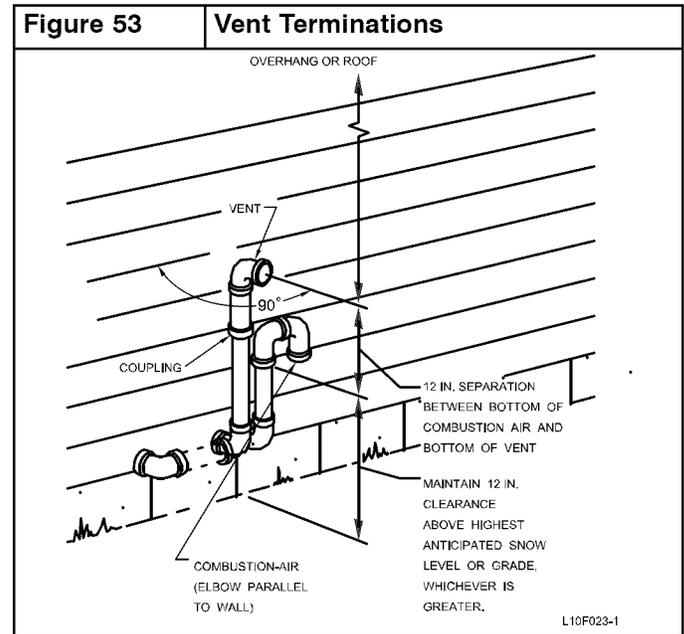
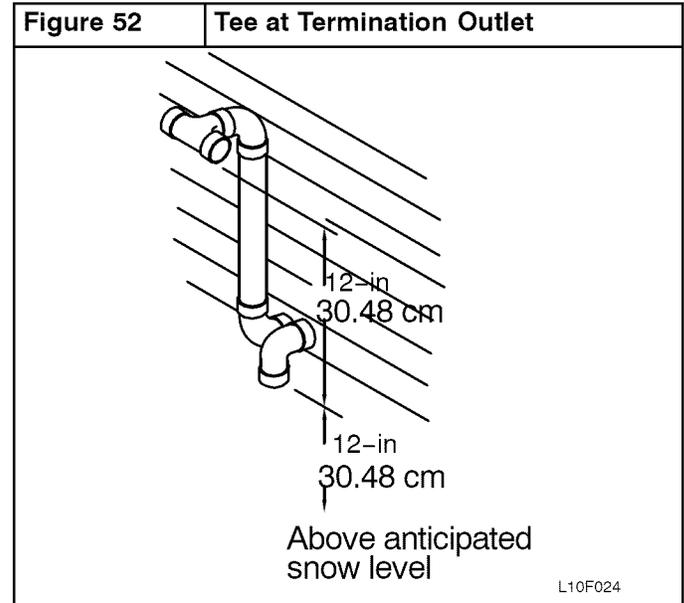
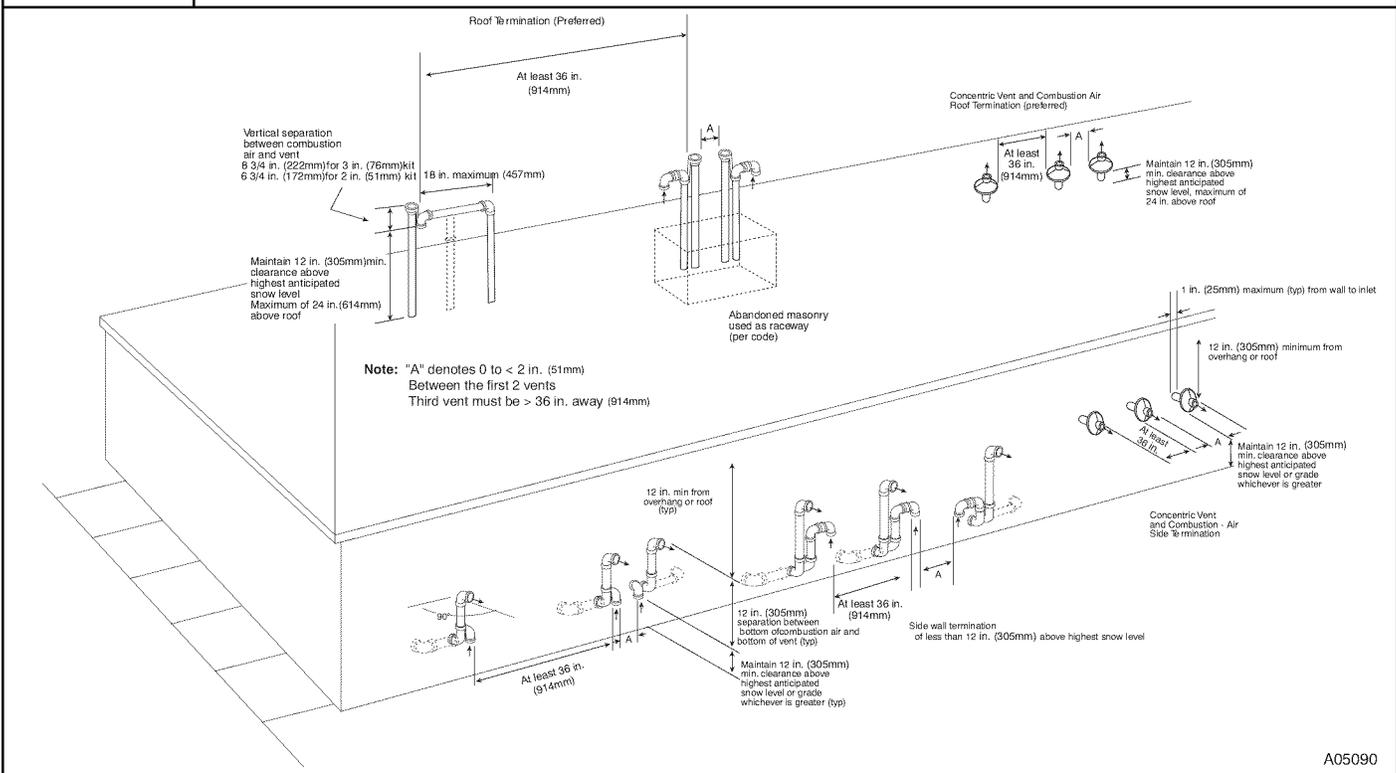
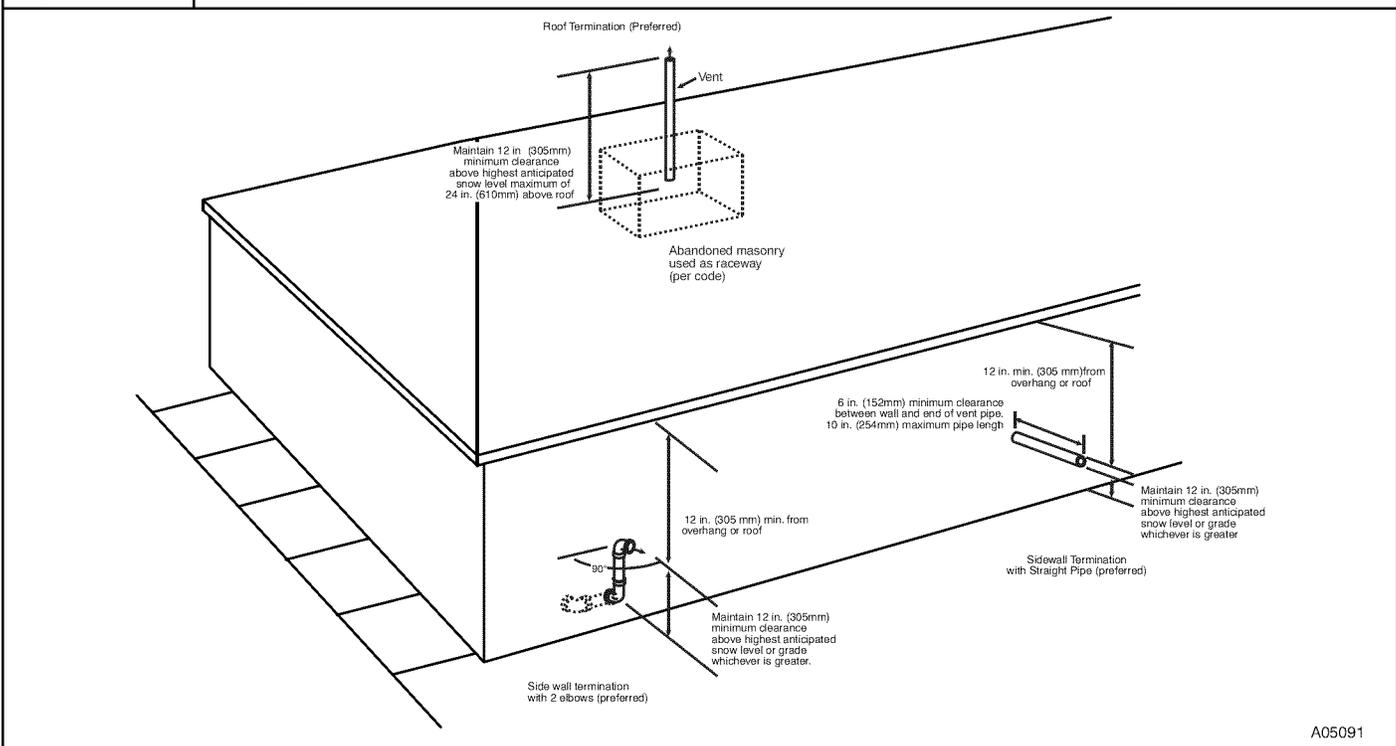


Figure 54 Combustion Air and Vent Pipe Termination for Direct Vent (2-Pipe) System



A05090

Figure 55 Vent Pipe Termination for Non-Direct Vent and Ventilated Combustion Air System



A05091

Size the Vent and Combustion Air Pipes

General

Furnace combustion air and vent pipe connections are sized for 2-in. (51 mm) pipe. Any pipe diameter change should be made outside furnace casing in vertical pipe. Any change in diameter to the pipe must be made as close to the furnace as reasonably possible.

The Maximum Vent Length for the vent pipe and combustion air pipe (when used) equals the Maximum Equivalent Vent Length

(MEVL) in Table 12 or Table 13, minus the number of fittings multiplied by the deduction for each type of fitting used from Table 14.

The measured length of pipe used in a single or 2-pipe termination is included in the total vent length. Include a deduction for a Tee when used for Alberta and Saskatchewan terminations. Concentric vent terminations, pipe lengths or elbows do not require a deduction from the Maximum Equivalent Vent Length.

1. Measure the individual distance from the furnace to the termination for each pipe.
2. Select a Maximum Equivalent Vent Length (MEVL) longer than the measured distance of the individual vent and combustion air connections to the vent termination.
3. Count the number of elbows for each pipe.
4. For each pipe, multiply the number of elbows by the equivalent length for the type of elbow used. Record the equivalent length of all the elbows for each pipe.
5. If a Tee is used on the termination, record the equivalent length of the Tee used.
6. Record the equivalent length of the termination to be used.
7. Subtract the equivalent lengths of the fittings and terminations from the Maximum Equivalent Vent Length.
8. If the Maximum Vent Length calculated is longer than the individual measured length of the vent pipe and combustion air pipe, then the diameter of pipe selected may be used.
9. If the Maximum Vent Length calculated is shorter than the individual measured length of either the vent pipe or the combustion air pipe, recalculate the Maximum Vent Length using the next larger diameter pipe.

NOTE: The vent pipe and combustion air pipe must be the same diameter.

NOTE: If the Maximum Vent Length for diameter of the pipe selected is longer than the measured length and the equivalent length of all the fitting and terminations, recalculate using the next smaller diameter. If the recalculated Maximum Vent Length is longer than the measured length of the vent pipe and combustion air pipe, then that diameter of pipe selected may be used.

When installing vent systems of short pipe lengths, use the smallest allowable pipe diameter. Do not use pipe size greater than required or incomplete combustion, flame disturbance, or flame sense lockout may occur.

Combustion Air and Vent Piping Insulation Guidelines

NOTE: Use closed cell, neoprene insulation or equivalent.

The vent pipe may pass through unconditioned areas. The amount of exposed pipe allowed is shown in **Table 15** and **Table 16**.

1. Using winter design temperature (used in load calculations), find appropriate temperature for your application and furnace model.
2. Determine the amount of total and exposed vent pipe.
3. Determine required insulation thickness for exposed pipe length(s).
4. When combustion air inlet piping is installed above a suspended ceiling, the pipe **MUST** be insulated with moisture resistant insulation such as Armaflex or other equivalent type of insulation.
5. Insulate combustion air inlet piping when run in warm, humid spaces.
6. Install the insulation per the insulation manufacturer's installation instructions.

NOTE: Pipe length (ft / M) specified for maximum pipe lengths located in unconditioned spaces (See **Table 15** and **Table 16**) cannot exceed total allowable pipe length as calculated from **Table 12** through **Table 13**.

Configure the Furnace

⚠ WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in personal injury or death.

To route the vent pipe and combustion air pipe through the furnace, the manufacturer supplied kit must be used. Failure to properly seal the blower compartment from the furnace vestibule could result in the circulation of carbon monoxide throughout the structure. The vent pipe and combustion air pipe must be a continuous pipe while passing through the blower compartment. Seals supplied in this kit must be installed per the instructions provided. Follow all procedures outlined in these instructions.

With the furnace installed in the required position, remove the desired knockouts from the casing. It will be necessary to remove one knockout for the vent pipe and the other knockout for the combustion air connection.

Use a flat blade screwdriver and tap on the knockout on opposite sides, where the knockout meets the casing. Fold the knockout down with duct pliers and work the knockout back and forth until it is removed. Trim any excess metal from the knockout with tin snips.

The vent elbow can be rotated to the required location on the casing if necessary. See **Figure 56** to rotate the vent elbow:

1. Loosen the clamp on the inlet of the vent elbow attached to the inducer.
2. Rotate the vent elbow to the required position. There are rounded notches in the vent elbow to align it with the inducer for each orientation.
3. Tighten the clamp around the vent elbow. Torque the clamp to 15 lb-in. See **Figure 43** through **Figure 48**, **Figure 57** and **Figure 58**.

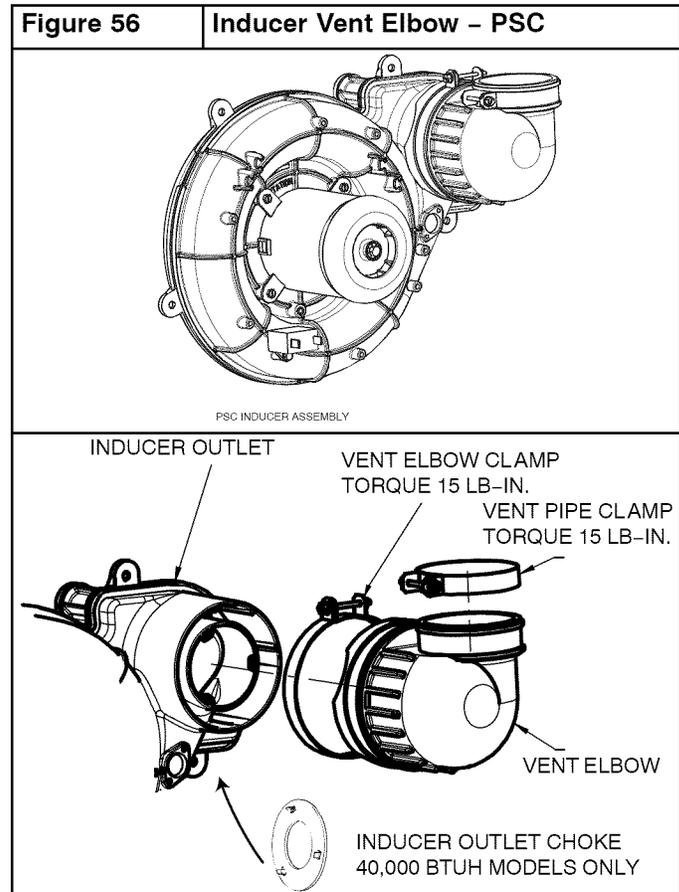
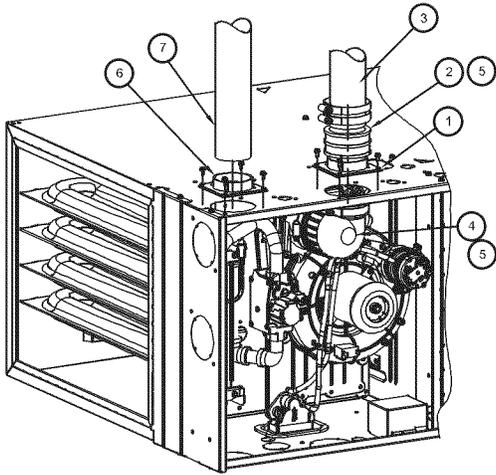
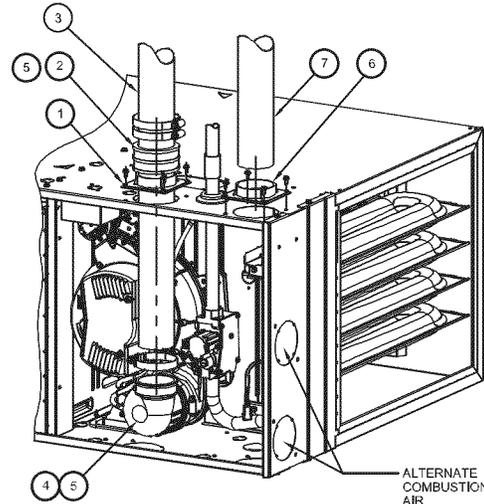


Figure 57 Horizontal Left Vent Configuration

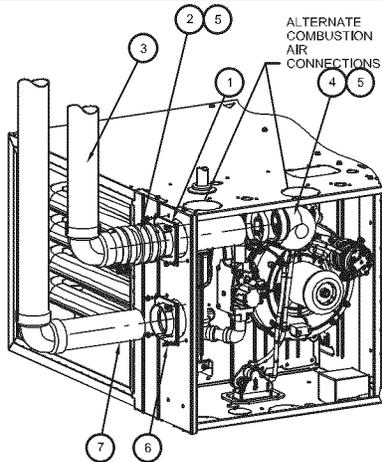


HORIZONTAL LEFT VERTICAL VENT A11327
 Representative drawing only, some models may vary in appearance.

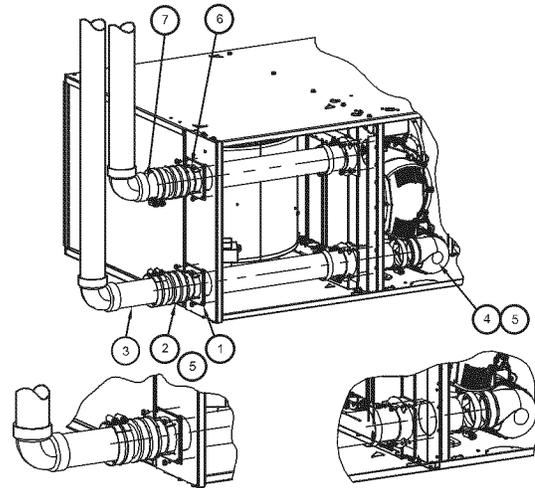
Figure 58 Horizontal Right Vent Configuration



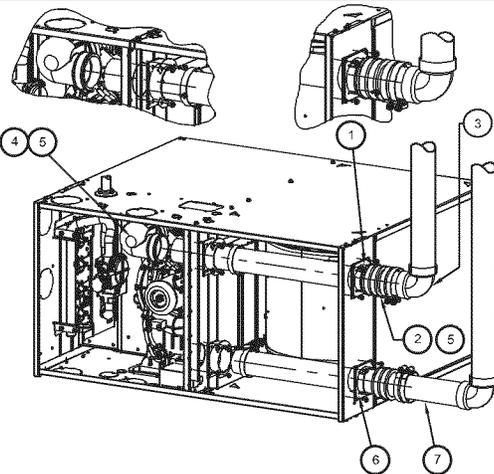
HORIZONTAL RIGHT, VERTICAL VENT A11337
 Representative drawing only, some models may vary in appearance.



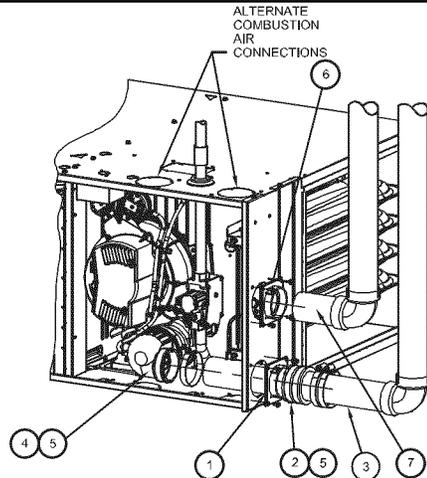
HORIZONTAL LEFT, LEFT VENT A11328
 Representative drawing only, some models may vary in appearance.



HORIZONTAL RIGHT, LEFT VENT A11336
 Representative drawing only, some models may vary in appearance.



HORIZONTAL LEFT, RIGHT VENT A11329
 Representative drawing only, some models may vary in appearance.



HORIZONTAL RIGHT, RIGHT VENT A11335
 Representative drawing only, some models may vary in appearance.

Installing the Vent Pipe Adapter and Combustion Air Pipe Adapter



WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow this warning could result in personal injury or death.

To route the vent pipe and combustion air pipe through the furnace, the manufacturer supplied kit must be used. Failure to properly seal the blower compartment from the furnace vestibule could result in the circulation of carbon monoxide throughout the structure. The vent pipe and combustion air pipe must be a continuous pipe while passing through the blower compartment. Seals supplied in this kit must be installed per the instructions provided. Follow all procedures outlined in these instructions.

NOTE: The rubber coupling that attaches to the vent pipe adapter must be used. The adapter seals the vent pipe to the casing and reduces the strain on the vent elbow attached to the inducer.

1. Apply the gaskets to the vent pipe and combustion air pipe adapters. See **Figure 49**.

NOTE: The vent pipe adapter has a larger ID than the combustion air pipe adapter.

2. Align the screw holes in the plastic vent pipe adapter with the dimples in the casing.
3. Pilot drill the screw holes for the adapter in the casing and attach the vent pipe adapter to the furnace with sheet metal screws
4. Slide the end of the rubber vent coupling with notches in it over the standoffs on the vent pipe adapter.
5. Insert a length of vent pipe through the coupling into the outlet of the vent elbow.
6. Tighten the clamp around the outlet of the vent elbow. Torque the clamp to 15 lb-in.

Install the remaining vent and combustion air pipes as shown below. It is recommended that all pipes be cut, prepared, and preassembled before permanently cementing any joint.

1. Working from furnace to outside, cut pipe to required length(s).
2. Deburr inside and outside of pipe.
3. Chamfer outside edge of pipe for better distribution of primer and cement.
4. Clean and dry all surfaces to be joined.
5. Check dry fit of pipe and mark insertion depth on pipe.
6. Insert the vent pipe into the vent elbow.
7. Torque clamp on vent elbow 15 lb-in.
8. Torque clamp on vent coupling 15 lb-in.
9. Insert the combustion air pipe into the adapter.
10. Pilot drill a screw hole through the adapter into the combustion air pipe and secure the pipe to the adapter with sheet metal screws.
11. Seal around the combustion air pipe with silicone or foil tape.
12. After pipes have been cut and preassembled, apply generous layer of cement primer to pipe fitting socket and end of pipe to insertion mark. Quickly apply approved cement to end of pipe and fitting socket (over primer). Apply cement in a light, uniform coat on inside of

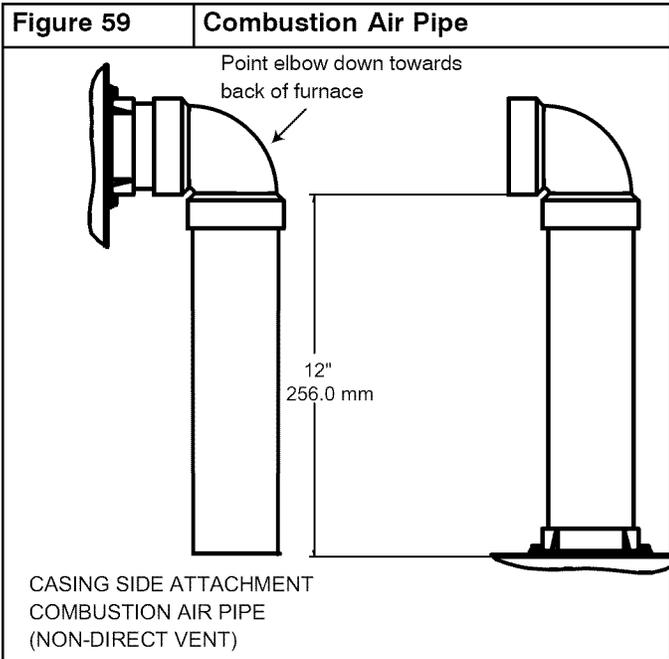
socket to prevent buildup of excess cement. Apply second coat.

13. While cement is still wet, twist pipe into socket with 1/4-in. turn. Be sure pipe is fully inserted into fitting socket.
14. Wipe excess cement from joint. A continuous bead of cement will be visible around perimeter of a properly made joint.
15. Handle pipe joints carefully until cement sets.
16. Horizontal portions of the venting system shall be supported to prevent sagging. Support combustion air piping and vent piping a minimum of every 5 ft. (1.5 M) [3 ft. (.91M) for SDR-21 or -26 PVC] using perforated metal hanging strap or commercially available hangars designed to support plastic pipe.
17. Prevent condensate from accumulating in the pipes by sloping the combustion air piping and vent piping downward towards furnace a minimum of 1/4-in. per linear ft. with no sags between hangers.
18. Complete the vent and combustion air pipe installation by connecting to the concentric vent or by installing the required termination elbows as shown in **Figure 54** and **Figure 55**, Alberta **Figure 52** and **Figure 53**.
19. For ventilated combustion air terminations, refer to **Figure 55**, Alberta **Figure 52** and **Figure 53**.
20. Use appropriate methods to seal openings where combustion air pipe and vent pipe pass through roof or sidewall.

Optional Installation of the vent pipe

This option provides a disconnect point for the vent pipe. The vent pipe must be cemented to the plastic vent pipe adapter to maintain a sealed vestibule. See **Figure 50** and **Figure 51**

1. Insert a length of vent pipe through the casing into the outlet of the vent elbow.
2. Slide the plastic vent pipe adapter over the length of the vent pipe down to the furnace casing. Mark the pipe where it is flush with the outlet of the adapter.
3. Remove the pipe from the furnace and the adapter and cut off any excess pipe.
4. Clean and prime the end of the pipe that is flush with the vent adapter with a primer that is appropriate for the type of pipe being used.
5. Re-insert the pipe through the casing into the vent elbow.
6. Tighten the clamp around the outlet of the vent elbow. Torque the clamp to 15 lb-in.
7. Apply cement to the end of the pipe and to the inside of the plastic vent adapter.
8. Slide the adapter over the vent pipe and align the screw holes in the adapter with the dimples in the furnace casing.
9. Pilot drill 1/8-in. screw holes for the adapter in the casing and secure the adapter to the furnace with sheet metal screws.
10. Loosen the clamps on the rubber vent coupling.
11. Slide the end of the coupling with notches in it over the standoffs in the vent pipe adapter.
12. Tighten the clamp of the coupling over the vent pipe adapter. Torque the lower clamp around the vent pipe adapter to 15 lb-in.
13. Pilot drill a 1/8-in. hole in the combustion air pipe adapter.
14. Complete the vent and combustion air pipe as shown in "Install the Vent and Combustion Air Pipe"



Holes in the roof for two pipe terminations should be spaced no more than 18-in. (457 mm) apart.

Termination elbows will be installed after the vent and (if used) combustion air pipe is installed.

Sidewall Terminations

Concentric Vent

Determine an appropriate location for termination kit using the guidelines provided in section "Locating The Vent Termination" in this instruction.

1. Cut one 4-in. diameter hole for 2-in. kit, or one 5-in. diameter hole for 3-in. kit.
2. Loosely assemble concentric vent/combustion air termination components together using instructions in kit.
3. Slide assembled kit with rain shield REMOVED through hole.

NOTE: Do not allow insulation or other materials to accumulate inside of pipe assembly when installing it through hole.

4. Locate assembly through sidewall with rain shield positioned no more than 1-in. (25 mm) from wall as shown in **Figure 54**.
5. Disassemble loose pipe fittings. Clean and cement using same procedures as used for system piping.

2-Pipe and 1-Pipe Vent Termination

Determine an appropriate location for termination kit using the guidelines provided in section "Locating The Vent Termination" in this instruction.

1. Cut two holes, one for each pipe, of appropriate size for pipe size being used.
2. Loosely install elbow on combustion air and vent pipe and place assembly on combustion-air pipe.

NOTE: For applications using vent pipe option indicated by dashed lines in **Figure 54** and **Figure 55**, rotate vent elbow 90° from position.

3. Disassemble loose pipe fittings. Clean and cement using same procedures as used for system piping.

(Direct Vent / 2-Pipe System ONLY)

When 2 or more furnaces are vented near each other, 2 vent terminations may be installed as shown in **Figure 54**, but next vent termination must be at least 36-in. (914 mm) away from first 2 terminations. It is important that vent terminations be made as shown in **Figure 54** to avoid recirculation of flue gases.

Inducer Outlet Restrictor (PSC models only)

To improve efficiency and operation of 40,000 BTUH input models on very short vent systems, an inducer outlet restrictor is required to be installed on the outlet of the inducer assembly. The outlet restrictor is shipped in the loose parts bag.

To determine if the outlet restrictor is required, see **Table 12**

NOTE: Failure to use an outlet choke when required may result in flame disturbance or flame sense lockout.

To install the outlet restrictor:

1. Remove the vent elbow from the inducer outlet
2. Align the lock tabs on the outlet restrictor with the slots on inside outlet of the inducer assembly.
3. Snap the outlet restrictor in place.
4. Re-install the vent elbow
5. Torque vent elbow clamp 15 lb-in.

Installing the Vent Termination

Roof Terminations

A roof termination of any type will require a 4-in. (102 mm) flashing for a 2-in. (51 mm) concentric vent or a 5-in. diameter (127 mm) flashing for a 3-in. (76 mm) concentric vent kit. For two-pipe or single pipe vent systems, a flashing for each pipe of the required diameter will be necessary.

It is recommended that the flashing be installed by a roofer or competent professional prior to installing the concentric vent. The terminations can be installed on a flat or pitched roof.

Concentric Vent

Single or multiple concentric vent must be installed as shown in **Figure 54**. Maintain the required separation distance between vents or pairs of vents as shown in **Figure 54** and all clearance shown in **Figure 62**.

Cut one 4-in. (102 mm) diameter hole for 2-in. (51 mm) kit, or one 5-in. (127 mm) diameter hole for 3-in. (76 mm) kit in the desired location.

Loosely assemble concentric vent/combustion air termination components together using instructions in kit.

Slide assembled kit with rain shield **REMOVED** through hole in wall or roof flashing.

NOTE: Do not allow insulation or other materials to accumulate inside of pipe assembly when installing it through hole.

Disassemble loose pipe fittings. Clean and cement using same procedures as used for system piping.

Two-Pipe and Single-Pipe Terminations

Single and two pipe vent must be installed as shown in **Figure 54** and **Figure 55**. Maintain the required separation distance between vents or pairs of vents as shown in **Figure 54** and **Figure 55** and all clearance shown in **Figure 62** or **Figure 63**.

Cut the required number of holes in the roof or sidewall for vent and (when used) combustion air pipes. Sidewall holes for two-pipe vent terminations should be side-by-side, allowing space between the pipes for the elbows to fit on the pipes.

Figure 60 Crawl Space Vent Termination

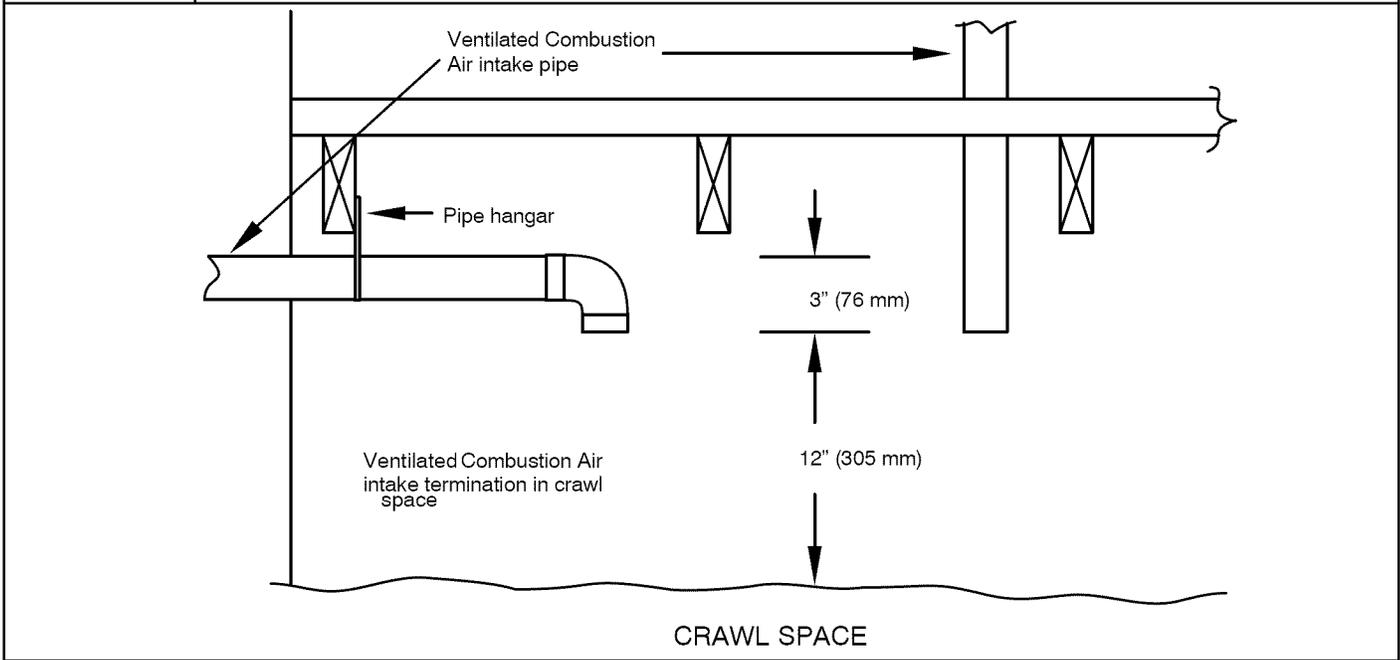


Figure 61 Attic Vent Termination

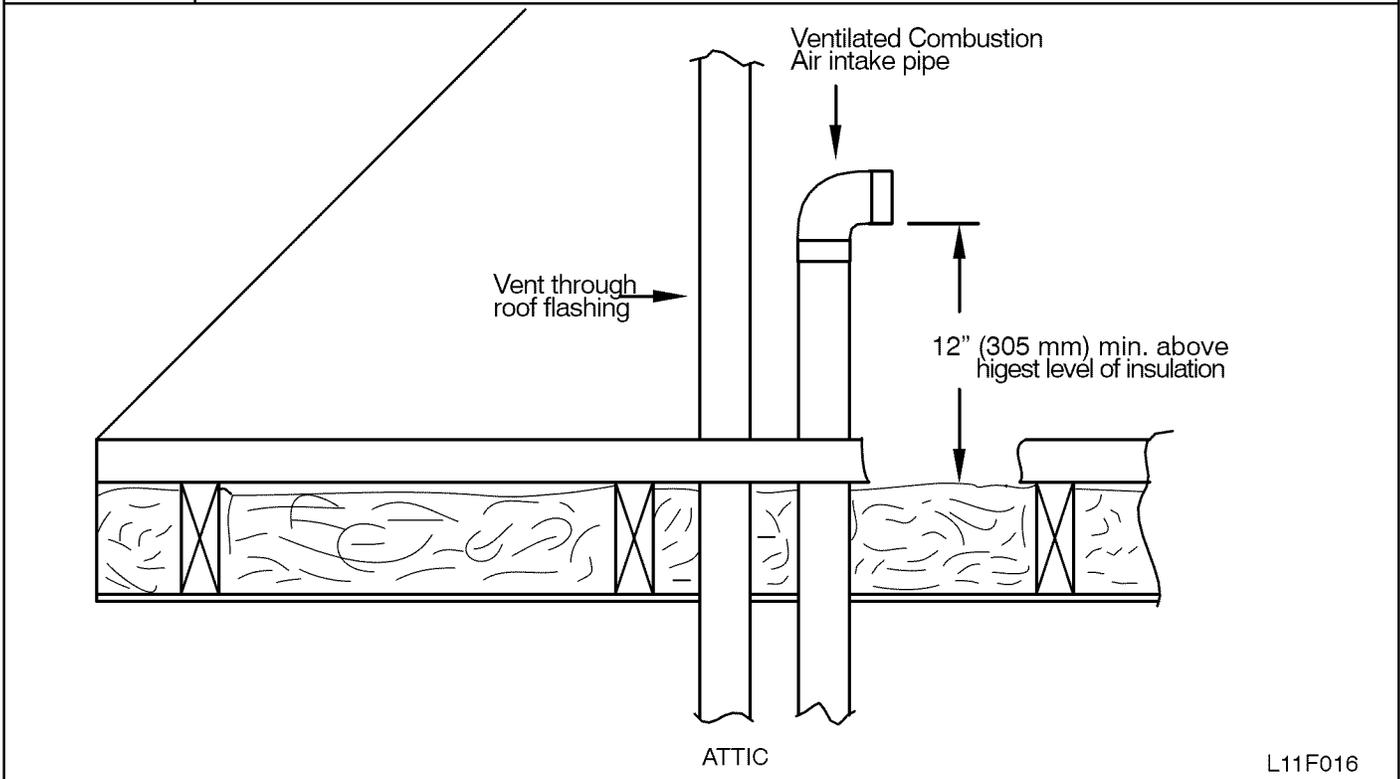
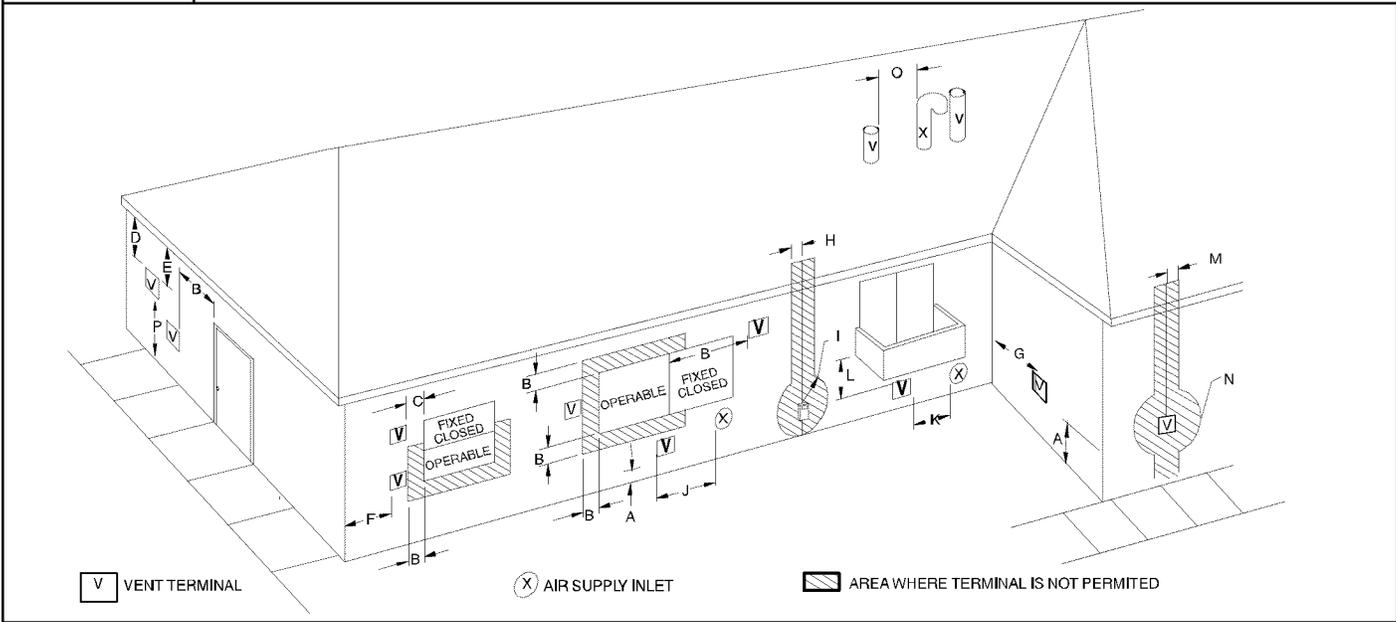


Figure 62 Direct Vent Termination Clearance



Item	Clearance Description	Canadian Installation (1)	U.S. Installation (2)
A	Clearance above grade, veranda, porch, deck, balcony, or anticipated snow level	12 in. (305 mm), 18 in. (457mm) above roof surface	12 in. (305 mm)
B	Clearance to a window or door that may be opened	12 in. (305 mm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in. (914 mm) for appliances > 100,000 Btuh (30 kW)	9 in. (229 mm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (14.7 kW), 12" (30 cm) for appliances > 50,000 Btuh (14.7 kW)
C	Clearance to a permanently closed window	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
D	Vertical clearance to a ventilated soffit located above the terminal within a horizontal distance of 2' (61cm) from the centerline of the terminal		
E	Clearance to an unventilated soffit		
F	Clearance to an outside corner		
G	Clearance to an inside corner		
H	Clearance to each side of the centerline extended above electrical meter or gas service regulator assembly	3 ft. (.9 m) within a height 15 feet (4.5 m) above the meter/regulator assembly	3 ft. (.9 m) within 15 feet (4.5 m) above the meter/regulator assembly
I	Clearance to service regulator vent outlet	3 ft. (.9 m)	3 ft. (.9 m) For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	12 in. (305 mm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36" (91 cm) for appliances > 100,000 Btuh (30 kW)	9 in. (23 cm) for appliances > 10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW), 12" (30 cm) for appliances > 50,000 Btuh (14.7 kW)
K	Clearance to a mechanical air supply inlet	6 ft. (1.8 m)	3 ft. (.9 m) above if within 10' (3m) horizontally
L	Clearance under a veranda, porch, deck, or balcony	12 in. (305 mm) Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
M	Clearance to each side of the centerline extended above or below vent terminal of the furnace to a dryer or water heater vent, or other appliance's direct vent intake or exhaust.	12 in. (305 mm)	12 in. (305 mm)
N	Clearance to the vent terminal of a dryer vent, water heater vent, or other appliances direct vent intake or exhaust.	3 ft. (.9 m)	3 ft. (.9 m)
O	Clearance from a plumbing vent stack	3 ft. (.9 m)	3 ft. (.9 m)
P	Clearance above a paved sidewalk or paved driveway located on public property.	7 ft. (2.1 m) A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.

> greater than, ≥ greater than or equal to, < less than, ≤ less than or equal to

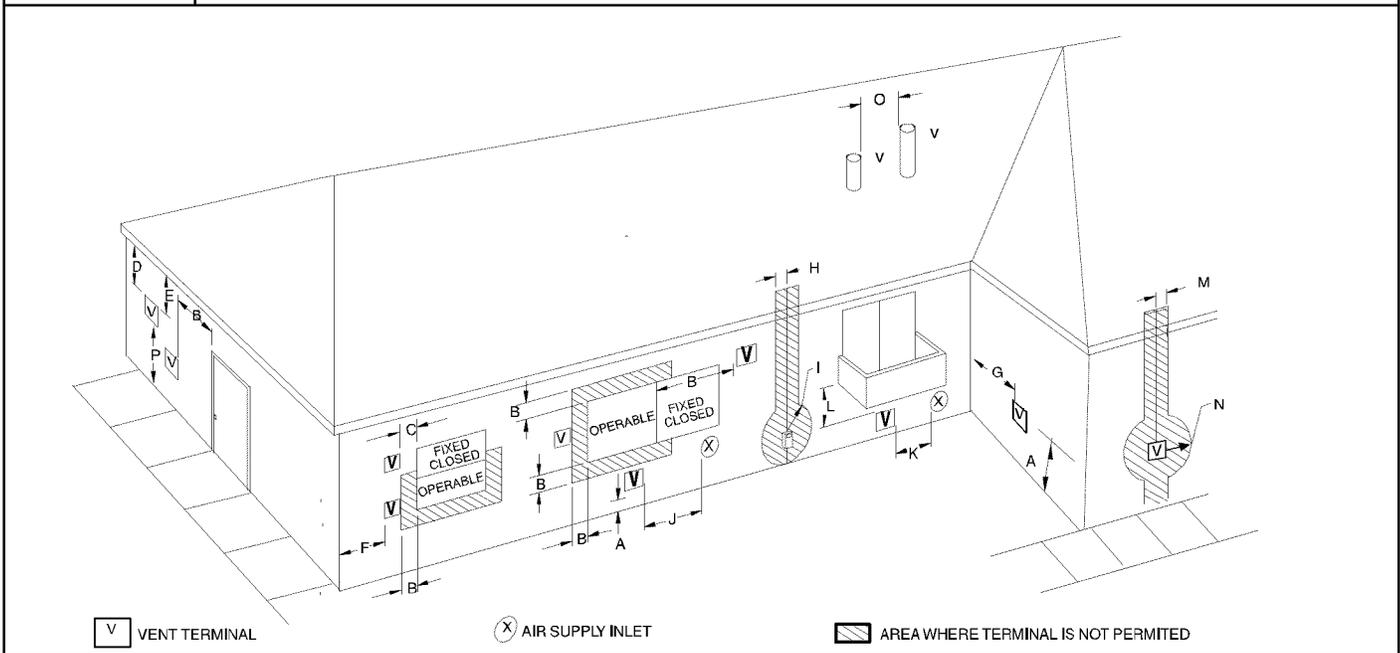
(1) In accordance with the current CAN/CSA B149.1, Natural Gas and Propane Installation Code

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

Notes:

- 1 The vent for this appliance shall not terminate
 - a. Over public walkways; or
 - b. Near soffit vents or crawl space vents or other areas where condensate or vapor could create a nuisance or hazard or property damage; or
 - c. Where condensate vapor could cause damage or could be detrimental to the operation of regulators, relief valves, or other equipment.
2. When locating vent terminations, consideration must be given to prevailing winds, location, and other conditions which may cause recirculation of the combustion products of adjacent vents. Recirculation can cause poor combustion, inlet condensate problems, and accelerated corrosion of the heat exchangers.
3. Avoid venting under a deck or large overhang. Recirculation could occur and cause performance or system problems.

Figure 63 Other than Direct Vent Clearance – Ventilated Combustion Air Option



Item	Clearance Descriptions	Canadian Installation (1)	U.S. Installation (2)
A	Clearance above grade, veranda, porch, deck, balcony, or anticipated snow level	12 in. (305 mm), 18 in. (457 mm) above roof surface	12 in. (305 mm)
B	Clearance to a window or door that may be opened	12 in. (305 mm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in. (914 mm) for appliances > 100,000 Btuh (30 kW)	4 ft. (1.2 m) below or to the side of the opening. 1 ft. (.3 m) above the opening.
C	Clearance to a permanently closed window	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
D	Vertical clearance to a ventilated soffit located above the terminal within a horizontal distance of 2' (61cm) from the centerline of the terminal		
E	Clearance to an unventilated soffit		
F	Clearance to an outside corner		
G	Clearance to an inside corner		
H	Clearance to each side of the centerline extended above electrical meter or gas service regulator assembly	3 ft. (.9 m) within a height 15ft (4.5 m) above the meter/regulator assembly	3 ft. (.9 m) within 15 ft. (4.5 m) above the meter/regulator assembly
I	Clearance to service regulator vent outlet	3 ft. (.9 m)	3 ft. (.9 m) For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	12 in. (305 mm) for appliances > 10,000 Btuh (3 kW) and ≤ 100,000 Btuh (30 kW), 36 in. (914 mm) for appliances > 100,000 Btuh (30 kW)	4 ft. (1.2 m) below or to the side of opening; 1 ft. (.3 m) above opening.
K	Clearance to a mechanical air supply inlet	6 ft. (1.83 m)	3 ft. (.9 m) above if within 10 ft. (3 m) horizontally
L	Clearance under a veranda, porch, deck, or balcony	12 in. (305 mm) Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor.	For clearances not specified in ANSI Z223.1/NFPA 54 or CAN/CSA B149.1, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
M	Clearance to each side of the centerline extended above or below vent terminal of the furnace to a dryer or water heater vent, or other appliance's direct vent intake or exhaust.	12 in. (305 mm)	12 in. (305 mm)
N	Clearance to the vent terminal of a dryer vent, water heater vent, or other appliances direct vent intake or exhaust.	3 ft. (.9 m)	3 ft. (.9 m)
O	Clearance from a plumbing vent stack	3 ft. (.9 m)	3 ft. (.9 m)
P	Clearance above a paved sidewalk or paved driveway located on public property.	7 ft. (2.1 m) A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.	7 ft. (2.1 m)

> greater than, ≥ greater than or equal to, < less than, ≤ less than or equal to
 (1) In accordance with the current CAN/CSA B149.1, Natural Gas and Propane Installation Code
 (2) In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code

- Notes:**
- The vent for this appliance shall not terminate
 - Over public walkways; or
 - Near soffit vents or crawl space vents or other areas where condensate or vapor could create a nuisance or hazard or property damage; or
 - Where condensate vapor could cause damage or could be detrimental to the operation of regulators, relief valves, or other equipment.
 - When locating vent terminations, consideration must be given to prevailing winds, location, and other conditions which may cause recirculation of the combustion products of adjacent vents. Recirculation can cause poor combustion, inlet condensate problems, and accelerated corrosion of the heat exchangers.
 - Avoid venting under a deck or large overhang. Recirculation could occur and cause performance or system problems.

Table 12		(F/G)9MVT, (F/G)9MXT, (F/G)9MXE - MAXIMUM EQUIVALENT VENT LENGTH - Feet (Meters)									
<p><i>Note: Maximum Equivalent Vent Length (MEVL) does NOT include elbows or terminations</i> Use Table 14 - DEDUCTIONS FROM MEVL to determine allowable vent length for each application.</p>											
Altitude FT (M)	Unit Size BTU/Hr	DIRECT VENT (2-PIPE) AND NON-DIRECT VENT (1-PIPE)									
		Vent Pipe Diameter (in.)									
		1-1/2		2		2-1/2		3		4	
0 to 2000 (0 to 610)	40,000 ^B	50	(15.2)	210	(64.0)	250	(76.2)	N/A		N/A	
	60,000	30	(9.1)	135	(41.1)	235	(71.6)	265	(80.8)	N/A	
	80,000	20	(6.1)	70	(21.3)	175	(53.3)	235	(71.6)	265	(80.8)
	100,000	N/A		25	(7.6)	110	(33.5)	235	(71.6)	265	(80.8)
	120,000	N/A		N/A		15	(4.6)	100	(30.5)	250	(76.2)
2001 to 3000 (610 to 914)	40,000	45	(13.7)	198	(60.4)	232	(70.7)	N/A		N/A	
	60,000	27	(8.2)	127	(38.7)	222	(67.7)	250	(76.2)	N/A	
	80,000	17	(5.2)	64	(19.5)	165	(50.3)	222	(67.7)	249	(75.9)
	100,000	N/A		22	(6.7)	104	(31.7)	223	(68.0)	250	(76.2)
	120,000	N/A		N/A		11	(3.4)	93	(28.3)	237	(72.2)
3001 to 4000 (914 to 1219)	40,000	39	(11.9)	184	(56.1)	214	(65.2)	N/A		N/A	
	60,000	23	(7.0)	119	(36.3)	210	(64.0)	235	(71.6)	N/A	
	80,000	15	(4.6)	59	(18.0)	155	(47.2)	210	(64.0)	232	(70.7)
	100,000	N/A		19	(5.8)	98	(29.9)	211	(64.3)	236	(71.9)
	120,000	N/A		N/A		8	(2.4)	86	(26.2)	224	(68.3)
4001 to 4500 (1219 to 1370)	40,000	36	(11.0)	177	(53.9)	205	(62.5)	N/A		N/A	
	60,000	21	(6.4)	115	(35.1)	204	(62.2)	228	(69.5)	N/A	
	80,000	14	(4.3)	56	(17.1)	150	(45.7)	202	(61.6)	224	(68.3)
	100,000	N/A		17	(5.2)	94	(28.7)	205	(62.5)	229	(69.8)
	120,000	N/A		N/A		N/A		83	(25.3)	217	(66.1)

See notes at end of Venting Tables

See **Table 13** for altitudes over 4500 ft (1370m).

Table 13		(F/G)9MVT, (F/G)9MXT, (F/G)9MXE - MAXIMUM EQUIVALENT VENT LENGTH - Feet (Meters)									
<p><i>Note: Maximum Equivalent Vent Length (MEVL) does NOT include elbows or terminations.</i> Use DEDUCTIONS FROM MEVL - Table 14 to determine allowable vent length for each application. Note: Vent sizing for Canadian installations over 4500 ft. (1370 M) above sea level are subject to acceptance by the local authorities having jurisdiction.</p>											
Altitude FT (M)	Unit Size	DIRECT VENT (2-PIPE) AND NON-DIRECT VENT (1-PIPE)									
		Vent Pipe Diameter									
		1-1/2		2		2-1/2		3		4	
4501 to 5000 (1370 to 1524)	40,000	33	(10.1)	171	(52.1)	196	(59.7)	N/A		N/A	
	60,000	20	(6.1)	111	(33.8)	198	(60.4)	221	(67.4)	N/A	
	80,000	13	(4.0)	54	(16.5)	146	(44.5)	195	(59.4)	216	(65.8)
	100,000	N/A		16	(4.9)	91	(27.7)	200	(61.0)	222	(67.7)
	120,000	N/A		N/A		N/A		80	(24.4)	211	(64.3)
5001 to 6000 (1524 to 1829)	40,000	27	(8.2)	158	(48.2)	179	(54.6)	N/A		N/A	
	60,000	16	(4.9)	103	(31.4)	186	(56.7)	207	(63.1)	N/A	
	80,000	11	(3.4)	49	(14.9)	137	(41.8)	183	(55.8)	200	(61.0)
	100,000	N/A		12	(3.7)	85	(25.9)	188	(57.3)	208	(63.4)
	120,000	N/A		N/A		N/A		74	(22.6)	199	(60.7)
6001 to 7000 (1829 to 2134)	40,000	21	(6.4)	145	(44.2)	162	(49.4)	N/A		N/A	
	60,000	13	(4.0)	96	(29.3)	174	(53.0)	194	(59.1)	N/A	
	80,000	N/A		44	(13.4)	120	(36.6)	171	(52.1)	185	(56.4)
	100,000	N/A		10	(3.0)	79	(24.1)	178	(54.3)	195	(59.4)
	120,000	N/A		N/A		N/A		68	(20.7)	187	(57.0)
7001 to 8000 (2134 to 2438)	40,000	15	(4.6)	133	(40.5)	146	(44.5)	N/A		N/A	
	60,000	10	(3.0)	89	(27.1)	163	(49.7)	181	(55.2)	N/A	
	80,000	N/A		40	(12.2)	120	(36.6)	159	(48.5)	170	(51.8)
	100,000	N/A		N/A		73	(22.3)	167	(50.9)	182	(55.5)
	120,000	N/A		N/A		N/A		62	(18.9)	175	(53.3)
8001 to 9000 (2438 to 2743)	40,000	10	(3.0)	121	(36.9)	130	(39.6)	N/A		N/A	
	60,000	7	(2.1)	82	(25.0)	152	(46.3)	168	(51.2)	N/A	
	80,000	N/A		35	(10.7)	111	(33.8)	148	(45.1)	156	(47.5)
	100,000	N/A		N/A		67	(20.4)	157	(47.9)	170	(51.8)
	120,000	N/A		N/A		N/A		56	(17.1)	164	(50.0)
9001 to 10,000 (2743 to 3048)	40,000	5	(1.5)	110	(33.5)	115	(35.1)	N/A		N/A	
	60,000	N/A		76	(23.2)	142	(43.3)	156	(47.5)	N/A	
	80,000	N/A		31	(9.4)	103	(31.4)	137	(41.8)	142	(43.3)
	100,000	N/A		N/A		62	(18.9)	147	(44.8)	157	(47.9)
	120,000	N/A		N/A		N/A		51	(15.5)	153	(46.6)

NOTES:

- A. 3- and 4-in. vent pipe systems require long radius elbows.
- B. Total equivalent vent lengths under 10' for 40,000 BTUH furnaces require the use of an outlet choke plate at altitudes of 0 to 2000' (0 to 610M).
Failure to use an outlet choke, when required, may result in flame disturbance or flame sense lockout.
- C. Vent sizing for Canadian installations over 4500 ft. (1370 M) above sea level are subject to acceptance by the local authorities having jurisdiction.
- D. N/A - Not Allowed; pressure switch will not close, or flame disturbance may result.
- E. Do not use pipe size greater than those specified in table or incomplete combustion, flame disturbance, or flame sense lockout may occur.
- F. Size both the combustion-air and vent pipe independently, then use the larger diameter for both pipes.
- G. Assume two 45° elbows equal one 90° elbow. Wide radius elbows are desirable and may be required in some cases.
- H. Elbows and pipe sections within the furnace casing and at the vent termination should not be included in vent length or elbow count.
- I. The minimum pipe length is 5 ft (1.5 M) for all applications.
- J. Use 3-in. (76 mm) diameter concentric vent termination kit for installations requiring 4-in (102 mm) diameter pipe.

Pipe Diameter (in):	1-1/2		2		2-1/2		3*		4*	
Mitered 90° Elbow	8	(2.4)	8	(2.4)	8	(2.4)				
Medium Radius 90° Elbow	5	(1.5)	5	(1.5)	5	(1.5)				
Long Radius 90° Elbow	3	(0.9)	3	(0.9)	3	(0.9)	3	(0.9)	3	(0.9)
Mitered 45° Elbow	4	(1.2)	4	(1.2)	4	(1.2)				
Medium Radius 45° Elbow	2.5	(0.8)	2.5	(0.8)	2.5	(0.8)				
Long Radius 45° Elbow	1.5	(0.5)	1.5	(0.5)	1.5	(0.5)	1.5	(0.5)	1.5	(0.5)
Tee	16	(4.9)	16	(4.9)	16	(4.9)	16	(4.9)	16	(4.9)

* Note: 3- and 4-in. vent pipe systems require long radius elbows.

Venting System Length Calculations

The maximum length for each vent pipe (inlet or exhaust) equals the Maximum Equivalent Vent Length (MEVL) from **Table 12** or **Table 13** minus the number of elbows multiplied by the deduction for each elbow in **Table 14**.

Standard vent terminations and concentric vent terminations count for zero deduction.

Example

A Direct-Vent 60,000 BTU/Hr furnace installed at 2100 ft altitude with 2-in. vent piping.

Venting system includes, FOR EACH PIPE, (3) 90° long radius elbows, (2) 45° long radius elbows and a concentric vent kit.

Maximum Equivalent Vent Length	=	127 ft			Table 12
Deduct (3) 90° long radius elbows		3 x 3 ft = - 9 ft			Table 14
Deduct (2) 45° long radius elbows		2 x 1.5 ft = - 3 ft			Table 14
Maximum vent length		115 ft			(For EACH vent or inlet pipe)

(F/G)9MXE Furnace Input		Winter Design Temp °F (°C)		Pipe Length in Ft. & M		Maximum Length of Uninsulated and Insulated Vent Pipe-Ft (M)														
						No Insulation					3/8-in. (9.5 mm) Insulation					1/2-in. (12.7 mm) Insulation				
						Pipe Diameter - in. (mm)					Pipe Diameter - in. (mm)					Pipe Diameter - in. (mm)				
						1 1/2	2	2 1/2	3	4	1 1/2	2	2 1/2	3	4	1 1/2	2	2 1/2	3	4
(38)	(51)	(64)	(76)	(102)	(38)	(51)	(64)	(76)	(102)	(38)	(51)	(64)	(76)	(102)						
40,000	20 (-10)	Ft.	48	42	42	N/A	N/A	50	122	111	N/A	N/A	50	144	130	N/A	N/A			
		M	14.6	12.8	12.8	N/A	N/A	15.2	37.2	33.8	N/A	N/A	15.2	43.9	39.6	N/A	N/A			
	0 (-20)	Ft.	25	19	17	N/A	N/A	50	75	66	N/A	N/A	50	90	79	N/A	N/A			
		M	7.6	5.8	5.2	N/A	N/A	15.2	22.9	20.1	N/A	N/A	15.2	27.4	24.1	N/A	N/A			
	-20 (-30)	Ft.	14	7	5	N/A	N/A	50	52	45	N/A	N/A	50	64	55	N/A	N/A			
		M	4.3	2.1	1.5	N/A	N/A	15.2	15.8	13.7	N/A	N/A	15.2	19.5	16.8	N/A	N/A			
	-40 (-40)	Ft.	7	0	0	N/A	N/A	50	38	31	N/A	N/A	50	48	40	N/A	N/A			
		M	2.1	0.0	0.0	N/A	N/A	15.2	11.6	9.4	N/A	N/A	15.2	14.6	12.2	N/A	N/A			
60,000	20 (-10)	Ft.	30	61	61	54	N/A	30	135	163	142	N/A	30	135	191	166	N/A			
		M	9.1	18.6	18.6	16.5	N/A	9.1	41.1	49.7	43.3	N/A	9.1	41.1	58.2	50.6	N/A			
	0 (-20)	Ft.	30	31	30	23	N/A	30	113	100	85	N/A	30	135	120	101	N/A			
		M	9.1	9.4	9.1	7.0	N/A	9.1	34.4	30.5	25.9	N/A	9.1	41.1	36.6	30.8	N/A			
	-20 (-30)	Ft.	24	17	15	7	N/A	30	81	70	57	N/A	30	98	85	70	N/A			
		M	7.3	5.2	4.6	2.1	N/A	9.1	24.7	21.3	17.4	N/A	9.1	29.9	25.9	21.3	N/A			
	-40 (-40)	Ft.	15	8	5	0	N/A	30	61	52	40	N/A	30	75	64	51	N/A			
		M	4.6	2.4	1.5	0.0	N/A	9.1	18.6	15.8	12.2	N/A	9.1	22.9	19.5	15.5	N/A			
80,000	20 (-10)	Ft.	20	70	78	70	60	20	70	175	183	154	20	70	175	215	181			
		M	6.1	21.3	23.8	21.3	18.3	6.1	21.3	53.3	55.8	46.9	6.1	21.3	53.3	65.5	55.2			
	0 (-20)	Ft.	20	42	41	33	21	20	70	132	111	89	20	70	157	133	107			
		M	6.1	12.8	12.5	10.1	6.4	6.1	21.3	40.2	33.8	27.1	6.1	21.3	47.9	40.5	32.6			
	-20 (-30)	Ft.	20	25	23	14	1	20	70	94	77	57	20	70	113	94	71			
		M	6.1	7.6	7.0	4.3	0.3	6.1	21.3	28.7	23.5	17.4	6.1	21.3	34.4	28.7	21.6			
	-40 (-40)	Ft.	20	14	12	3	0	20	70	71	56	38	20	70	86	70	50			
		M	6.1	4.3	3.7	0.9	0.0	6.1	21.3	21.6	17.1	11.6	6.1	21.3	26.2	21.3	15.2			
100,000	20 (-10)	Ft.	N/A	25	99	89	78	N/A	25	110	233	265	N/A	25	110	235	229			
		M	N/A	7.6	30.2	27.1	23.8	N/A	7.6	33.5	71.0	80.8	N/A	7.6	33.5	71.6	69.8			
	0 (-20)	Ft.	N/A	25	55	46	33	N/A	25	110	145	117	N/A	25	110	173	140			
		M	N/A	7.6	16.8	14.0	10.1	N/A	7.6	33.5	44.2	35.7	N/A	7.6	33.5	52.7	42.7			
	-20 (-30)	Ft.	N/A	25	34	24	11	N/A	25	110	103	79	N/A	25	110	124	97			
		M	N/A	7.6	10.4	7.3	3.4	N/A	7.6	33.5	31.4	24.1	N/A	7.6	33.5	37.8	29.6			
	-40 (-40)	Ft.	N/A	23	20	11	0	N/A	25	95	77	55	N/A	25	110	94	70			
		M	N/A	7.0	6.1	3.4	0.0	N/A	7.6	29.0	23.5	16.8	N/A	7.6	33.5	28.7	21.3			
120,000	20 (-10)	Ft.	N/A	N/A	15	99	86	N/A	N/A	15	100	219	N/A	N/A	15	100	250			
		M	N/A	N/A	4.6	30.2	26.2	N/A	N/A	4.6	30.5	66.8	N/A	N/A	4.6	30.5	76.2			
	0 (-20)	Ft.	N/A	N/A	15	51	38	N/A	N/A	15	100	130	N/A	N/A	15	100	156			
		M	N/A	N/A	4.6	15.5	11.6	N/A	N/A	4.6	30.5	39.6	N/A	N/A	4.6	30.5	47.5			
	-20 (-30)	Ft.	N/A	N/A	15	28	14	N/A	N/A	15	100	88	N/A	N/A	15	100	108			
		M	N/A	N/A	4.6	8.5	4.3	N/A	N/A	4.6	30.5	26.8	N/A	N/A	4.6	30.5	32.9			
	-40 (-40)	Ft.	N/A	N/A	15	14	0	N/A	N/A	15	85	62	N/A	N/A	15	100	79			
		M	N/A	N/A	4.6	4.3	0.0	N/A	N/A	4.6	25.9	18.9	N/A	N/A	4.6	30.5	24.1			

Table 16 (F/G)9MVT & (F/G)9MXT High Heat Input		Maximum Allowable Exposed Vent Lengths in Unconditioned Space - Two-Stage																
		Maximum Length of Uninsulated and Insulated Vent Pipe-Ft (M)																
		Winter Design Temp °F (°C)	Pipe Length in Ft. & M	No Insulation					3/8-in. (9.5 mm)					1/2-in. (12.7 mm)				
				Pipe Diameter - in. (mm)					Pipe Diameter - in. (mm)					Pipe Diameter - in. (mm)				
1.5 (38)	2.0 (51)			2.5 (64)	3.0 (76)	4.0 (102)	1.5 (38)	2.0 (51)	2.5 (64)	3.0 (76)	4.0 (102)	1.5 (38)	2.0 (51)	2.5 (64)	3.0 (76)	4.0 (102)		
40,000	20 (-10)	Ft.	40.0	35.0	35.0	N/A	N/A	50.0	104.0	94.0	N/A	N/A	50.0	122.0	110.0	N/A	N/A	
		M	12.2	10.7	10.7	N/A	N/A	15.2	31.7	28.7	N/A	N/A	15.2	37.2	33.5	N/A	N/A	
	0 (-20)	Ft.	19.0	14.0	12.0	N/A	N/A	50.0	61.0	54.0	N/A	N/A	50.0	74.0	65.0	N/A	N/A	
		M	5.8	4.3	3.7	N/A	N/A	15.2	18.6	16.5	N/A	N/A	15.2	22.6	19.8	N/A	N/A	
	-20 (-30)	Ft.	9.0	3.0	1.0	N/A	N/A	50.0	41.0	35.0	N/A	N/A	50.0	51.0	43.0	N/A	N/A	
		M	2.7	0.9	0.3	N/A	N/A	15.2	12.5	10.7	N/A	N/A	15.2	15.5	13.1	N/A	N/A	
	-40 (-40)	Ft.	3.0	0.0	0.0	N/A	N/A	39.0	29.0	23.0	N/A	N/A	48.0	37.0	30.0	N/A	N/A	
		M	0.9	0.0	0.0	N/A	N/A	11.9	8.8	7.0	N/A	N/A	14.6	11.3	9.1	N/A	N/A	
60,000	20 (-10)	Ft.	30.0	51.0	51.0	45.0	N/A	30.0	135.0	138.0	120.0	N/A	30.0	135.0	162.0	141.0	N/A	
		M	9.1	15.5	15.5	13.7	N/A	9.1	41.1	42.1	36.6	N/A	9.1	41.1	49.4	43.0	N/A	
	0 (-20)	Ft.	30.0	24.0	23.0	16.0	N/A	30.0	93.0	82.0	69.0	N/A	30.0	111.0	98.0	83.0	N/A	
		M	9.1	7.3	7.0	4.9	N/A	9.1	28.3	25.0	21.0	N/A	9.1	33.8	29.9	25.3	N/A	
	-20 (-30)	Ft.	18.0	11.0	9.0	1.0	N/A	30.0	65.0	56.0	44.0	N/A	30.0	79.0	68.0	55.0	N/A	
		M	5.5	3.4	2.7	0.3	N/A	9.1	19.8	17.1	13.4	N/A	9.1	24.1	20.7	16.8	N/A	
	-40 (-40)	Ft.	10.0	3.0	0.0	0.0	N/A	30.0	48.0	40.0	29.0	N/A	30.0	59.0	50.0	38.0	N/A	
		M	3.0	0.9	0.0	0.0	N/A	9.1	14.6	12.2	8.8	N/A	9.1	18.0	15.2	11.6	N/A	
80,000	20 (-10)	Ft.	20.0	64.0	64.0	56.0	47.0	20.0	70.0	173.0	150.0	125.0	20.0	70.0	175.0	177.0	147.0	
		M	6.1	19.5	19.5	17.1	14.3	6.1	21.3	52.7	45.7	38.1	6.1	21.3	53.3	53.9	44.8	
	0 (-20)	Ft.	20.0	32.0	30.0	22.0	11.0	20.0	70.0	104.0	87.0	67.0	20.0	70.0	124.0	104.0	82.0	
		M	6.1	9.8	9.1	6.7	3.4	6.1	21.3	31.7	26.5	20.4	6.1	21.3	37.8	31.7	25.0	
	-20 (-30)	Ft.	20.0	17.0	14.0	6.0	0.0	20.0	70.0	71.0	57.0	40.0	20.0	70.0	86.0	71.0	52.0	
		M	6.1	5.2	4.3	1.8	0.0	6.1	21.3	21.6	17.4	12.2	6.1	21.3	26.2	21.6	15.8	
	-40 (-40)	Ft.	15.0	7.0	5.0	0.0	0.0	20.0	61.0	52.0	40.0	24.0	20.0	70.0	64.0	50.0	33.0	
		M	4.6	2.1	1.5	0.0	0.0	6.1	18.6	15.8	12.2	7.3	6.1	21.3	19.5	15.2	10.1	
100,000	20 (-10)	Ft.	N/A	25.0	79.0	70.0	59.0	N/A	25.0	110.0	186.0	155.0	N/A	25.0	110.0	219.0	182.0	
		M	N/A	7.6	24.1	21.3	18.0	N/A	7.6	33.5	56.7	47.2	N/A	7.6	33.5	66.8	55.5	
	0 (-20)	Ft.	N/A	25.0	40.0	31.0	19.0	N/A	25.0	110.0	109.0	86.0	N/A	25.0	110.0	131.0	104.0	
		M	N/A	7.6	12.2	9.4	5.8	N/A	7.6	33.5	33.2	26.2	N/A	7.6	33.5	39.9	31.7	
	-20 (-30)	Ft.	N/A	23.0	21.0	13.0	0.0	N/A	25.0	91.0	74.0	54.0	N/A	25.0	110.0	90.0	68.0	
		M	N/A	7.0	6.4	4.0	0.0	N/A	7.6	27.7	22.6	16.5	N/A	7.6	33.5	27.4	20.7	
	-40 (-40)	Ft.	N/A	13.0	10.0	1.0	0.0	N/A	25.0	68.0	53.0	35.0	N/A	25.0	83.0	66.0	46.0	
		M	N/A	4.0	3.0	0.3	0.0	N/A	7.6	20.7	16.2	10.7	N/A	7.6	25.3	20.1	14.0	
120,000	20 (-10)	Ft.	N/A	N/A	15.0	85.0	73.0	N/A	N/A	15.0	100.0	190.0	N/A	N/A	15.0	100.0	224.0	
		M	N/A	N/A	4.6	25.9	22.3	N/A	N/A	4.6	30.5	57.9	N/A	N/A	4.6	30.5	68.3	
	0 (-20)	Ft.	N/A	N/A	15.0	41.0	29.0	N/A	N/A	15.0	100.0	109.0	N/A	N/A	15.0	100.0	131.0	
		M	N/A	N/A	4.6	12.5	8.8	N/A	N/A	4.6	30.5	33.2	N/A	N/A	4.6	30.5	39.9	
	-20 (-30)	Ft.	N/A	N/A	15.0	20.0	7.0	N/A	N/A	15.0	94.0	71.0	N/A	N/A	15.0	114.0	88.0	
		M	N/A	N/A	4.6	6.1	2.1	N/A	N/A	4.6	28.7	21.6	N/A	N/A	4.6	34.7	26.8	
	-40 (-40)	Ft.	N/A	N/A	15.0	7.0	0.0	N/A	N/A	15.0	69.0	48.0	N/A	N/A	15.0	85.0	62.0	
		M	N/A	N/A	4.6	2.1	0.0	N/A	N/A	4.6	21.0	14.6	N/A	N/A	4.6	25.9	18.9	