

INSTALLATION INSTRUCTIONS

Single-Stage, PSC Blower Motor 35" Tall, High Efficiency Condensing Gas Furnace F9MES (A Series) 220-V 50Hz

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

CONSUMER: Retain these instructions for future reference.

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.



WARNING

FIRE HAZARD

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

Solvent cements and primers are combustible. Keep away from heat, sparks and open flame. Use only in well-ventilated areas. Avoid breathing in vapor or allowing contact with skin or eyes.



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** and **NOTICE** are used to highlight suggestions which will result in enhanced installation, reliability, or operation.

1. Remove shipping blower supports prior to operating unit.
2. Use only with type of gas approved for this furnace. Refer to the furnace rating plate.
3. Install this furnace only in a location and position as specified in the "Location" section of these instructions.
4. Provide adequate combustion and ventilation air to the furnace space as specified in "Air for Combustion and Ventilation" section.
5. Combustion products must be discharged outdoors. Connect this furnace to an approved vent system only, as specified in the "Venting" section of these instructions.
6. 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.
7. 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.
8. 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.
9. 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**)
10. 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 6 of these instructions.
11. These Multipoise Gas-Fired Furnaces are designed 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. An accessory gas conversion kit is required to convert furnace for use with propane gas.

12. See **Table 1** for required clearances to combustible construction.
13. 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)	
Recommended for service	*24 (610)	
All Sides of Supply Plenum	*1 (25)	
Sides	0	
Vent	0	
Top of Furnace	1 (25)	

* Consult local building codes

14. These furnaces **SHALL NOT** be installed directly on carpeting, combustible 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.

NOTICE

IMPORTANT INSTALLATION AND START-UP PROCEDURES

Failure to follow this procedure may result in a nuisance smoke or odor complaint.

The manifold pressure, gas rate by meter clocking, temperature rise and operation must be checked after installation. Minor smoke and odor may be present temporarily after start-up from the manufacturing process. Some occupants are more sensitive to this minor smoke and odor. It is recommended that doors and windows be open during the first heat cycle.

Introduction

The 4-way multipoise Category IV condensing furnace is designed as a direct vent (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.

NOTE: Downflow installation is not allowed for 140,000 BTU model.

These furnaces are not approved for installation in recreational vehicles, outdoors or in manufactured housing/mobile home.

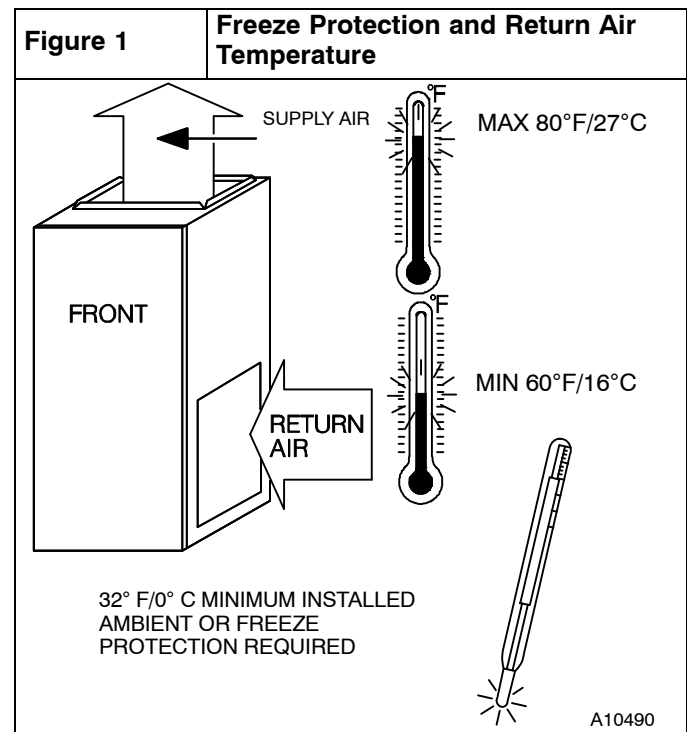
This furnace is designed for minimum continuous return-air temperature of 60°F (15°C) db or intermittent operation down to 55°F (15°C) db such as when used with a night setback thermostat. Return-air temperature must not exceed 80°F (27°C) db. Failure to follow these return-air temperature limits may 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. None of the furnace model sizes can be used if the heating load is 20,000 BTU or lower. Use Air Conditioning Contractors of America (Manual J and S); American Society of Heating, Refrigerating, and Air-Conditioning Engineers; or other approved engineering method to calculate heating load estimates and select the furnace. Excessive oversizing of the furnace may cause the furnace and/or vent to fail prematurely, customer discomfort and/or vent freezing.

Failure to follow these guidelines is considered faulty installation and/or misapplication of the furnace; and resulting failure, damage, or repairs may impact warranty coverage.

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, follow all codes and standards for the following:

Safety

- US: National Fuel Gas Code (NFGC) NFPA 54-2012/ANSI Z223.1-2012 and the Installation Standards, Warm Air Heating and Air Conditioning Systems ANSI/NFPA 90B

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.

Combustion and Ventilation Air

- US: Section 9.3 of the NFPA54/ANSI Z223.1–2012, Air for Combustion and Ventilation

Duct Systems

- US: 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: 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 Z223.1–2012, NFGC; Chapters 5, 6, 7, and 8 and national plumbing codes.

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) NFPA 70–2011

Condensate Drain Connection

- US: National Standard Plumbing Code 2009, Section 8.7.

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.

1. 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.

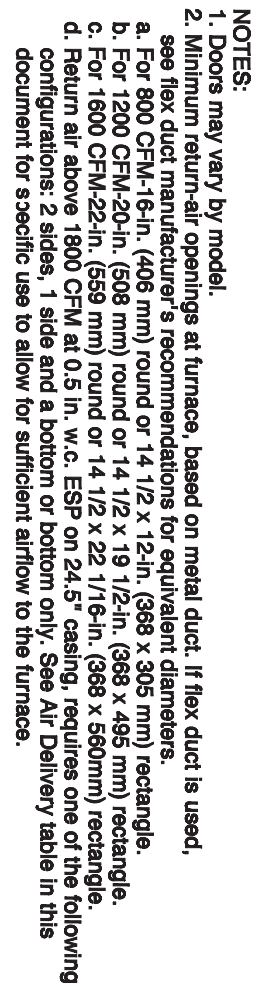
2. Firmly touch the clean, unpainted, metal surface of the furnace chassis which is close to the control. Tools held in a person's hand during grounding will be satisfactorily discharged.
3. After touching the chassis, you may proceed to service the control or connecting wires as long as you do nothing to recharge your body with static electricity (for example; DO NOT move or shuffle your feet, do not touch ungrounded objects, etc.).
4. 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.
5. Use this procedure for installed and uninstalled (ungrounded) furnaces.
6. 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.
7. 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	DESCRIPTION – See NOTE (Provided in Loose Parts Bag)
1	Air Intake Pipe Flange
1	Vent Pipe Flange
2	Pipe Flange Gaskets
10	Sharp Tip Screws (Vent and Inlet Flanges)
1	Vent Pipe Coupling
2	Vent Pipe Coupling Clamps
1	Pressure Switch Tube
1	Rubber Drain Elbow
4	Drain Elbow Clamps
1	1/2"CPVC to 3/4" PVC Pipe Adapter
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
Provided separately in furnace	
1	Drain Extension Tube – "Z" Pipe

Dimensions



N9MSE FURNACE SIZE	A	B	C	D	SHIP WT. LB (KG)
	CABINET WIDTH	OUTLET WIDTH	BOTTOM INLET WIDTH	AIR INTAKE	
1002120	21 (533)	19-3/8 (492)	19-1/2 (495)	10-1/2 (267)	173.5 (78.1)
1202420	24-1/2 (622)	22-7/8 (581)	23 (584)	12-1/4 (311)	191.0 (85.9)
1402420	24-1/2 (622)	22-7/8 (581)	23 (584)	12-1/4 (311)	195.0 (87.8)

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 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:

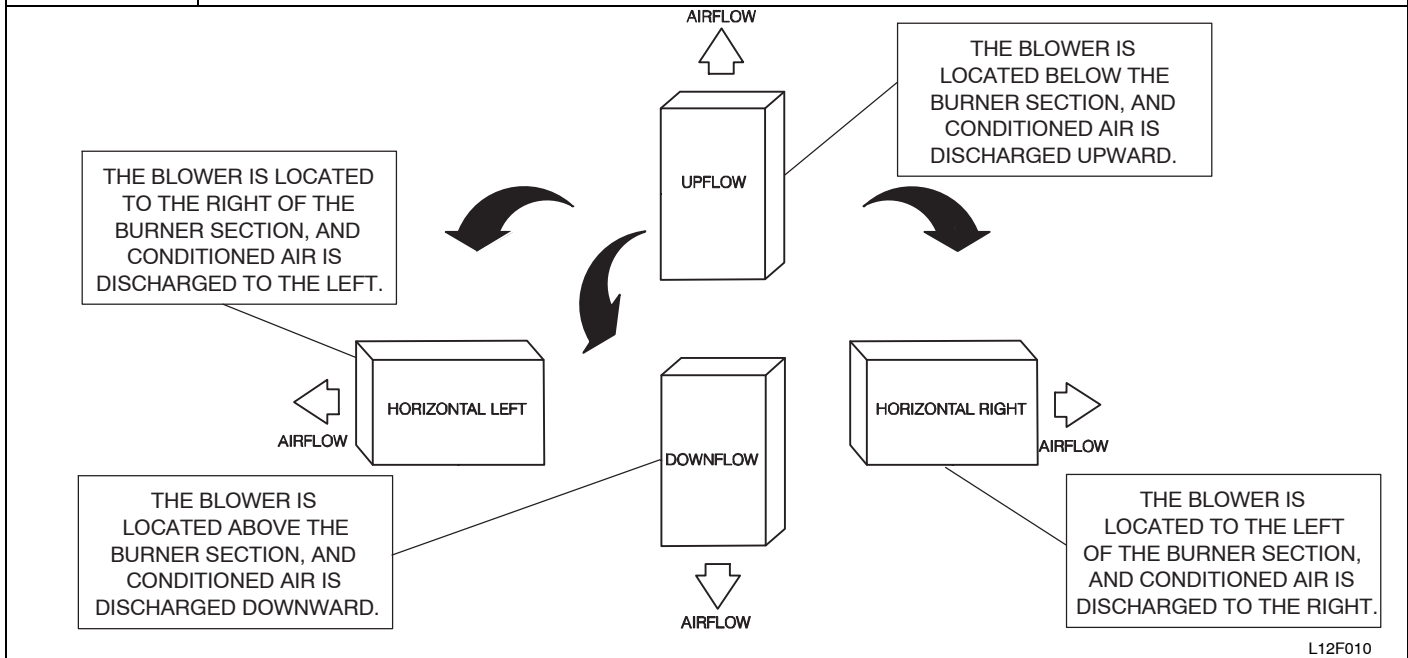
- Commercial buildings
- Buildings with indoor pools
- Laundry rooms
- Hobby or craft rooms, and
- Chemical storage areas

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



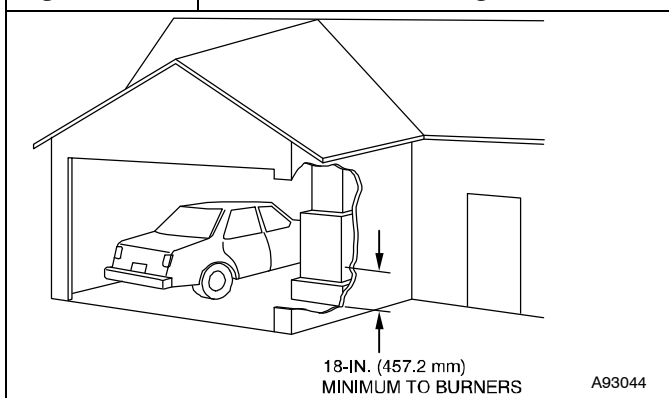
WARNING

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 Z223.1–2012. (See **Figure 4**)

Figure 4 Installation in a Garage



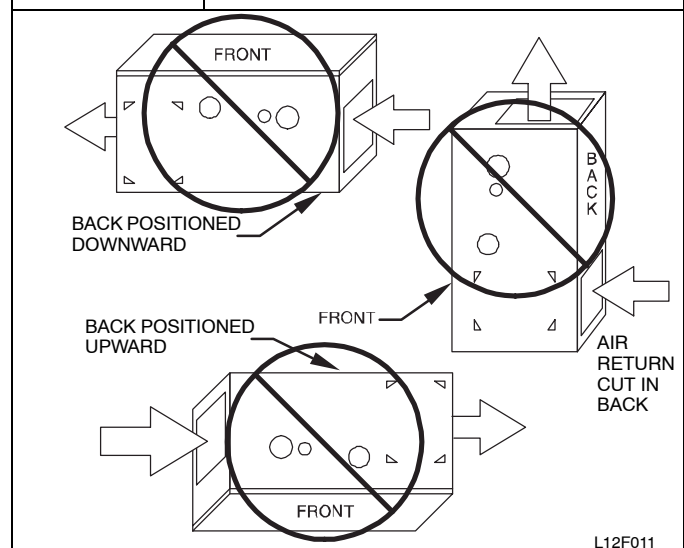
WARNING

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, crawlspace, or equipment closet) 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.A. Installations: Section 9.3 of the NFPA 54/ANSI Z223.1-2012 , Air for Combustion and Ventilation and applicable provisions of the local building codes.



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.



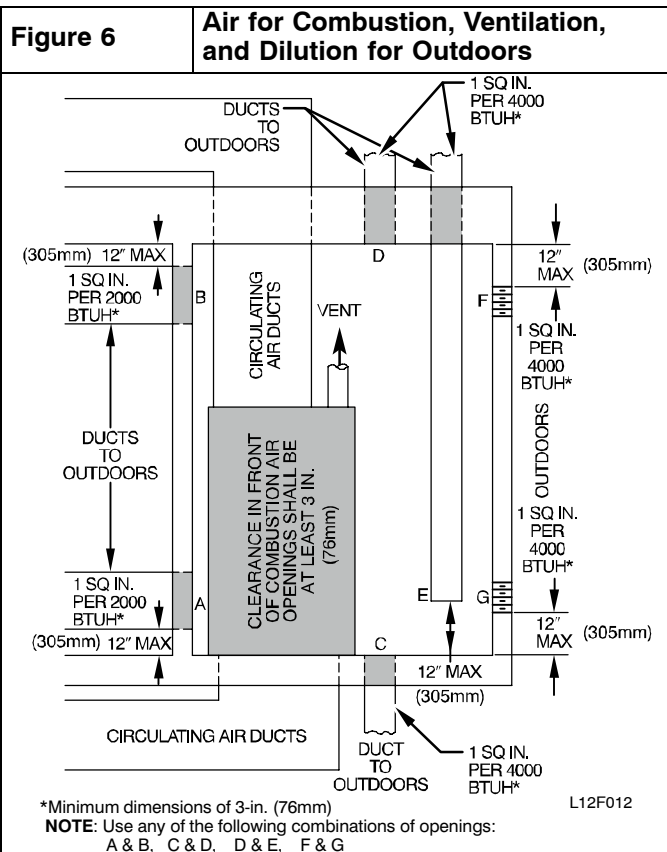
WARNING

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 54–2012, 9.3.2.2:

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

$$\text{Volume}_{\text{Other}} = \frac{21 \text{ ft}^3}{\text{ACH}} \left(\frac{I_{\text{other}}}{1000 \text{ Btu/hr}} \right) \quad \text{A04002}$$

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

$$\text{Volume}_{\text{Fan}} = \frac{15 \text{ ft}^3}{\text{ACH}} \left(\frac{I_{\text{fan}}}{1000 \text{ Btu/hr}} \right) \quad \text{A04003}$$

If:

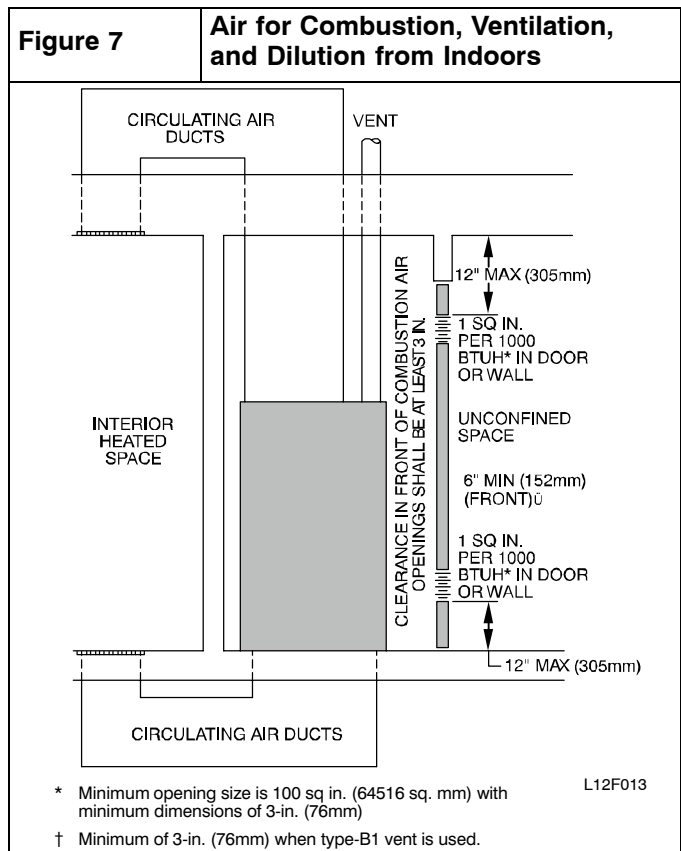
I_{other} =combined input of all **other than fan-assisted appliances** in Btuh/hr

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

- Indoor openings shall comply with the **Indoor Combustion Air** Method below and,
- Outdoor openings shall be located as required in the **Outdoor Combustion Air** Method mentioned previously and,
- Outdoor openings shall be sized as follows:

- Calculate the Ratio of all Indoor Space volume divided by required volume for **Indoor Combustion Air** Method.
- Outdoor opening size reduction **Factor** is one minus the **Ratio** in a. above.
- 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).

Table 3	Minimum Free Area Required for Each Combustion Air Opening or Duct to Outdoors					
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.
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)

EXAMPLE: Determining Free Area

FURNACE		WATER HEATER		TOTAL INPUT	
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

Table 4	Minimum Space Volumes for 100% Combustion, Ventilation and Dilution Air from Outdoors								
OTHER THAN FAN-ASSISTED TOTAL (1,000'S BTUH GAS INPUT RATE)				FAN-ASSISTED TOTAL (1,000'S BTUH GAS INPUT RATE)					
ACH	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

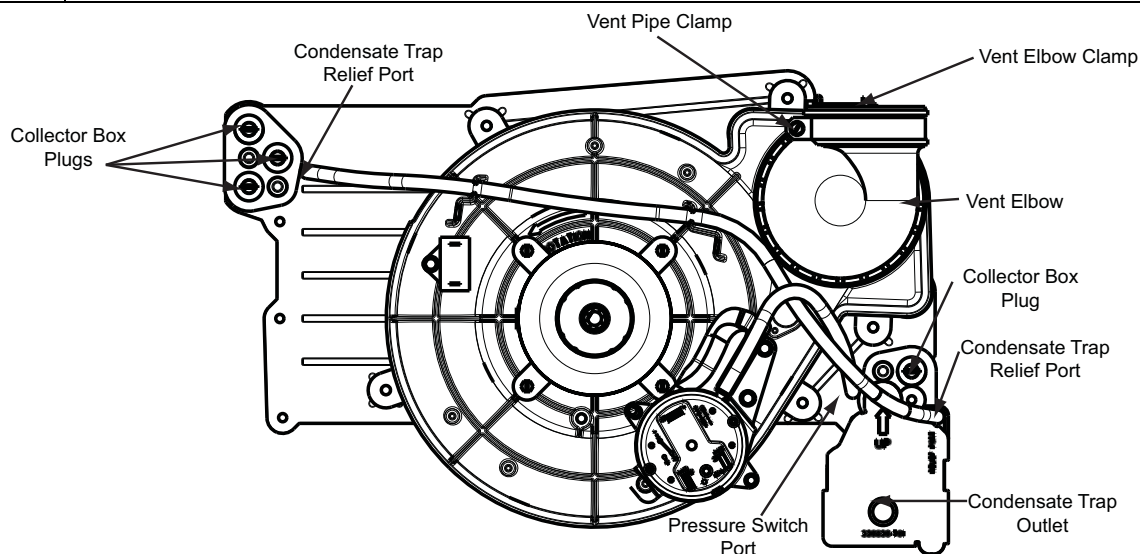
When the furnace is installed in the downflow position, the condensate trap will be initially located at the upper left corner of the collector box, as received from the factory. See the top

image in **Figure 9**. When the furnace is installed in the downflow orientation, the condensate trap must be relocated for proper condensate drainage. See the bottom image in **Figure 9**.

To Relocate the Condensate Trap:

- Orient the furnace in the downflow position.
- **Figure 9** shows the condensate trap and tubing before and after relocation. Refer to **Figure 9** to begin the trap conversion.
- Refer to Condensate Drain section for information how to install the condensate drain.

Figure 8 Upflow Trap Configuration

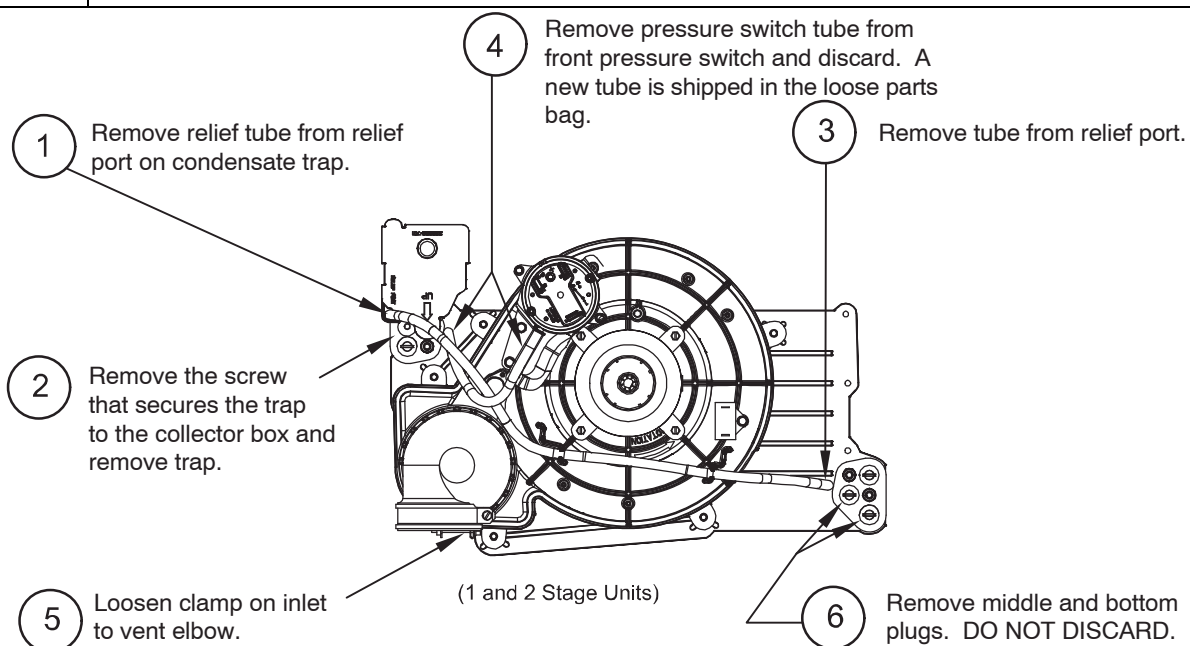


UPFLOW TRAP CONFIGURATION
1 & 2 Stage Units

Representative drawing only, some models may vary in appearance.

A11307

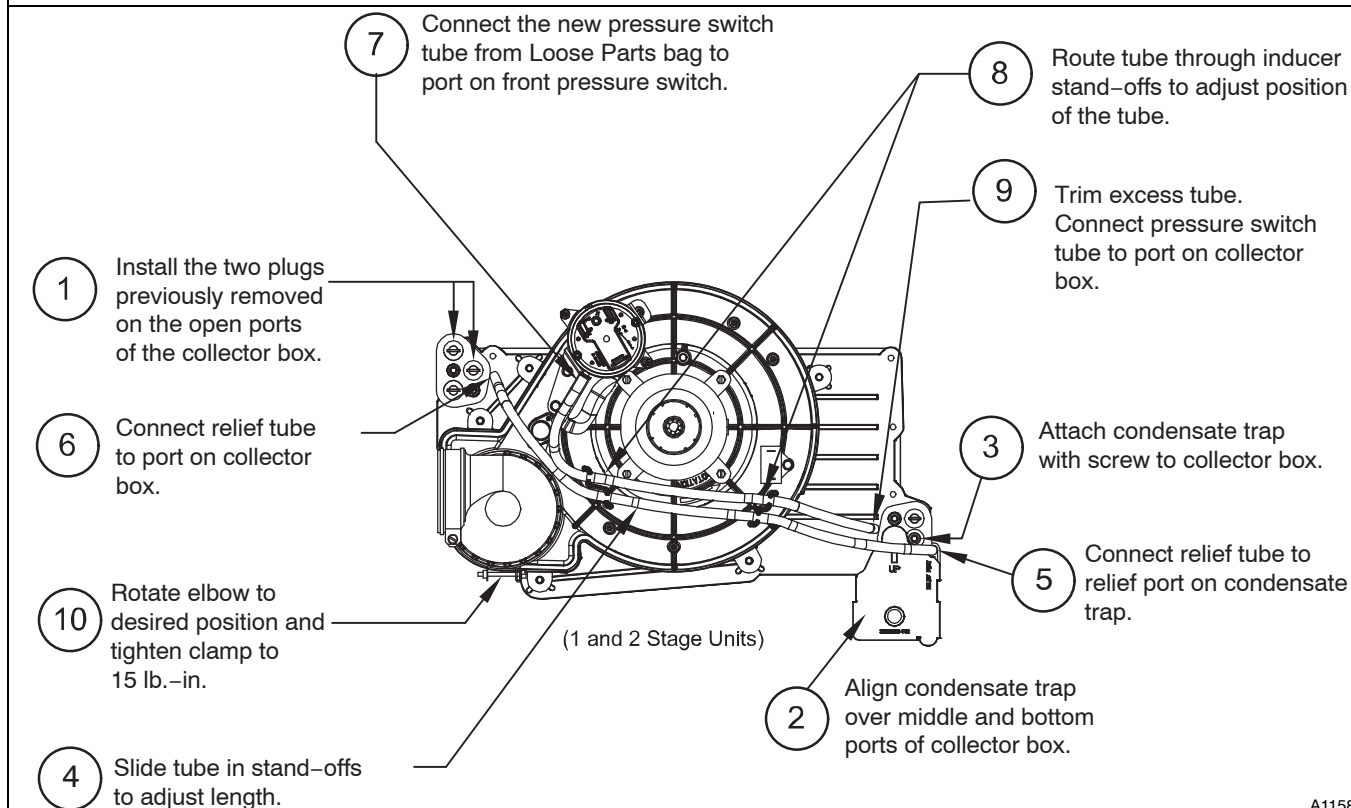
Figure 9 Unconverted Factory Configuration as viewed in the Downflow Orientation



Representative drawing only, some models may vary in appearance.

A11587LA

Downflow Trap Configuration (continued)



Representative drawing only, some models may vary in appearance.

A11587LB

Condensate Trap – Horizontal Orientation

When the furnace is installed in the horizontal right position, the condensate trap will be initially located at the bottom of the collector box, as received from the factory. See the top image in **Figure 10**. When the furnace is installed in the horizontal left position, the condensate trap will be initially located at the top of the collector box, as received from the factory. See the top image in **Figure 11**. In both cases the trap must be repositioned on the collector box for proper condensate drainage. See bottom images in **Figure 10** and **Figure 11**.

A field-supplied, accessory Horizontal Installation Kit (trap grommet) is required for all direct-vent horizontal installations (only). The kit contains a rubber casing grommet designed to seal between the furnace casing and the condensate trap. (See **Figure 16**)

NOTICE

The field-supplied, accessory horizontal drain trap grommet is **ONLY REQUIRED FOR DIRECT VENT APPLICATIONS**. It is **NOT** required for applications using single-pipe or ventilated combustion air venting.

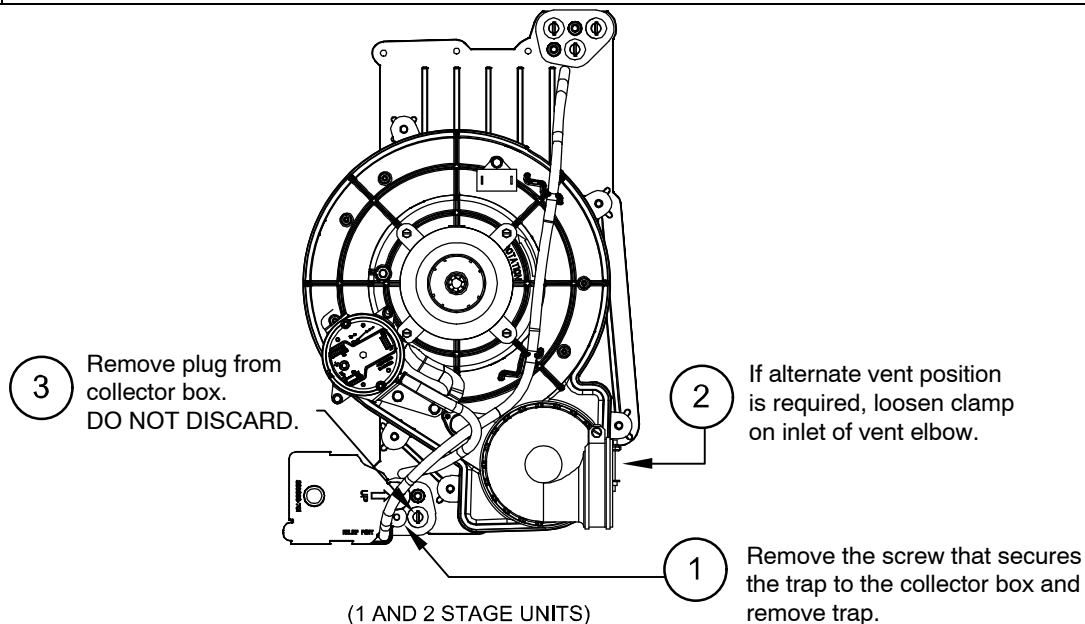
NOTICE

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. Allow at least 1/4-in. per foot (20mm per meter) of slope down and away from the furnace in horizontal sections of drain line.

To Relocate the Condensate Trap:

- Remove the knockout in the casing for the condensate trap.
- Install the grommet in the casing when required for direct-vent horizontal applications.
- Orient the furnace in the desired position.
- Allow for 2 in. (51 mm) of clearance underneath the furnace for the condensate trap and drain line.
- **Figure 10** shows the condensate trap and tubing before and after relocation in the horizontal right position.
- **Figure 11** shows the condensate trap and tubing before and after relocation in the horizontal left position.
- Refer to the appropriate figure to begin the trap conversion.
- Refer to Condensate Drain section for information how to install the condensate drain.

Figure 10 **Unconverted Factory Configuration as viewed in the Horizontal Right Orientation**

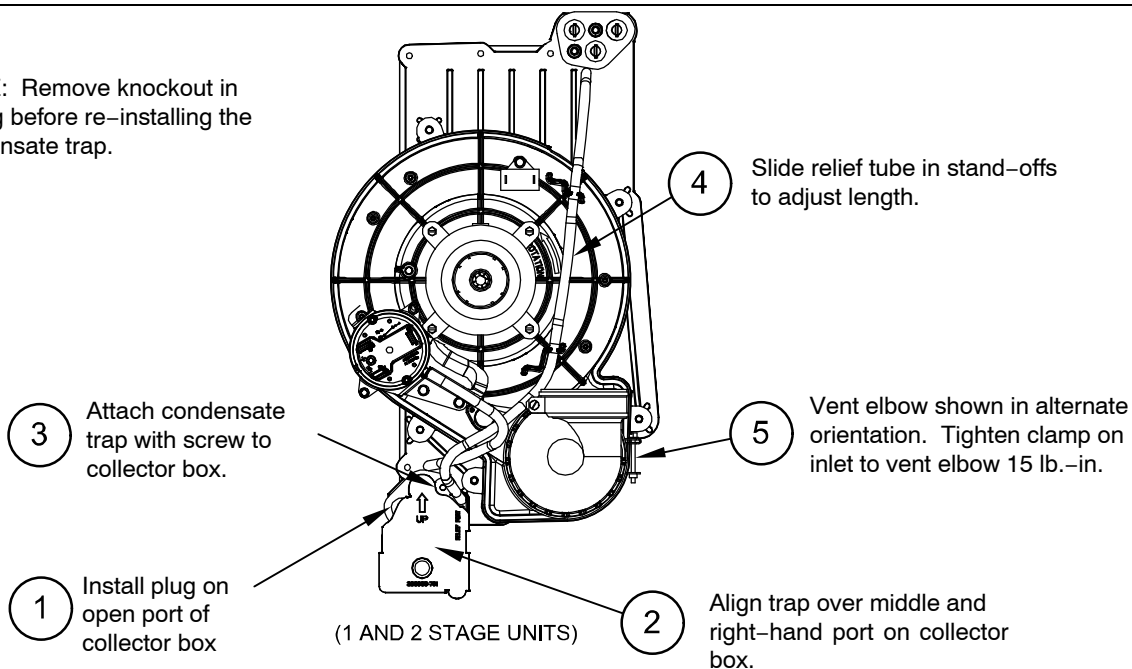


Representative drawing only, some models may vary in appearance.

A11573LA

Horizontal Right Trap Configuration

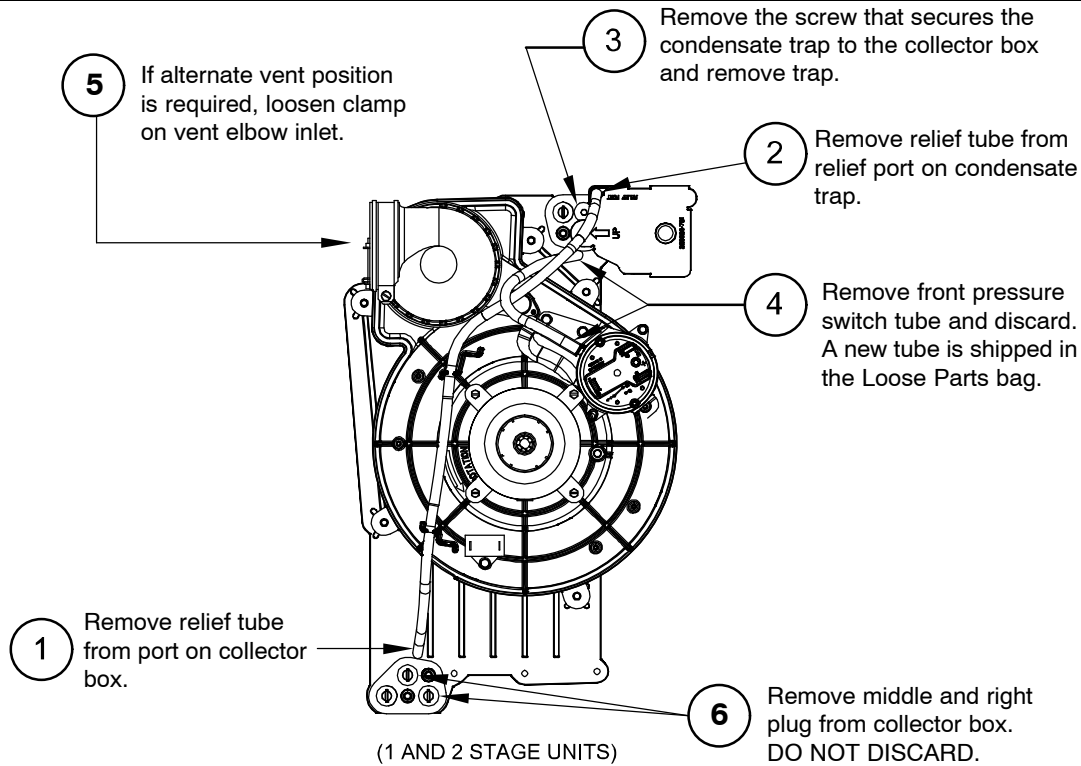
NOTE: Remove knockout in casing before re-installing the condensate trap.



Representative drawing only, some models may vary in appearance.

A11573LB

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

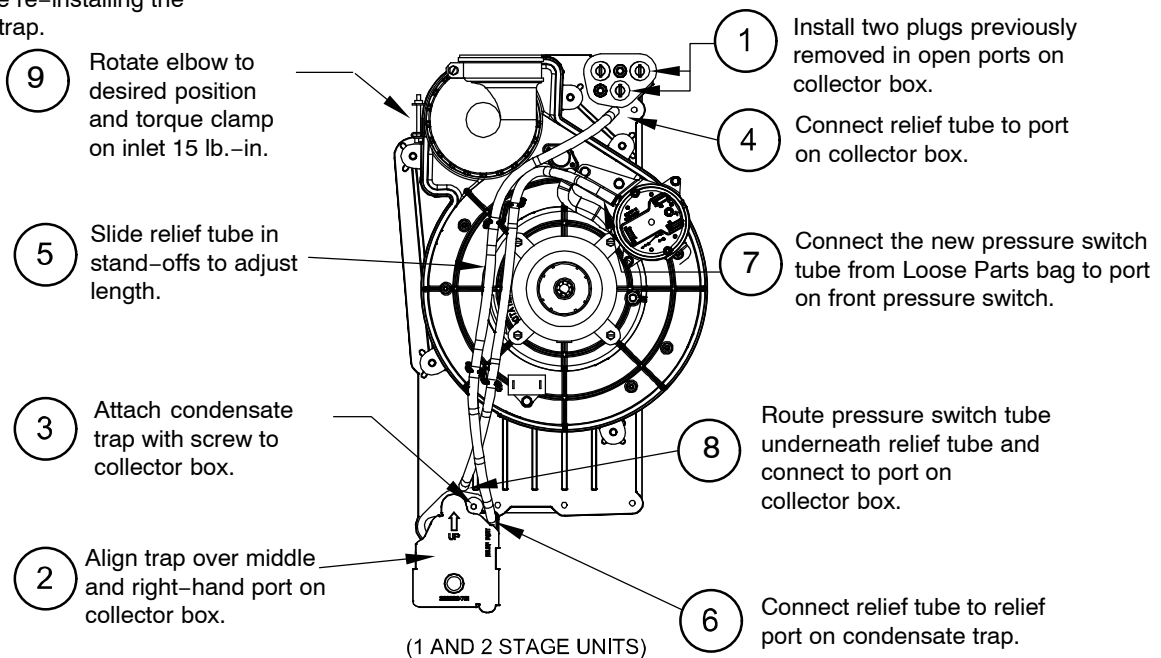


Representative drawing only, some models may vary in appearance.

A11574LA

Horizontal Left Trap Configuration

NOTE: Remove knockout in casing before re-installing the condensate trap.



Representative drawing only, some models may vary in appearance.

A11574LB

Condensate Drain Connection



CAUTION

FROZEN AND BURST WATER PIPE HAZARD

Failure to protect against the risk of freezing may result in property damage.

Special precautions **MUST** be made if installing furnace in an area which may drop below freezing. This can cause improper operation or damage to equipment. If furnace environment has the potential of freezing, the drain trap and drain line must be protected. The use of accessory drain trap heaters, electric heat tape and/or RV antifreeze is recommended for these installations.



CAUTION

PROPERTY DAMAGE HAZARD

Failure to follow this caution may result in burst water pipes and/or property damage.

If a condensate pump is installed, a plugged condensate drain or a failed pump may cause the furnace to shut down. Do not leave the home unattended during freezing weather without turning off water supply and draining water pipes or otherwise protecting against the risk of frozen pipes.

DO NOT trap the drain line in any other location than at the condensate drain trap supplied with the furnace. If possible, DO NOT route the drain line where it may freeze. The drain line must terminate at an inside drain to prevent freezing of the condensate and possible property damage.

Special precautions **MUST** be made if installing furnace in an area which may drop below 32°F (0°C). This can cause improper operation or damage to the equipment. If the furnace environment has the potential of freezing, the drain trap and drain line must be protected. In areas where the temperature may be below 32°F (0°C), a Condensate Freeze Protection kit is required. The kit includes a condensate trap with heat pad and replaces the factory-installed condensate trap. Refer to the accessory section of the Specification Sheets for current kit number. A self-regulating, shielded and waterproof heat tape rated at 3 to 6 watt per foot (10 to 20 watt per meter) at 115 volt, 40° F (4° C) may be used to provide freeze protection of the remaining condensate drain line. Wrap the drain trap and the drain line with the heat tape and secure with appropriate plastic ties. Follow the heat tape manufacturer's recommendations. Prime the trap before furnace operation.

The condensate drain line must be supported and/or secured per local codes. Supports and clamps should be spaced to prevent the drain line from sagging or being dislocated from the furnace or termination point. In the absence of local codes, consult the edition of the National Standard Plumbing Code 2009, in the US.

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/facing the furnace from the front.)

An indoor coil condensate drain or humidifier drain can be connected to the external furnace condensate drain provided:

- The drains are not hard piped together, and
- There is an air gap at the point where the two drain lines meet or

- All condensate piping is at least 1/2 in. PVC and there is a relief tee at the top of condensate drain piping as shown below:

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/facing the furnace from the front.) The furnace condensate drain can be connected to the indoor coil condensate drain, humidifier or auxiliary drain traps as shown in **Figure 13**.

NOTE: On narrower casings, 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.

For Right Side Condensate Drain:

- Remove the 7/8-in. knock-out from the right side of the casing. (See **Figure 12** for suggested knockout removal technique.)
- Remove the pre-formed rubber drain elbow and two spring clamps from the loose parts bag.
- Slide a spring clamp 1 in. (25 mm) down the plain end (the end without the formed grommet) of the drain elbow.
- From inside the casing, insert the formed grommet end of the elbow through the 7/8-in. knockout in the casing.
- Pull the grommet through the casing from the outside until it is seated in the knockout
- Attach the plain end of the drain elbow to the outlet stub on the drain trap. Secure the drain elbow to the trap with the spring clamp.

The remaining drain line can be constructed from field supplied 1/2-in. CPVC or 3/4-in. PVC pipe in compliance with local building codes. A factory-supplied 1/2-in. CPVC to 3/4-in PVC adapter is supplied in the loose parts bag for use as required.

- Install the adapter or connect the 1/2-in. CPVC pipe by sliding a spring clamp over the open end of the grommet on the outside of the furnace casing.
- Open the spring clamp and insert the long end of the adapter of the 1/2-in. CPVC pipe into the outlet stub on the drain elbow.
- Connect additional condensate piping to a code-approved drain, or to a condensate pump approved for use with acidic furnace condensate and compatible with mineral and vegetable oils, such as canola oil.

Allow at least 1/4-in. per foot (20 mm per meter) of slope down and away from the furnace in horizontal sections of drain line.

TIPS FROM CONTRACTORS: Contractors have found that temporarily removing the inducer assembly in upflow applications while performing the steps below, makes upflow left-side drain connections easier.

For Left Side Condensate Drain Connection:

- For left side condensate drainage, the drain line is routed from the condensate trap, behind the inducer (upflow) or gas valve (downflow) and out through the left side of the furnace casing. A pre-formed 1/2-in. CPVC "Z" pipe is provided with the furnace. The "Z" pipe is long enough to extend across the casing for drain connections.
- Locate the "Z" pipe. Remove the pre-formed drain elbow and four spring clamps from the loose parts bag.
- The "Z" pipe is connected to the condensate trap and the outside of the furnace by modifying the formed rubber drain elbow as shown in **Figure 15**.
- Remove the formed grommet from the rubber drain elbow by cutting the elbow along the vertical line located

about 1 3/8-in. (35 mm) away from the formed grommet. See **Figure 12**. DO NOT DISCARD THE FORMED GROMMET OR THE RUBBER ELBOW. Both of these pieces will be used.

Assemble and route the drain line to the opposite side of the furnace as detailed below:

- Remove the knock-out from the left side of the casing. (See **Figure 12** for suggested knockout removal technique.)
- From the outside of the casing, insert the angled end of the "Z" pipe through drain hole in the left side of the casing and behind the inducer or gas valve. Allow the "Z" pipe to temporarily rest on the blower shelf (upflow) or burner box (downflow). (**NOTE:** When the inducer housing has been removed to ease installation in upflow applications, this step is not needed.)
- After inserting the "Z" pipe through the casing, slide a spring clamp over each end of the "Z" pipe.
- From inside the casing, insert the short end of the formed grommet cut from the rubber drain elbow through the 7/8-in. drain knockout in the casing.
- Pull the grommet through the casing from the outside until it is seated in the knockout.
- Align the "Z" pipe with the long end of the grommet inside the furnace and insert slightly. The angled end of the tube at the other side of the casing should be facing the front of the furnace.
- Slide a spring clamp over the end of the remaining rubber drain elbow.
- Attach the drain elbow to the angled end of "Z" pipe and the drain trap outlet stub. Adjust the length of "Z" pipe inserted into the grommet at the opposite side of the furnace as necessary for proper fit and positioning. In both upflow and downflow orientations, the "Z" pipe should NOT be resting on any sheet metal parts.
- Secure the rubber elbow to the drain trap and the "Z" pipe with spring clamps.
- Secure the grommet to the "Z" pipe with the spring clamp. The remaining drain line can be constructed from field supplied 1/2-in. CPVC or 3/4-in. PVC pipe, in compliance with local building codes. A factory-supplied 1/2-in. CPVC to 3/4-in. PVC adapter is supplied in the loose parts bag for use as required.
- Install the adapter or connect the 1/2-in. CPVC pipe by sliding a spring clamp over the open end of the grommet on the outside the furnace casing.
- Open the spring clamp and insert the long end of the adapter or the 1/2-in. CPVC pipe into the outlet stub on the drain elbow.
- Connect additional condensate piping to a code-approved drain, or to a condensate pump approved for use with acidic furnace condensate and compatible with mineral and vegetable oils, such as canola oil.

Allow at least 1/4-in. per foot (20 mm per meter) of slope down and away from the furnace in horizontal sections of drain line.

NOTICE

The field-supplied, accessory horizontal drain trap grommet is **ONLY REQUIRED FOR DIRECT VENT APPLICATIONS**. It is **NOT** required for applications using single-pipe or ventilated combustion air venting.

TIPS FROM CONTRACTORS: When installing the furnace horizontally, use the entire drain elbow (that is, do NOT cut as

shown in **Figure 15**) to connect the trap to the drain line. This helps to prevent bumps and shocks to the drain line from damaging the furnace drain trap. Avoid misalignment of the drain pipe which may cause kinks in the elbow.

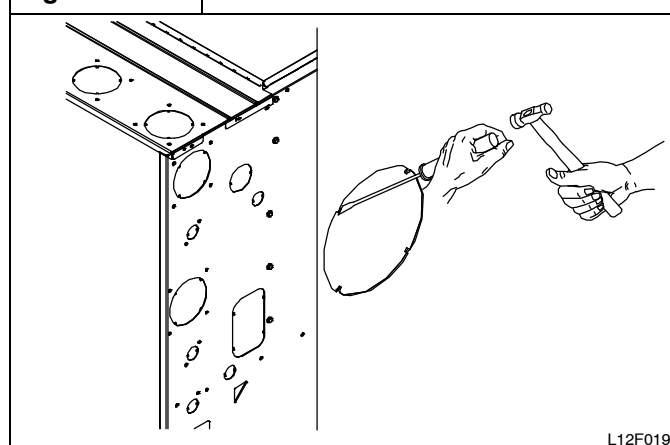
Horizontal Orientation

- The condensate trap outlet extends 2-in. (51 mm) below the furnace casing. Leave enough clearance between the furnace and the furnace platform for the trap.
- To allow for servicing the trap, the condensate drain elbow in the loose parts bag can be used to make a coupler to allow for future service of the condensate trap and drain line.
- Remove the knockout for the condensate trap in the side of the casing.
- Install the drain trap grommet in the casing, if required for direct-vent applications. If necessary, remove the trap, install the grommet and re-install the trap.
- Remove the pre-formed rubber drain elbow and two spring clamps from the loose parts bag.
- Connect the full or modified elbow and/or grommet to the outlet of the condensate trap with one spring clamp. Avoid misalignment of the drain pipe which may cause kinks in the elbow or grommet.
- The remaining drain line can be constructed from field supplied 1/2-in. CPVC or 3/4-in. PVC pipe, in compliance with local building codes. A factory-supplied 1/2-in. CPVC to 3/4-in. PVC adapter is supplied in the loose parts bag for use as required.
- Install the adapter or connect the 1/2-in. CPVC pipe by sliding a spring clamp over the open end of the elbow or grommet on the outside the furnace casing.
- Open the spring clamp and insert the long end of the adapter or the 1/2-in. CPVC pipe into the outlet stub on the drain elbow.
- Connect additional condensate piping to a code-approved drain, or to a condensate pump approved for use with acidic furnace condensate and compatible with mineral and vegetable oils, such as canola oil.

Allow at least 1/4-in. per foot (20 mm per meter) of slope down and away from the furnace in horizontal sections of drain line.

Figure 12

Knockout Removal



L12F019



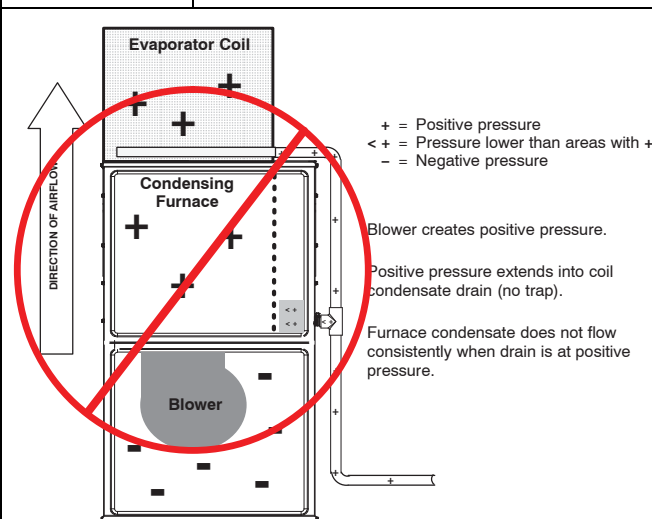
CAUTION

CUT HAZARD

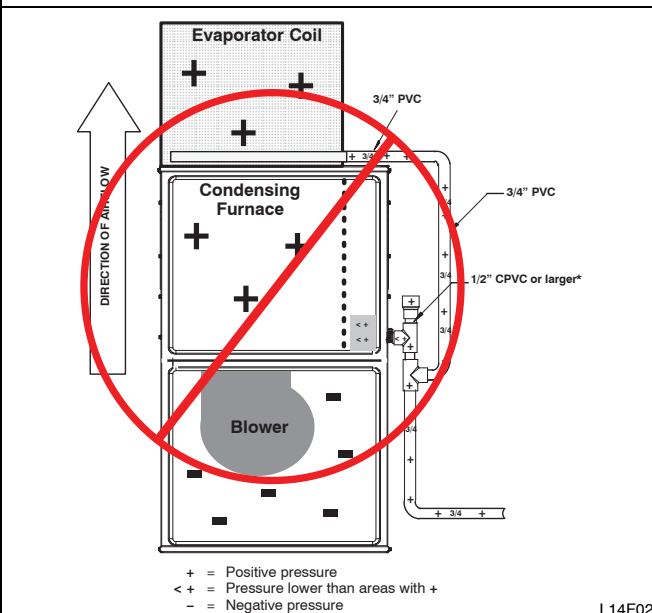
Failure to follow this caution may result in personal injury. Sheet metal parts may have sharp edges or burrs. Use care and wear appropriate protective clothing, safety glasses and gloves when handling parts, and servicing furnaces.

Figure 13

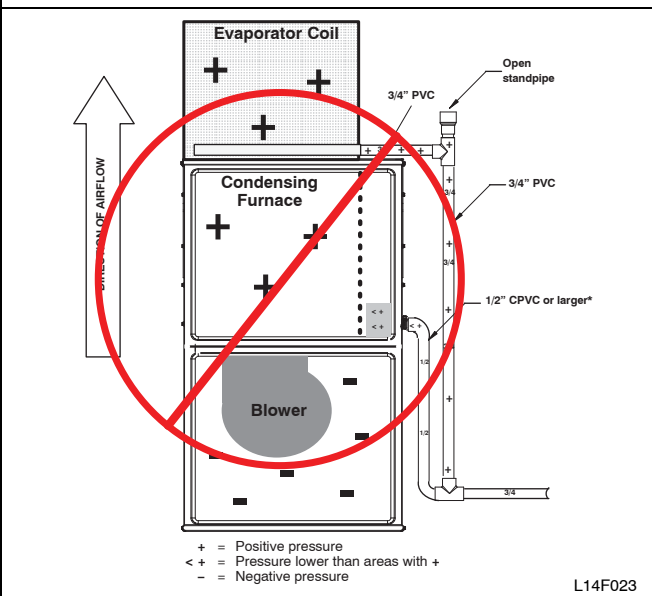
Example of Field Drain Attachment (NOT ALLOWED)



L14F021



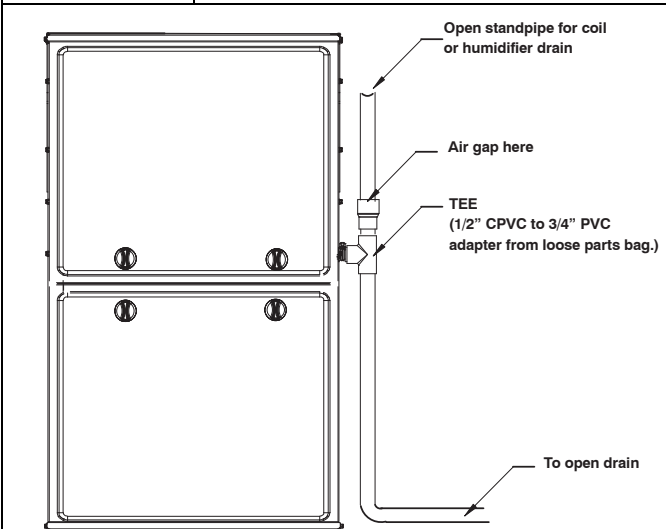
L14F022



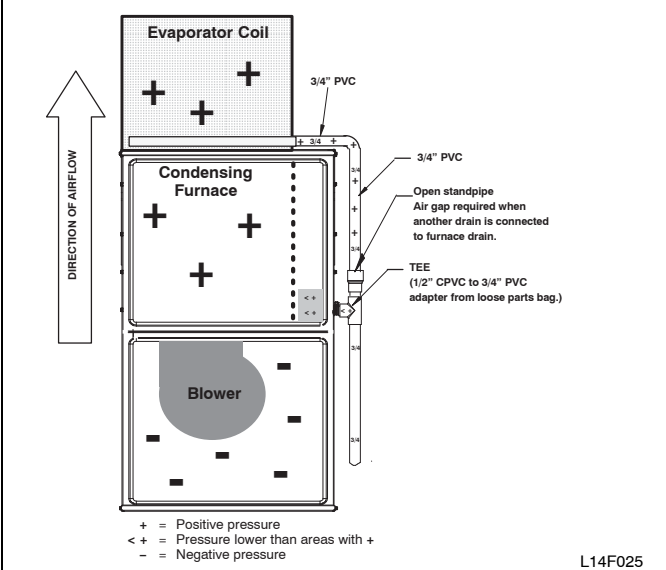
L14F023

Figure 14

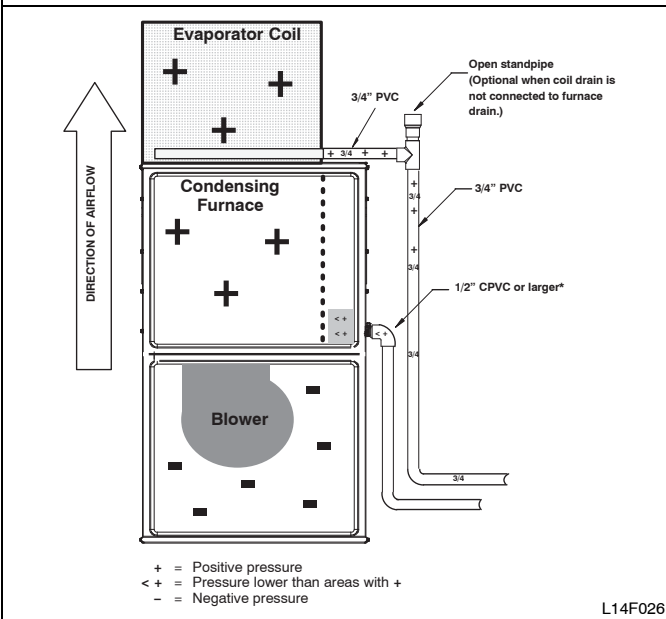
Example of Field Drain Attachment



L14F024

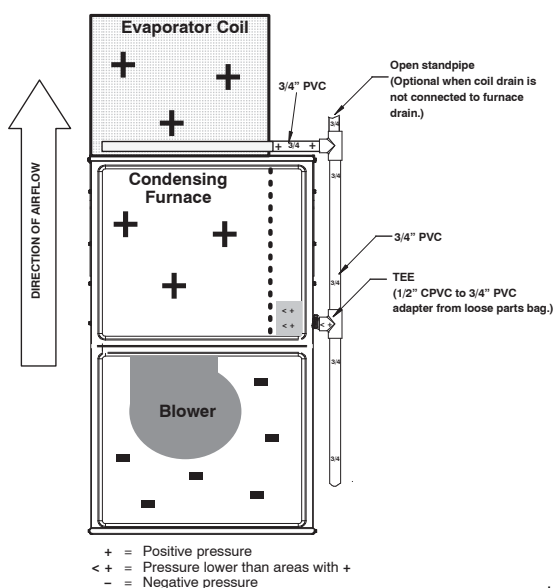


L14F025



L14F026

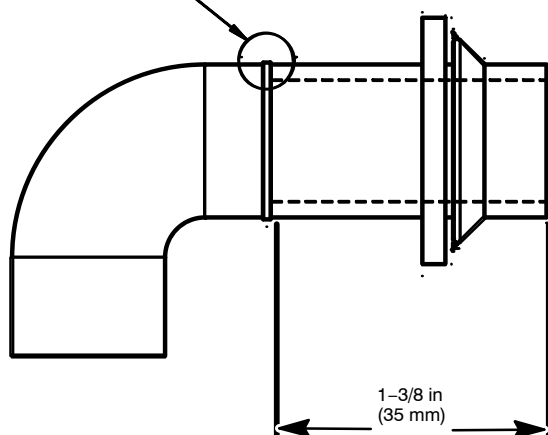
Example of Field Drain Attachment cont.



L14F027

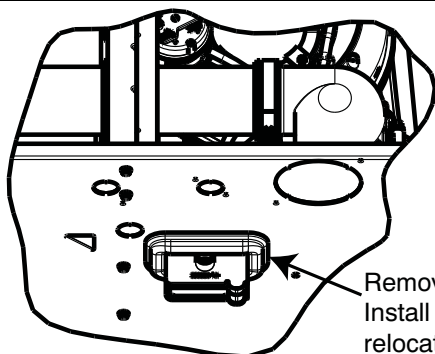
Figure 15 Modify Rubber Drain Elbow

Cut line for left side condensate drain.
Do not discard parts after cutting.



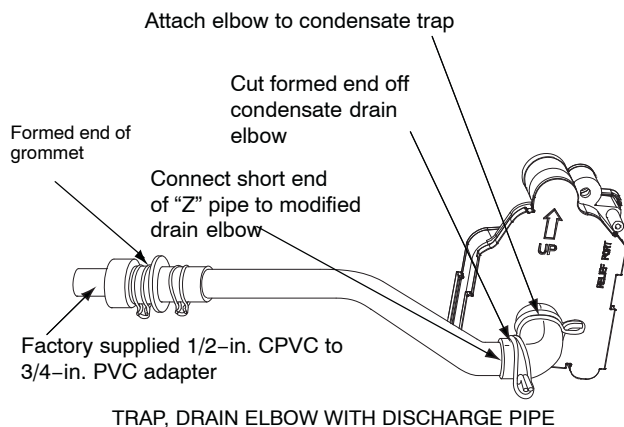
L11F089

Figure 16 Horizontal Drain Trap Grommet



A11348

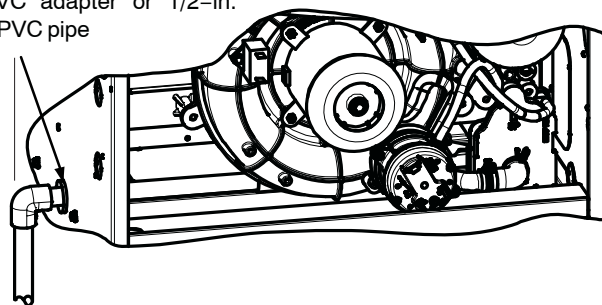
Figure 17 Drain Trap Connection and Routing



Formed end of grommet

Open spring clamp. Insert 1/2-in. to 3/4-in. CPVC to PVC adapter or 1/2-in. CPVC pipe

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



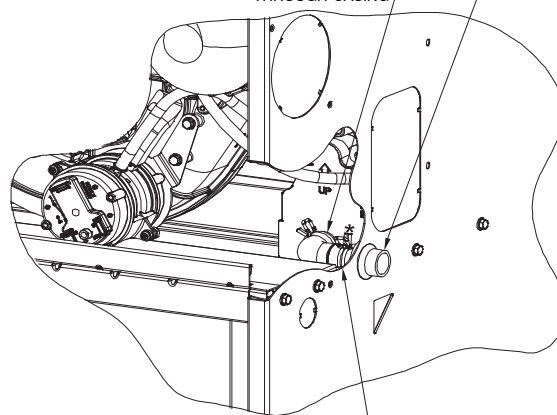
NOTE: Remove Inducer Housing for easier access, if desired.

L12F015

Figure 18 Formed Rubber Drain Grommet

INSTALL CLAMPS ON DRAIN ELBOW
ATTACH DRAIN ELBOW TO CONDENSATE DRAIN TRAP

PULL DRAIN STUB THROUGH CASING



OPEN SPRING CLAMP

INSERT FACTORY-SUPPLIED 1/2-IN. CPVC TO 3/4-IN. PVC ADAPTER OR 1/2-IN. CPVC PIPE

*CLAMP MAY BE LOCATED ON OUTSIDE OF DRAIN ELBOW

RIGHT SIDE DRAIN INSTALLATION

L12F022

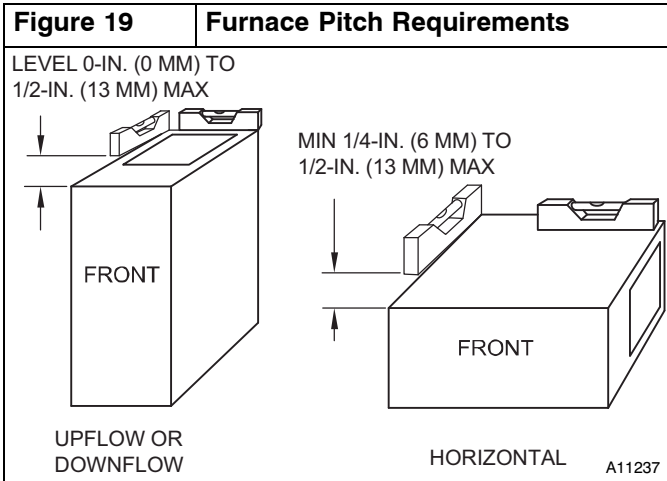
INSTALLATION

NOTICE

This furnace is certified to leak 2% or less of nominal air conditioning CFM delivered when pressurized to 1-inch water column (250 Pa) with all present air inlets (including bottom closure in upflow and horizontal applications), air outlets, and plumbing and electrical ports sealed.

UPFLOW INSTALLATION

NOTE: The furnace must be pitched as shown in **Figure 19** for proper condensate drainage.



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 23**) 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 supply-side 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.

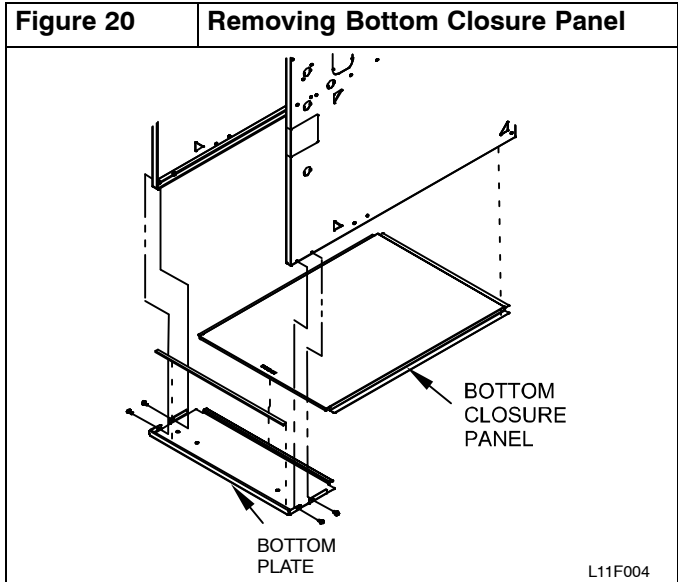
The return-air duct must be connected to bottom, sides (left or right), or a combination of bottom and side(s) of main furnace casing. Bypass humidifier may be attached into unused return air side of the furnace casing. (See **Figure 28**, **Figure 29** and **Figure 30**)

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 20**)
2. Remove bottom plate.
3. Remove bottom closure panel.
4. Reinstall bottom plate and screws.



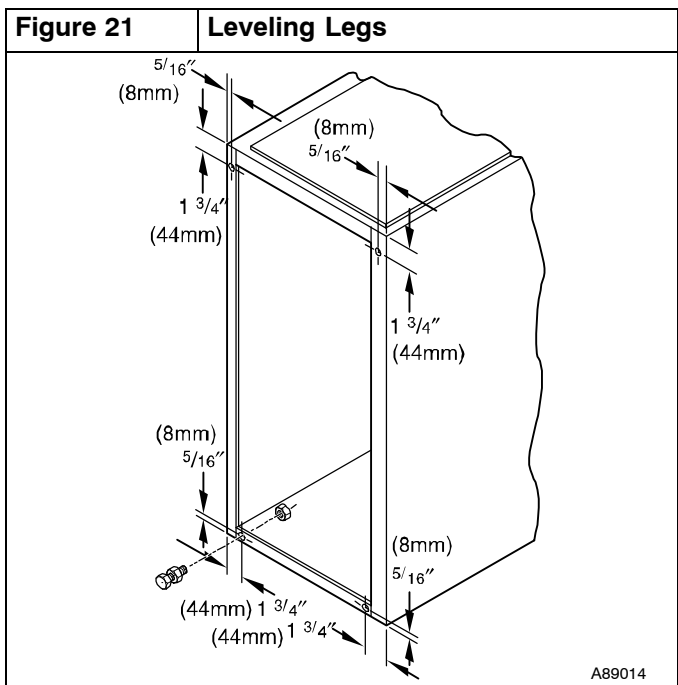
Side Return Air Inlet

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 28**, **Figure 29** and **Figure 30**)

Leveling Legs (If Desired)

In upflow position with side return inlet(s), leveling legs may be used. (See **Figure 21**) 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

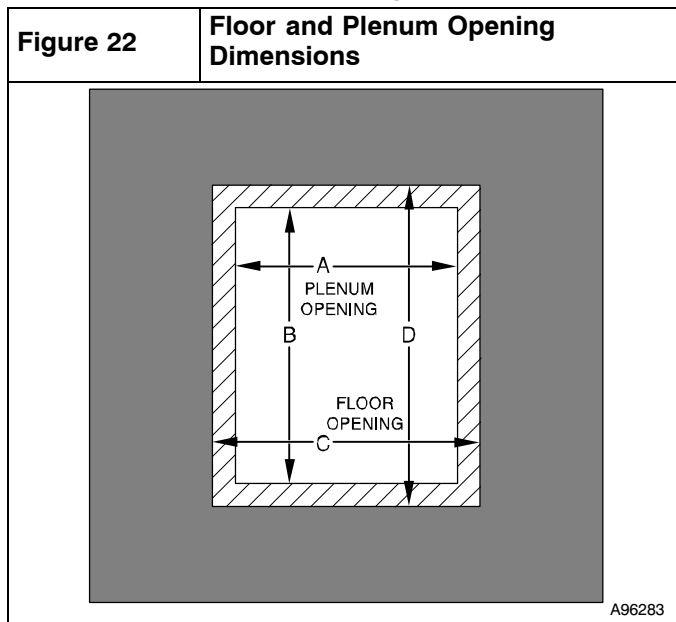
NOTE: The furnace must be pitched as shown in **Figure 19** for proper condensate drainage.

NOTE: Downflow installation not allowed for 140,000 BTU model.

Supply Air Connections

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

- Special Base – NAHA01101SB
 - Cased Coil Assembly – EAM4X, END4X, ENW4X, EAD4X
1. Determine application being installed from **Table 5**.
 2. Construct hole in floor per **Table 5** and **Figure 22**.
 3. Construct plenum to dimensions specified in **Table 5** and **Figure 22**.
 4. Install as shown in **Figure 24**. If Coil Assembly Part is used, install as shown in **Figure 25**.



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 23**)



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 23**) 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 supply-side 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 28**. **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 28**)

Figure 23 **Duct Flanges**

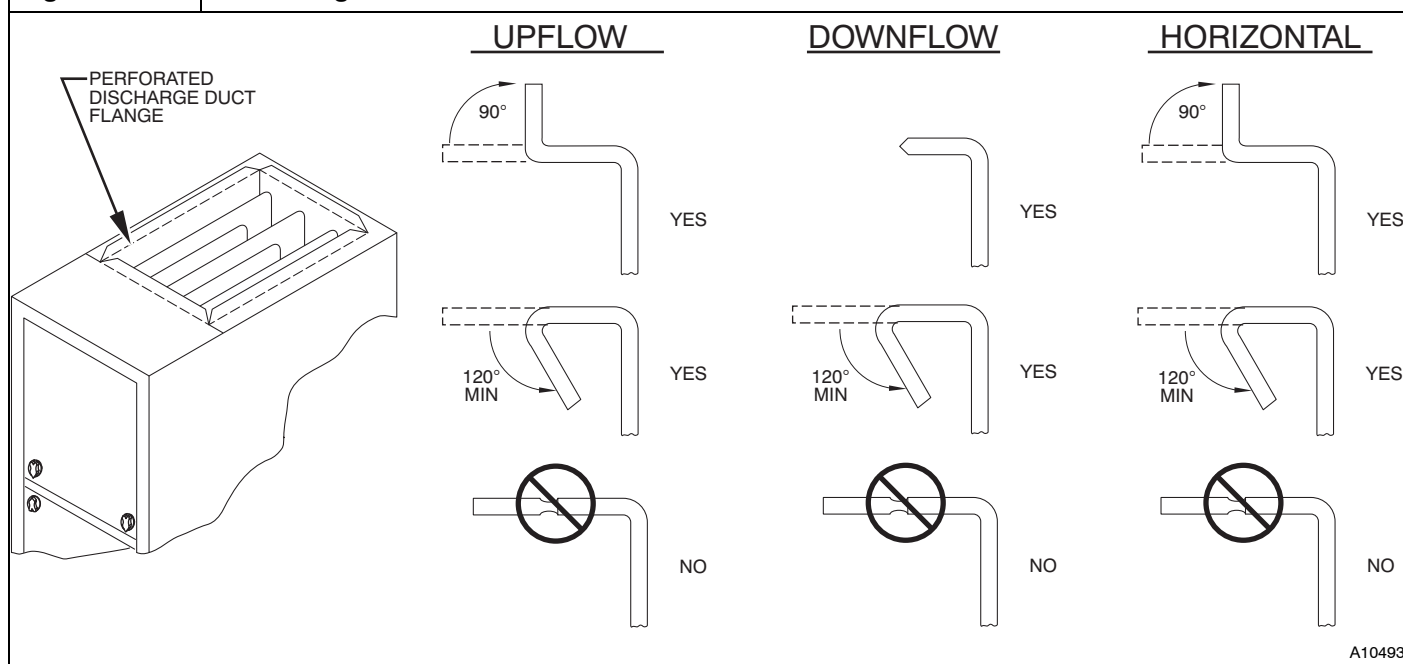


Table 5		Opening Dimensions – in. (mm)			
FURNACE CASING WIDTH IN. (mm)	APPLICATION	PLENUM OPENING		FLOOR OPENING	
		A	B	C	D
21 (533)	Upflow Applications on Combustible or Noncombustible Flooring (subbase not required)	19–1/2 (495)	21–5/8 (549)	20–1/8 (511)	22–1/4 (565)
	Downflow Applications on Noncombustible 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)

Figure 24

Furnace, Plenum, and Subbase Installed on a Combustible Floor

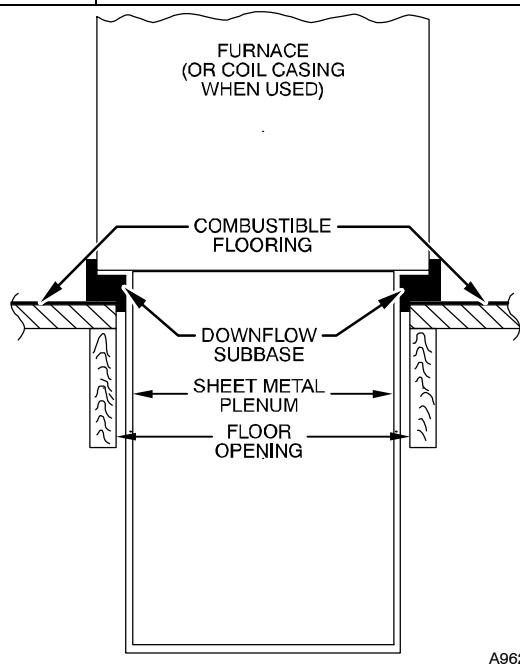
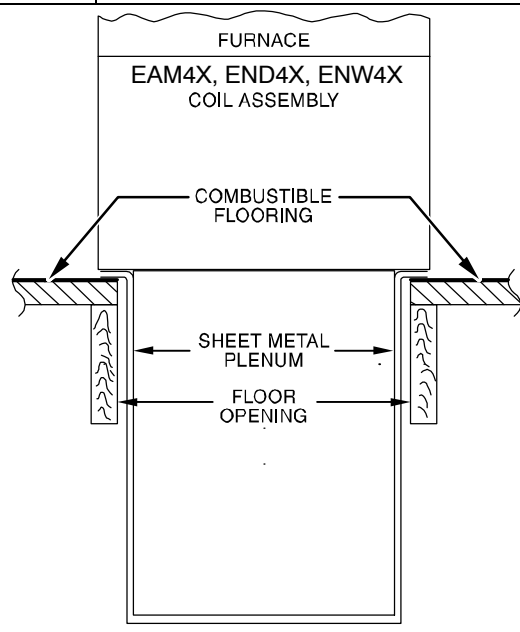


Figure 25

Furnace, Plenum, and Coil Assembly on a Combustible Floor



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 20**)
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 19** 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.



CAUTION

MINOR PROPERTY HAZARD

Failure to follow this caution may result in minor property damage.

Local codes may require a drain pan under entire furnace and condensate trap when a condensing furnace is used in an attic application or over a finished ceiling.

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.

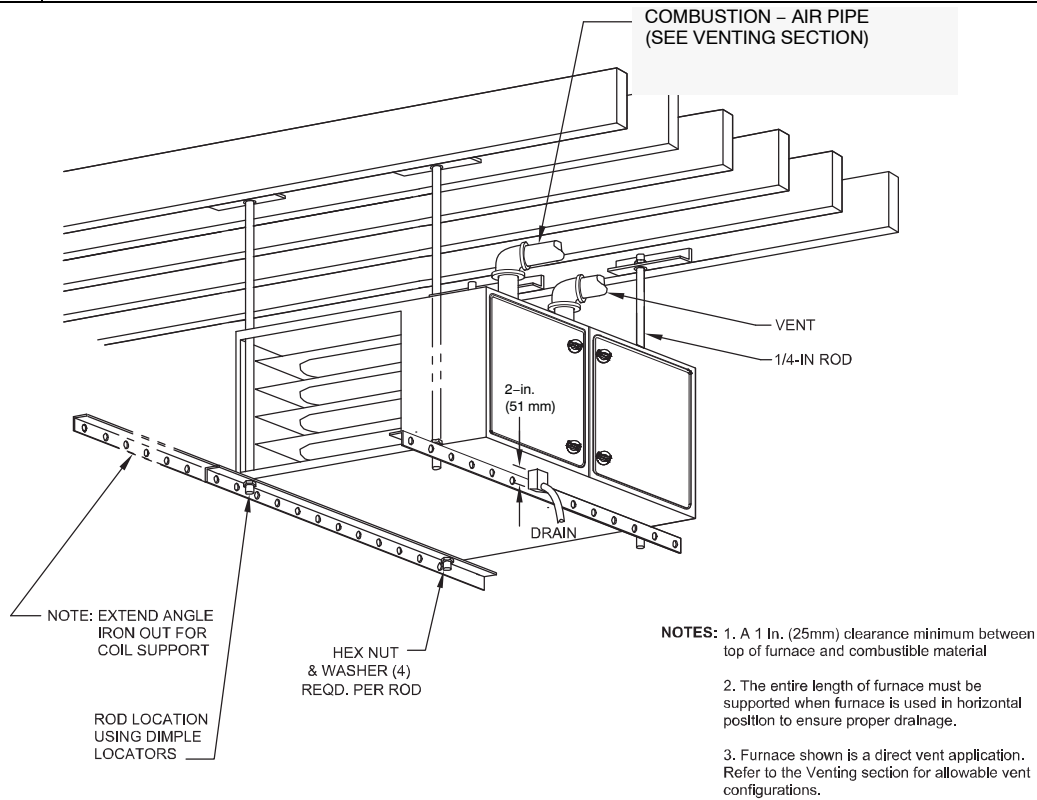
Suspended Furnace Support

The furnace may be supported under the entire length of the furnace with threaded rod and angle iron. (See **Figure 26**) 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 27**) 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.

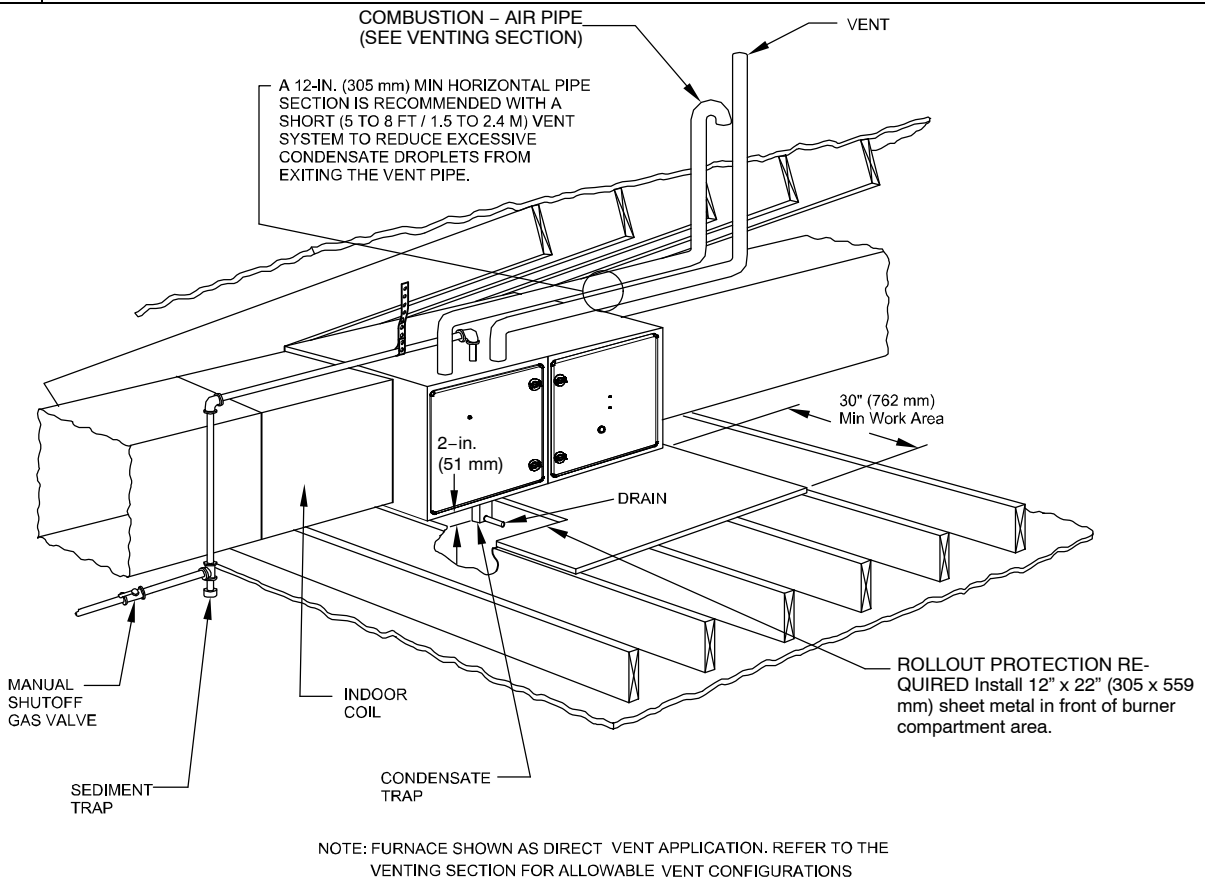
Figure 26 **Suspended Furnace Installation**



A11155

NOTE: Local codes may require a drain pan and condensate trap when a condensing furnace is installed over a finished ceiling.

Figure 27 **Working Platform for Attic Installation**



L14F019

NOTE: Local codes may require a drain pan and condensate trap when a condensing furnace is installed over a finished ceiling.

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 27** 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 23**) 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 supply-side accessories **MUST** be connected to duct external to furnace main casing.

Return Air Connections

The return-air duct may 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 upward facing 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 30**)

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 20**)
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 30**)

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 29**, **Figure 32**, 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 28** and **Figure 31** and **Table 9**).

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 30**. If both side and bottom openings are used in **Figure 30**, 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	
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.

Filter and Return Duct Sizing

Pressure drop must be taken into account when sizing filters, filter racks, IAQ devices, and associated system ductwork. See **Table 7** for a comparison of Pressure Drop (initial/clean resistance to airflow) versus Airflow for a variety of filter media types and sizes. These are representative numbers. Consult the filter or IAQ device manufacturers' specification sheet for performance data for a particular filter media or IAQ device.

Design the filter and associated ductwork for the best match of pressure drop versus filter size. Best practice usually chooses filter systems with pressure drops under 0.2 in. w.c. (50 Pa), with the best blower electrical efficiency and system airflow performance occurring with filter pressure drops under 0.1 in wg (25 Pa).

Due to the relatively high pressure drops of 1-in (25 mm) thick after-market filter media, it is recommended that the filtration system be designed for at least 2-in (51 mm) thick media.

TIPS FROM CONTRACTORS: Install a media cabinet capable of incorporating a 4-in (102 mm) thick media filter. This allows room for future upgrades to other IAQ devices.

NOTICE

Design the duct system **FIRST** to determine how much pressure drop may be allowed in the filter system. See the AIR DUCTS section. Excessive filter pressure drop often compromises system airflow and duct performance, causes inadequate airflow to the furthest ends of the duct system, as well as causes excess noise and higher than anticipated electrical consumption.

Provide duct transitions, as required, to smoothly transition airflow from the return duct system to the filter (or IAQ device) to the furnace when the dimensions of the ductwork or furnace return air opening do not match the required filter or IAQ device dimensions. See the instructions supplied with factory-accessory duct adapters.

Table 7		Filter Media Pressure Drop (Clean) Versus Airflow - in. w.c. (Pa)					
14 x 25 Filter		Factory-Accy Washable	Representative After-Market Filter Media*				
			Fiberglass*		Pleated*		
CFM	L/s	(1-in. / 2.5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	
600	(283)	0.04 (12)	0.07 (17)	0.10 (26)	0.24 (60)	0.16 (40)	
800	(378)	0.06 (15)	0.10 (25)	0.15 (39)	0.34 (85)	0.23 (59)	
1000	(472)	0.07 (18)	0.13 (34)	0.21 (52)	- -	0.32 (81)	
1200	(566)	0.08 (20)	0.17 (43)	0.27 (68)	- -	- -	
16x 25 Filter		Factory-Accy Washable	Representative After-Market Filter Media*				
			Fiberglass*		Pleated*		
CFM	L/s	(1-in. / 2.5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	
600	(283)	0.04 (10)	0.06 (15)	0.09 (22)	0.20 (51)	0.13 (34)	
800	(378)	0.05 (13)	0.08 (21)	0.13 (32)	0.29 (72)	0.20 (49)	
1000	(472)	0.06 (16)	0.11 (28)	0.17 (43)	- -	0.27 (67)	
1200	(566)	0.07 (18)	0.14 (36)	0.22 (56)	- -	- -	
1400	(661)	0.08 (21)	0.18 (45)	0.28 (70)	- -	- -	
1600	(755)	0.09 (23)	0.21 (54)	- -	- -	- -	
1800	(850)	0.10 (25)	0.26 (64)	- -	- -	- -	
20 x 25 Filter		Factory-Accy Washable	Representative After-Market Filter Media*				
			Fiberglass*		Pleated*		
CFM	(L/s)	(1-in. / 2.5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	
800	(378)	0.04 (11)	0.06 (16)	0.09 (24)	0.22 (55)	0.15 (37)	
1000	(472)	0.05 (13)	0.08 (21)	0.13 (32)	0.29 (72)	0.20 (49)	
1200	(566)	0.06 (15)	0.11 (27)	0.16 (41)	- -	0.25 (63)	
1400	(661)	0.07 (17)	0.13 (33)	0.20 (51)	- -	0.31 (79)	
1600	(755)	0.08 (19)	0.16 (40)	0.24 (61)	- -	- -	
1800	(850)	0.08 (21)	0.18 (47)	0.29 (73)	- -	- -	
2000	(944)	0.09 (23)	0.21 (54)	- -	- -	- -	
2200	(1038)	0.09 (24)	0.25 (62)	- -	- -	- -	
25 x 25 Filter		Factory-Accy Washable	Representative After-Market Filter Media*				
			Fiberglass*		Pleated*		
CFM	L/s	(1-in. / 2.5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	
800	(378)	0.03 (9)	0.05 (12)	0.07 (18)	0.17 (43)	0.11 (28)	
1000	(472)	0.04 (11)	0.06 (16)	0.09 (24)	0.22 (55)	0.15 (37)	
1200	(566)	0.05 (13)	0.08 (20)	0.12 (31)	0.27 (68)	0.18 (47)	
1400	(661)	0.06 (15)	0.10 (24)	0.15 (38)	- -	0.23 (58)	
1600	(755)	0.06 (16)	0.11 (29)	0.18 (45)	- -	0.28 (69)	
1800	(850)	0.07 (18)	0.13 (34)	0.21 (53)	- -	- -	
2000	(944)	0.08 (19)	0.16 (39)	0.24 (61)	- -	- -	
2200	(1038)	0.08 (21)	0.18 (45)	0.28 (70)	- -	- -	

* Representative estimates from filter manufacturer data sheets.

See manufacturers' specifications for pressure drop versus airflow data for specific filter media.

If the filter size that you are looking for is not contained in **Table 7**, refer to **Table 8** for a comparison of Pressure Drop (initial/clean resistance to airflow) versus Face Velocity for a variety of filter media types.

The following equations relate Face Velocity (FPM), Filter Area and Airflow (CFM):

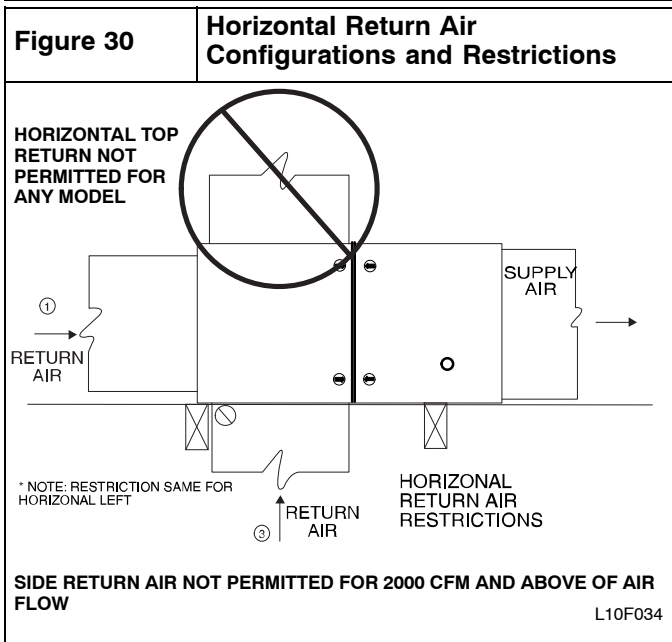
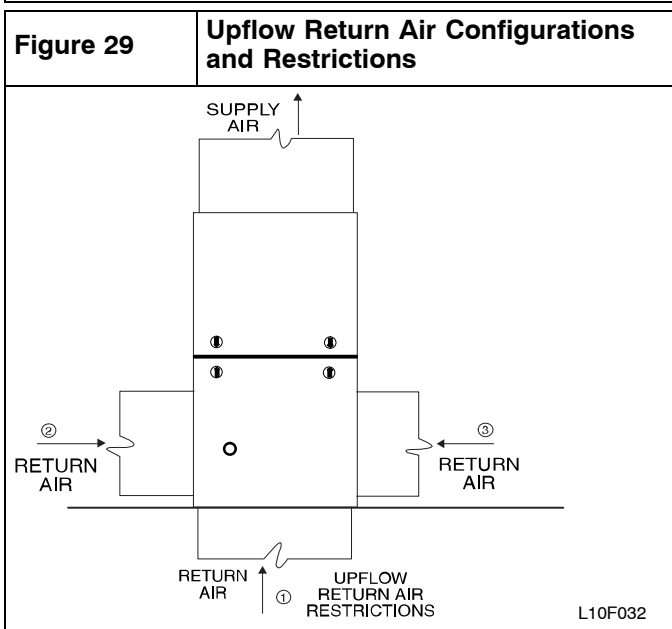
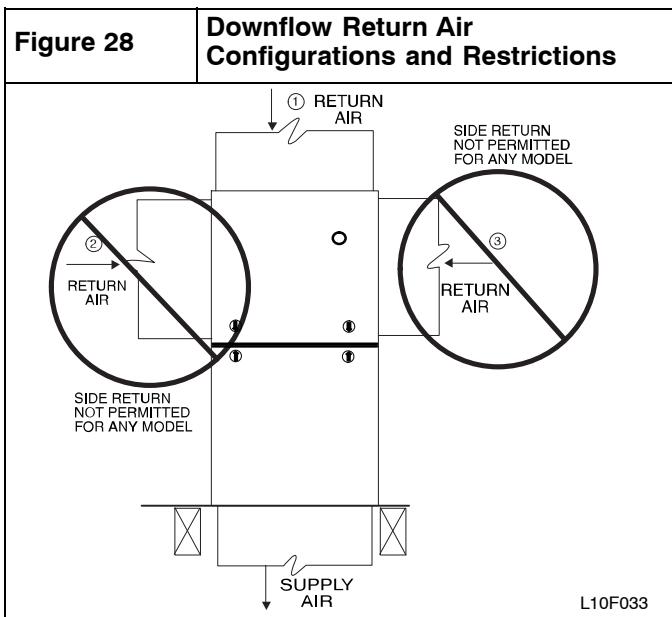
$$\text{Filter Face Velocity} = \text{Airflow} / \text{Filter Area}$$

$$\text{Minimum Filter Area} = \text{Rated System Airflow} / \text{Maximum Filter Face Velocity}$$

Table 8		Filter Media Pressure Drop (Clean) Versus Velocity - in. w.c. (Pa)					
Face Velocity		Factory-Accy Washable	Representative After-Market Filter Media*				
			Fiberglass*		Pleated*		
FPM	(m/s)	(1-in. / 2.5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	(1-in. / 2.5 cm)	(2-in. / 5 cm)	
200	(1)	0.04 (10)	0.05 (13)	0.08 (20)	0.18 (47)	0.12 (31)	
300	(1.5)	0.05 (14)	0.09 (22)	0.13 (34)	0.30 (75)	0.21 (52)	
400	(2)	0.07 (17)	0.13 (32)	0.20 (50)	- -	0.31 (78)	
500	(2.5)	0.08 (21)	0.18 (44)	0.27 (69)	- -	- -	
600	(3)	0.09 (23)	0.23 -	- -	- -	- -	
700	(3.6)	0.10 (26)	0.29 -	- -	- -	- -	

* Representative estimates from filter manufacturer data sheets.

See manufacturers' specifications for pressure drop versus airflow data for specific filter media.



External Filter Cabinet Configurations

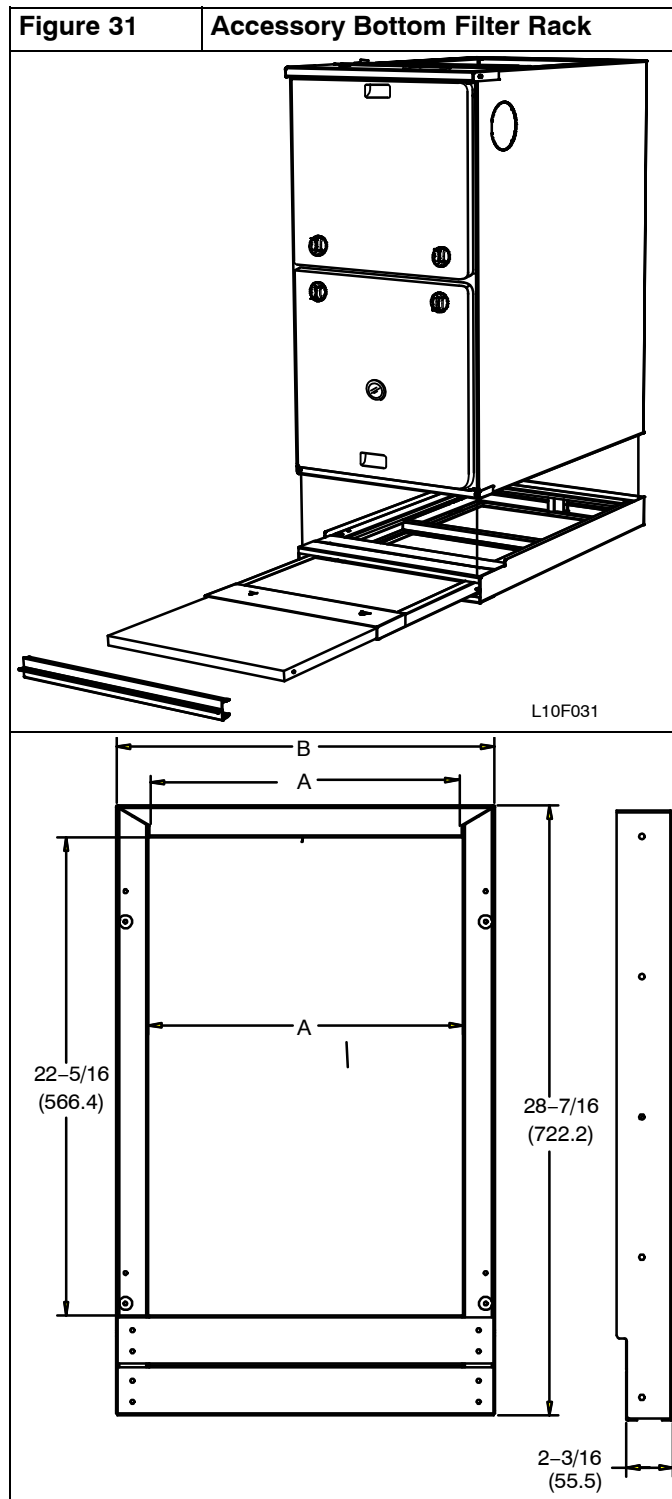
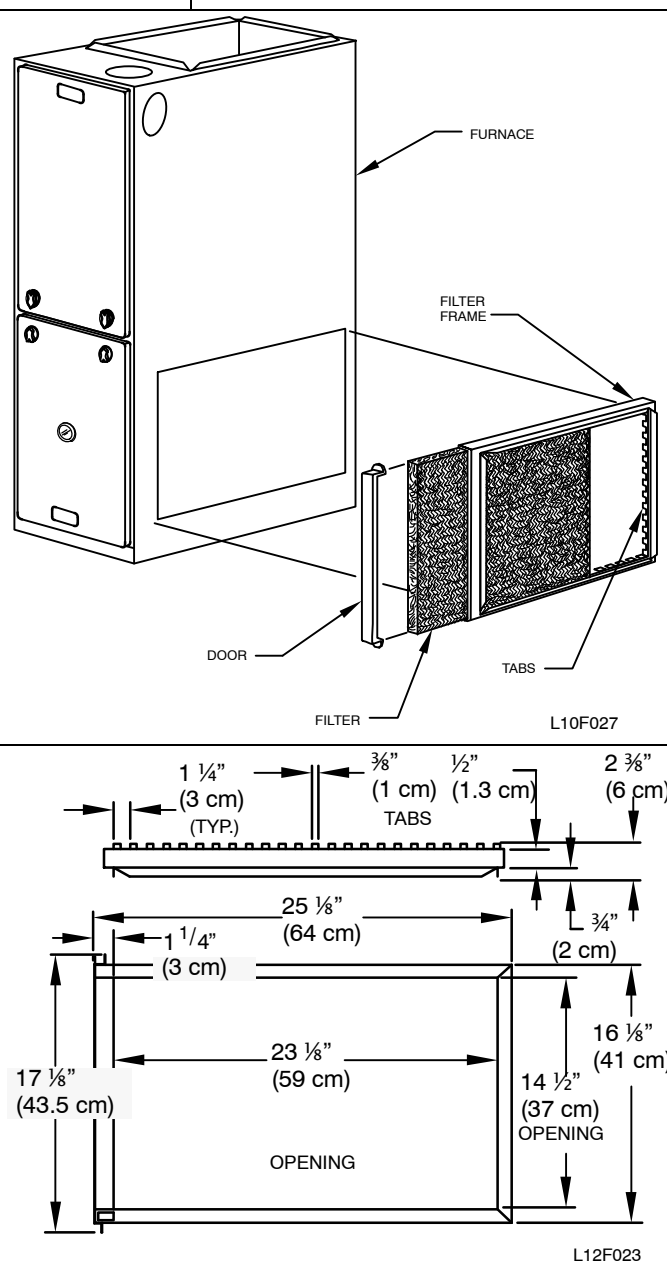


Table 9	Dimensional Drawing - in. (mm)		
KIT NO.	FURNACE WIDTH	A	B
NAHB00701FF	21 (533.4)	18-1/8 (460.4)	21-1/8 (536.6)
NAHB00801FF	24-1/2 (622.3)	21-5/8 (549.3)	24-5/8 (625.5)

Figure 32 **Accessory Side Filter Rack**



Air Ducts

NOTICE

Many states, provinces and localities are considering or have implemented standards and/or restrictions on duct sizing practices, ductwork leakage, and/or ductwork thermal, airflow and electrical efficiencies. **CONSULT LOCAL CODE OFFICIALS** for ductwork design and performance requirements in your area.

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 Manual D), 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.

Return Duct Sizing

Refer to the Filter Selection and Duct Sizing section for information on the proper selection of filter sizes and the associated ductwork and duct transitions. Improperly designed filtering systems and return ductwork are the most common causes of airflow and/or noise complaints in HVAC systems.

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.

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.

Refer to **Table 10** 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 one 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 10		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

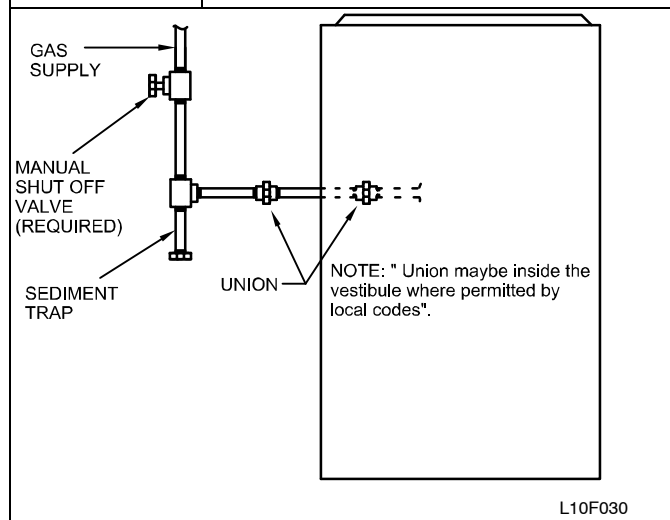
* Cubic ft. of gas per hr for gas pressures of 0.5 psig (14-in. w.c.) or less and a pressure drop of 0.5-in. w.c. (based on a 0.60 specific gravity gas). Ref: **Table 10** above, and 6.2 of NFPA54/ANSI Z223.1-2012.

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 33**. 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.

Figure 33

Typical Gas Pipe Arrangement



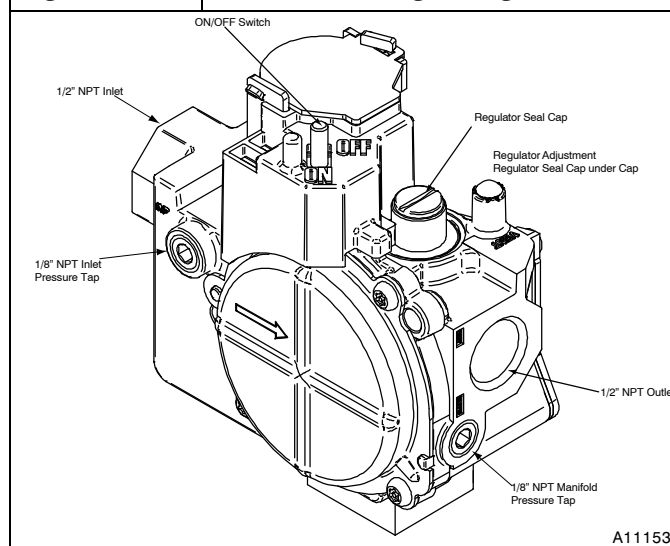
A 1/8-in. (3 mm) NPT plugged tapping, accessible for test gauge connection, **MUST** be installed immediately upstream of gas supply connection to furnace and downstream of manual equipment shutoff valve.

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. 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 34**)

Figure 34

Gas Valve - Single Stage



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

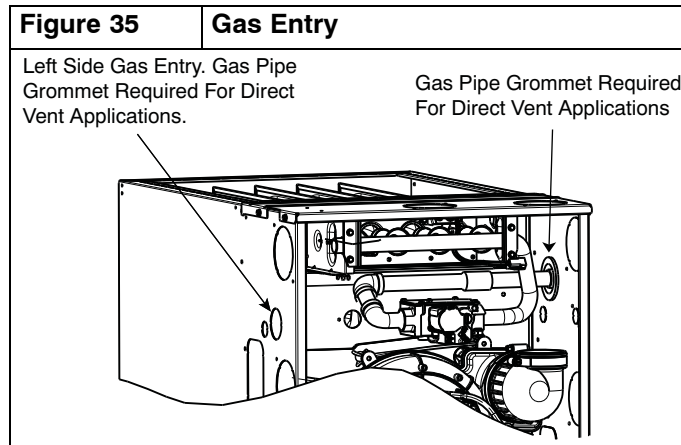
lines and check for leakage at furnace prior to operating furnace.

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 35**)

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 35**)



ELECTRICAL CONNECTIONS

⚠ WARNING

ELECTRICAL SHOCK, FIRE OR EXPLOSION HAZARD

Failure to follow safety warnings could result in dangerous operation, serious injury, death or property damage.

Improper servicing could result in dangerous operation, serious injury, death or property damage.

- Before servicing, disconnect all electrical power to furnace.
- When servicing controls, label all wires prior to disconnecting. Reconnect wires correctly.
- Verify proper operation after servicing.

⚠ WARNING

ELECTRICAL SHOCK HAZARD

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

Blower door switch opens 220-V power to control. No component operation can occur. Do not bypass or close switch with blower door removed.

See **Figure 36** for field wiring diagram showing typical field 220-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 NFPA 70-2011 or local codes to minimize personal injury if an electrical fault should occur. 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.



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.

220-V Wiring

Furnace must have a 220-v power supply properly connected and grounded.

NOTE: Proper polarity must be maintained for 220-v wiring. If polarity is incorrect, control status indicator light flashes code 10 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 11** for equipment electrical specifications.

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

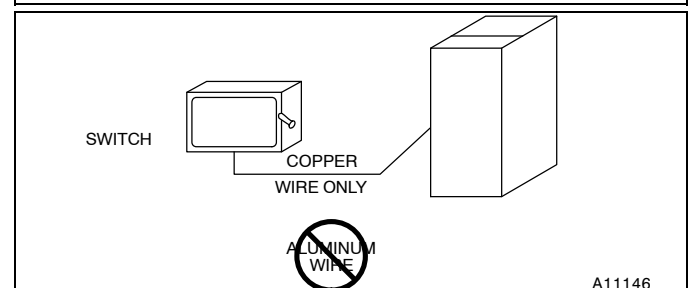


WARNING

FIRE HAZARD

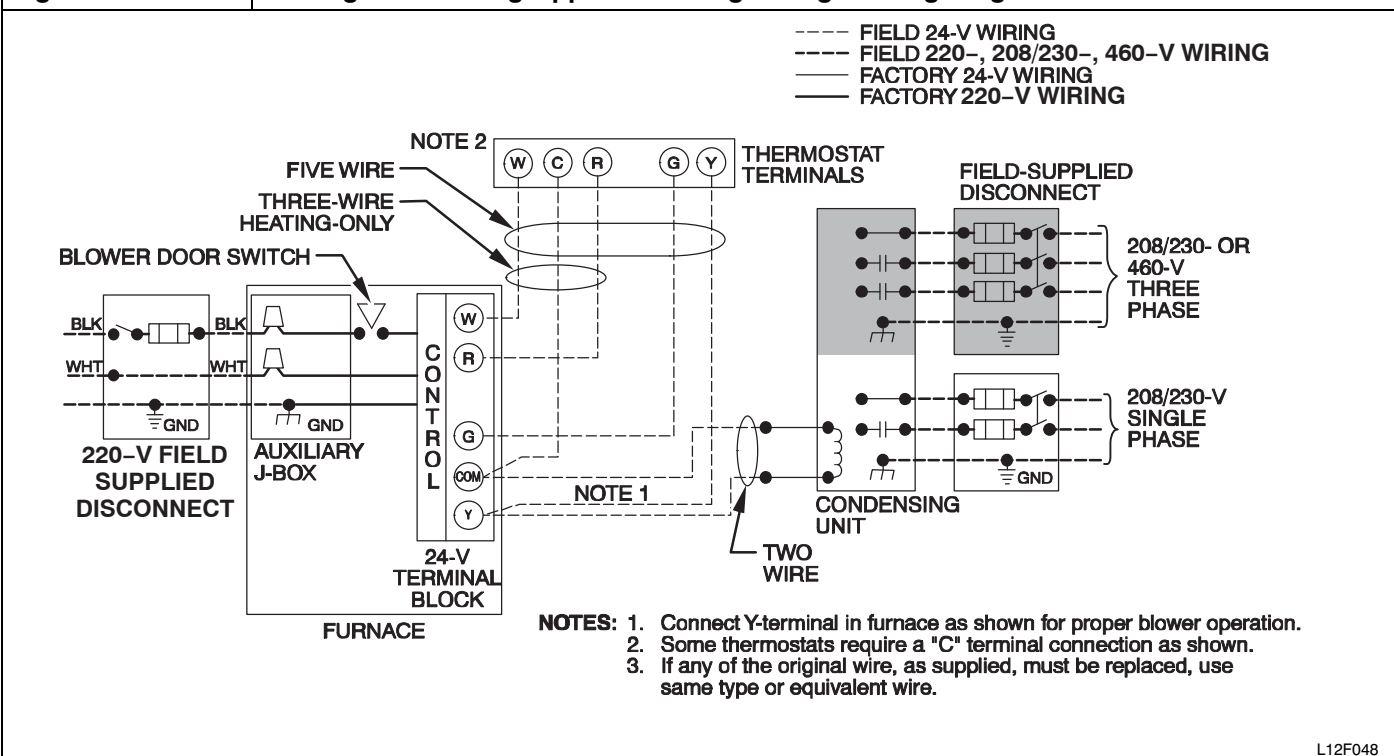
Failure to follow this warning could result in personal injury, death, or property damage.

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



Use a separate, fused branch electrical circuit with a properly sized fuse or circuit breaker for this furnace. See **Table 11** for wire size and fuse specifications. A readily accessible means of electrical disconnect must be located within sight of the furnace.

Figure 36 Heating and Cooling Application Single Stage Wiring Diagram



J-Box Installation



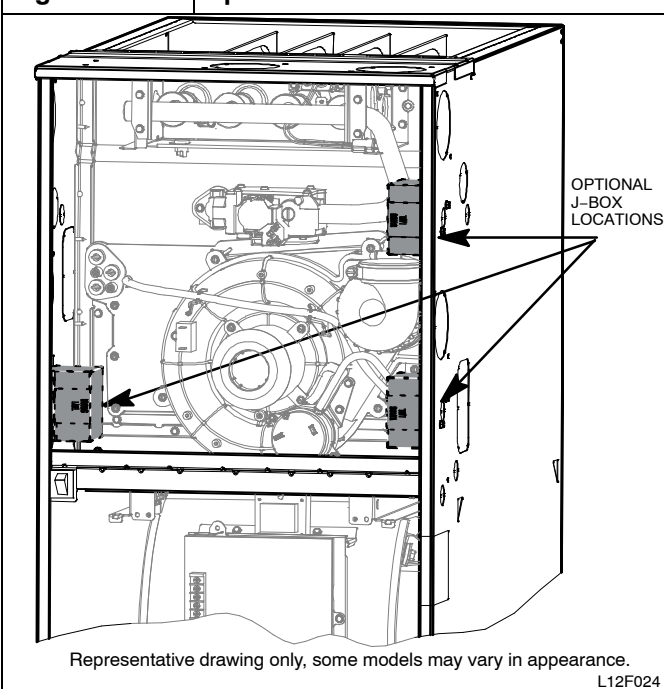
WARNING

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.

Figure 37 Optional J-Box Locations



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 37**)

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.

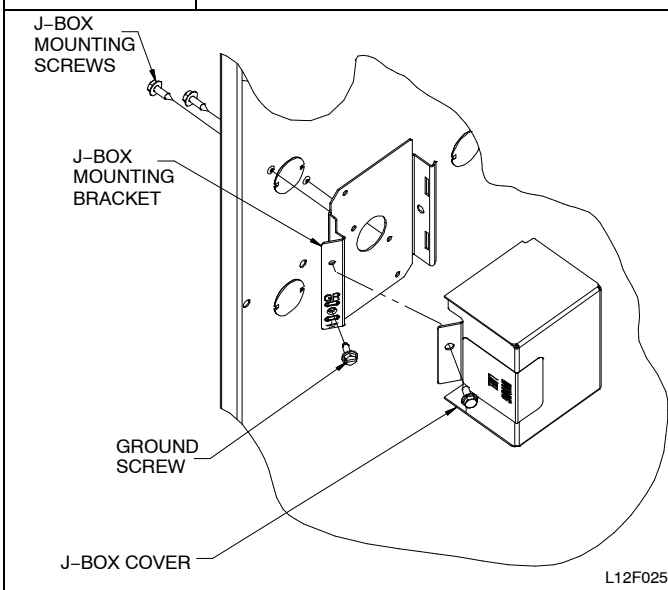
Align the J-Box mounting bracket against the inside of the casing and secure the mounting bracket with the screws. (See **Figure 38**)

Electrical Box on Furnace Casing Side

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

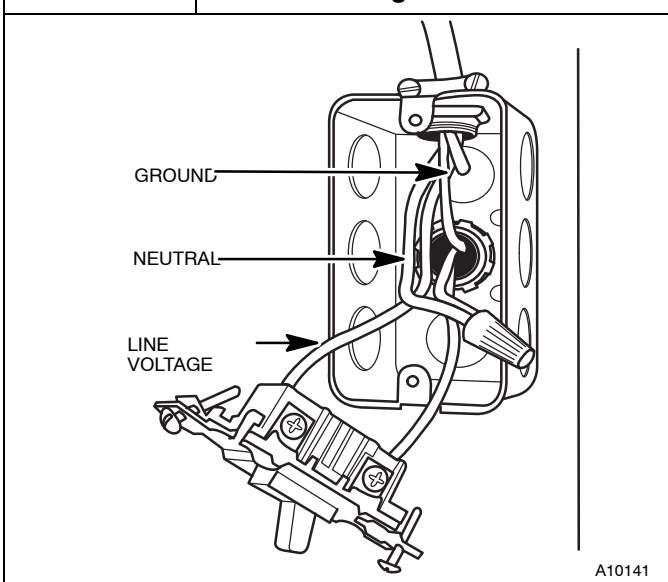
1. Fasten a field-supplied external electrical box to the outside of the casing by driving two field-supplied screws from inside electrical box into casing. (See **Figure 39**)
2. Route field power wiring into external electrical box.
3. Pull furnace power wires through 1/2-in. (12 mm) diameter hole 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 38**.

Figure 38 J-Box Bracket Installation



7. Connect field power and neutral leads to furnace power leads, as shown in **Figure 36**.
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 39**. Use best practices. (NEC in U.S.A. for wire bushings, strain relief, etc.)

Figure 39 Field-Supplied Electrical Box on Furnace Casing



Power Cord Installation in Furnace J-Box

NOTE: Power cords must be able to handle the electrical requirements listed in **Table 11**. Refer to power cord manufacturer's listings.

1. Install J-Box mounting bracket to inside of furnace casing. (See **Figure 38**)
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 38**.
6. Connect power cord power and neutral leads to furnace power leads as shown in **Figure 36**.
7. 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

1. Install J-Box mounting bracket to inside of furnace casing.
2. Route BX connector through 7/8-in. (22 mm) diameter hole in casing and J-Box bracket.
3. Secure BX cable to J-Box bracket with connectors approved for the type of cable used.
4. Connect field ground wire and factory ground wire to green ground screw on J-Box mounting bracket as shown in **Figure 38**.
5. Connect field power and neutral leads to furnace power leads, as shown in **Figure 36**.
6. Attach furnace J-Box cover to mounting bracket with screws supplied in loose parts bag. Do not pinch wires between cover and bracket.



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.

Do no drill into blower shelf of furnace to route control wiring. Route any control or accessory wiring to the blower compartment through external knockouts on the casing.

24-V Wiring

Make field 24-V connections at the 24-V terminal strip. (See **Figure 40**) Connect terminal Y as shown in **Figure 36** 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 **Figure 40**)

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

Accessories (See **Figure 41** and/or **Figure 40**)

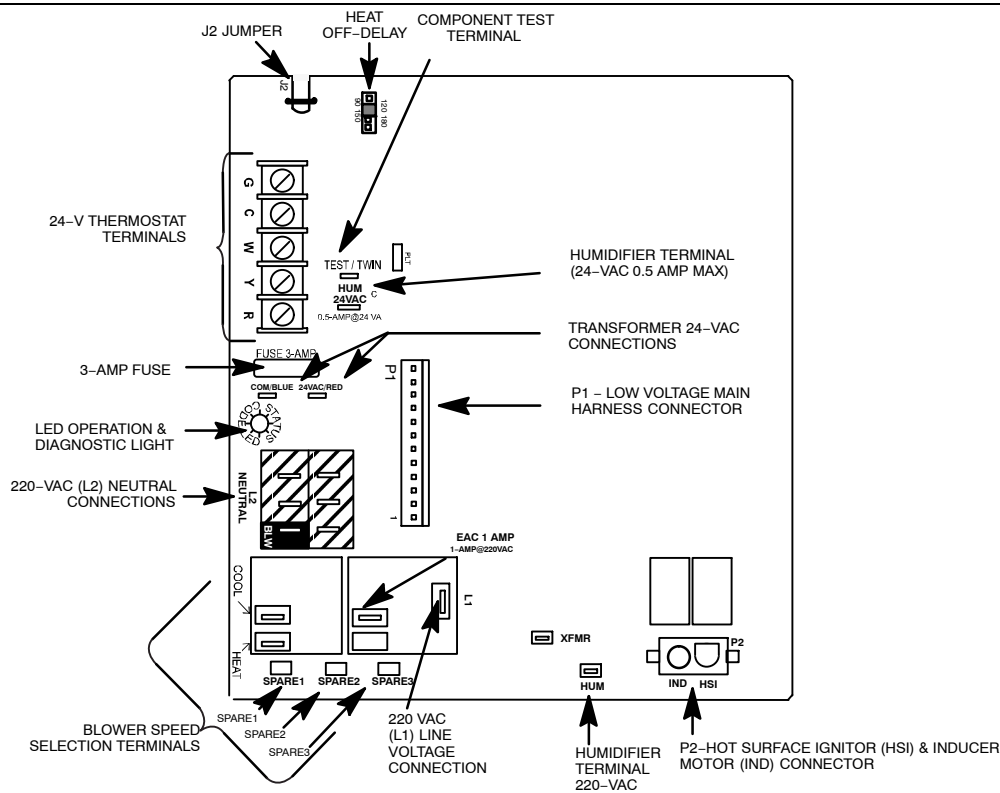
1. Electronic Air Cleaner (EAC):
Connect an accessory Electronic Air Cleaner (if used) using 1/4-in female quick connect terminals to the two male 1/4-in quick-connect terminals on the control board marked EAC and NEUTRAL. The terminals are rated for 220 VAC, 1.0 amps maximum and are energized during blower motor operation. (See **Figure 40**)
2. Humidifier (HUM 24VAC and HUM)
 - a. HUM 24VAC: Connect an accessory 24 VAC, 0.5 amp maximum humidifier (if used) to the 1/4-in male quick-connect HUM 24VAC terminal and C screw terminal on the control board thermostat strip. The HUM 24VAC terminal is energized when there is a call for heat (W) and the pressure switch (LPS) closes. (See **Figure 40**)
 - b. HUM: Connect an accessory 220VAC (EAC and HUM are 1 amp maximum combined) humidifier (if

used) to the ¼-inch male quick connect HUM terminal and NEUTRAL ¼-inch quick connect. The HUM terminal is energized when the inducer motor is energized (IDR). (See **Figure 40**)

NOTE: A field-supplied, 220-V controlled relay connected to EAC terminals may be added if humidifier operation is desired during blower operation.

NOTE: DO NOT connect furnace control HUM 24VAC terminal to H (humidifier) terminal on humidity sensing thermostat, or similar device. See humidity sensing thermostat, thermostat, or controller manufacturer's instructions for proper connection.

Figure 40 Example of Single Stage Furnace Control for PSC Blower Motor



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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 11** 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.

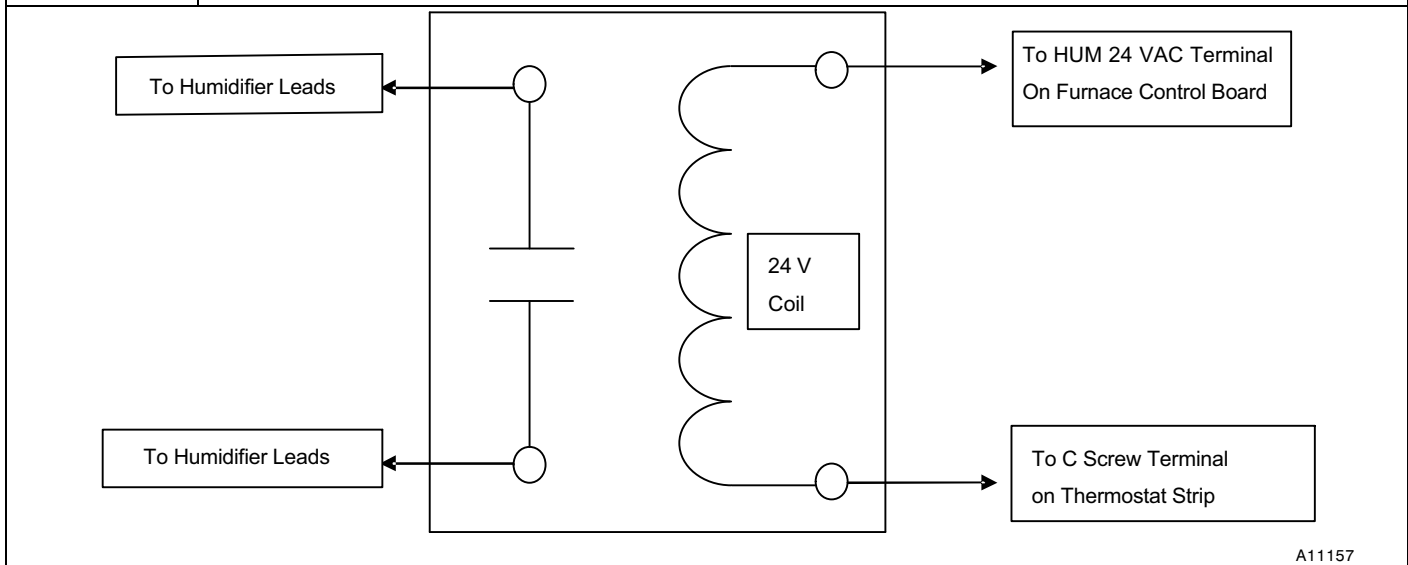
Table 11		Electrical Data							
F9MES SINGLE-STAGE, PSC BLOWER FURNACES									
UNIT SIZE	VOLTS-HERTZ-PHASE	OPERATING VOLTAGE RANGE*		MAXIMUM UNIT AMPS	UNIT AMPACITY#	MINIMUM WIRE SIZE AWG	MAXIMUM WIRE LENGTH FT (M)‡		MAXIMUM FUSE OR CKT BKR AMPS†
		Maximum*	Minimum*						
1002120	220-50-1	242	198	7.66	10.47	14	35	10.7	15
1202420	220-50-1	242	198	7.66	10.47	14	35	10.7	15
1402420	220-50-1	242	198	7.66	10.47	14	35	10.7	15

* 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 41 Isolation Relay for Humidifiers with Internal Power Supply

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VENTING

NOTE: Planning for the venting system should be done in conjunction with planning for the ductwork, drainage, and furnace accessories, such as air cleaners and humidifiers. Begin assembling the venting system **AFTER** the furnace is set in place in the required orientation.

Venting for this furnace shall follow all Local codes for category IV venting systems.

NOTE: THESE INSTRUCTIONS **DO NOT** CONTAIN DETAILED INSTALLATION INSTRUCTIONS FOR POLYPROPYLENE VENTING SYSTEMS. Refer to the polypropylene venting system manufacturer's installation instructions for the polypropylene venting system installation.

NOTE: When using polypropylene venting systems, all venting materials used, including the vent terminations, must be from the same manufacturer.



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, ANSI Z223.1/NFPA 54 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, ANSI Z223.1/NFPA 54.
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.

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 49** for Direct Vent (2-Pipe) system, or **Figure 50** for single-pipe or 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 direct-vent (two-pipe), ventilated combustion air, or non-direct (single-pipe) vent system. Each type of venting system is described below. Common venting between these furnaces or other appliances is 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 13** for approved materials for use in the U.S.A.

Venting Systems



WARNING

CARBON MONOXIDE POISONING HAZARD

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

For all venting configurations for this appliance and other gas appliances placed into operation for the structure, 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 1-2012, Air for Combustion and Ventilation and applicable provisions of the local building codes.

NOTICE

RECOMMENDED SUPPORT FOR VENT TERMINATIONS

It is recommended that sidewall vent terminations of over 24 inches (0.6 M) in length or rooftop vent terminations of over 36 inches (1 M) in length be supported by EITHER the factory accessory vent termination kit or field-supplied brackets or supports attached to the structure. A factory accessory vent termination kit may be used for direct vent terminations. Termination kits are available for 2-in. or 3-in. pipe. See **Table 12** for available options.

Table 12	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)
2-in (51 mm) Termination Bracket Kit	2-Pipe Termination System	1, 1-1/2, 2, or 2-1/2 (25, 38, 51, 64 mm)
3-in (76 mm) Termination Bracket Kit	2-Pipe Termination System	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 (preferred) or a sidewall. See **Figure 62** for references to clearances required by National code authorities.

NOTICE

OPTIONAL CONFIGURATION FOR COMBUSTION AIR INLET PIPE

In applications where there is a risk of excessive moisture entering the combustion air inlet pipe, a moisture trap may be added to the inlet pipe to help prevent moisture from entering the furnace from the combustion air inlet pipe. See **Figure 52**.

When sizing venting systems, the equivalent length of the optional inlet pipe moisture trap must be taken into account.

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 references to clearances required by National code authorities.

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:

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. See **Figure 63** for references to clearances required by National code authorities.

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. (50 mm Nominal Dimension– ND) tight radius 90 degree elbow is required to be attached to the combustion air pipe adapter on the furnace. (See **Figure 59**) This short inlet air pipe helps to ensure stable combustion, as well as allow for sound attenuation. To aid sound attenuation, point the inlet air pipe away from occupants. An extra elbow and/or five feet (1.5 M) of pipe may be used to accomplish the sound attenuation function.

NOTICE

OPTIONAL VENTING BELOW THE FURNACE

The venting system may be positioned below the furnace ONLY IF the factory accessory External Vent Trap Kit is used. The External Vent Trap Kit is only approved for PVC/ABS DWV venting systems.

CAREFULLY FOLLOW THE INSTRUCTIONS PROVIDED WITH THE EXTERNAL VENT TRAP KIT FOR LAYING OUT THE VENTING SYSTEM AND THE DRAIN SYSTEM. The instructions included with this furnace DO NOT APPLY to vent systems that are located below the furnace



WARNING

CARBON MONOXIDE POISONING HAZARD

Failure to follow the instructions outlined in Locating the Vent Termination for each appliance being placed into operation could result in carbon monoxide poisoning or death.

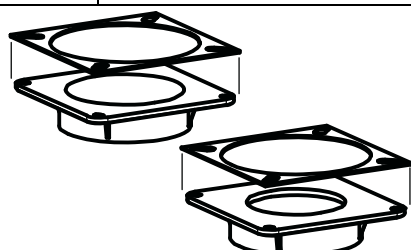
The instructions included with this furnace DO NOT APPLY to vent systems that are located below the furnace. **CAREFULLY FOLLOW THE INSTRUCTIONS PROVIDED WITH THE EXTERNAL VENT TRAP KIT FOR LAYING OUT THE VENTING SYSTEM AND THE DRAIN SYSTEM** when all or part of the venting system is placed below the furnace.

Proper configuration of the venting and drain system is critical when placing all or part of the venting system below the level of the furnace. **VENT GASSES COULD BE RELEASED FROM THE DRAINAGE SYSTEM**, if the instructions provided with the External Vent Trap Kit are not followed.

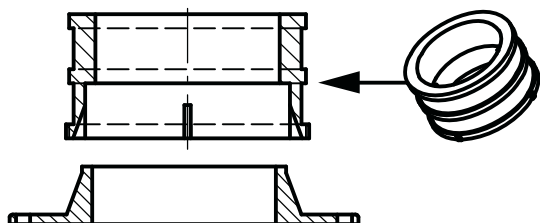
Table 13		Approved Combustion-Air and Vent Pipe, Fitting and Cement Materials (U.S.A. Installation)			
ASTM SPECIFICATION (MARKED ON MATERIAL)	MATERIAL	PIPE	FITTINGS	SOLVENT CEMENT AND PRIMERS	DESCRIPTION
D1527	ABS	Pipe	–	–	Schedule–40
D1785	PVC	Pipe	–	–	Schedule–40
D2235	For ABS	–	–	Solvent Cement	For 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 42

Vent Coupling and Adapter with Gaskets



Attach gaskets to vent pipe and combustion air adapters



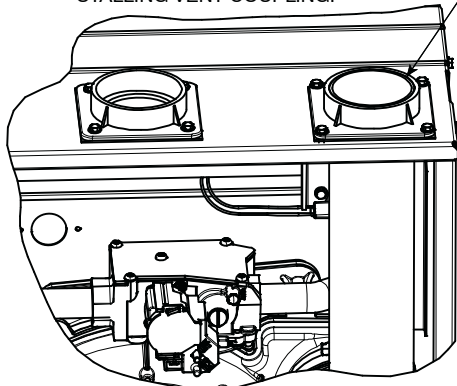
Vent Coupling and Adapter

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Figure 43

Vent Pipe Flush with Adaptor

VENT PIPE ADAPTER WITH GASKET INSTALLED ON FURNACE. VENT PIPE IS CUT FLUSH WITH TOP OF ADAPTER. PRIME AND CEMENT VENT PIPE TO ADAPTER. ALLOW TO DRY BEFORE INSTALLING VENT COUPLING.

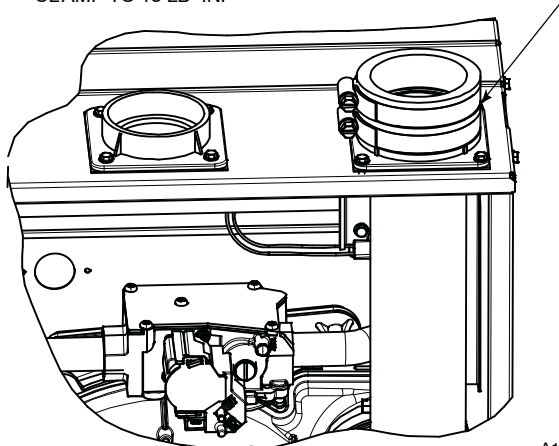


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Figure 44

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.



A13076B

Locating the Vent Termination

General

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

For vent termination clearance, references to National codes are shown in **Figure 62** for Direct Vent/2-Pipe system and **Figure 63** for Ventilated Combustion Air/Non-direct Vent/1-Pipe system. For exterior termination arrangements, refer to **Figure 62** for Direct Vent/2-Pipe system and **Figure 63** for Ventilated Combustion Air/Non-Direct/1-Pipe system. Contact Local code authorities for other requirements to and/or exemptions from the National codes shown in the figures.

Roof termination is the recommended termination location. Roof terminations provide better performance against sustained prevailing winds. The roof location is preferred since the vent and combustion air system is less susceptible to damage or contamination. The termination is usually located away from adjacent structures or other obstacles such as inside corners, windows, doors or other appliances. It is less prone to icing conditions, and it often has less visible vent vapors.

Sidewall terminations may require sealing or shielding of building surfaces with a corrosive resistance material due to the corrosive properties of combustion products from the vent system, as well as protection of adjacent structures.

NOTICE

RECOMMENDED SUPPORT FOR VENT TERMINATIONS

It is recommended that side-wall vent terminations in excess of 24 inches (0.6 M) or rooftop terminations in excess of 36 inches (1.0 M) in vertical length be supported by EITHER the Direct Vent Termination Kit shown in **Table 12** or by field-supplied brackets or supports fastened to the structure.

NOTE: (Direct Vent/2-Pipe system ONLY) Terminate with the standard termination as shown in **Figure 62** or use a factory-approved accessory termination kit.

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, air conditioning equipment or utility meters.
3. Do not locate termination directly into prevailing winds. Termination should be positioned so that it will not be affected by sustained prevailing winds over 30 mph, wind eddy, such as inside building corners, or 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.

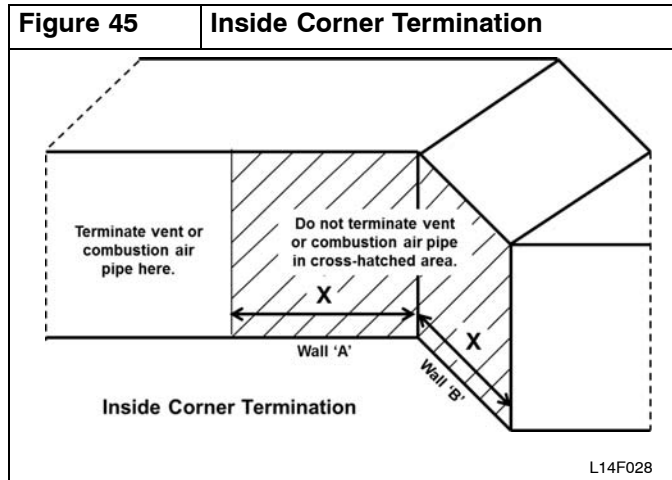
INSIDE CORNER TERMINATIONS

Corner terminations for Direct Vent (2-pipe) terminations are permitted provided that:

1. The Direct Vent termination is located on the longer of the two walls.
2. The Direct Vent termination is located at a distance farther away from the inside corner than the length of the adjacent wall
3. All other clearance requirements are met

Example:

1. The length of wall "A" is 15-ft and the length of wall "B" is 6-ft.
2. Therefore, the Direct Vent termination must be located on wall "A".
3. The Direct Vent termination must be located at least 6-ft. away from the inside corner.



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. See **Figure 62** for references to vent clearances required by National code authorities. Allowable vent and combustion air terminations are shown in **Figure 49**.



WARNING

CARBON MONOXIDE POISONING HAZARD

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

For all venting configurations for this appliance and other gas appliances placed into operation for the structure, 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 1-2012, Air for Combustion and Ventilation and applicable provisions of the local building codes.

Ventilated Combustion Air

The vent pipe for a Ventilated Combustion Air System must terminate outdoors. See **Figure 62** for references to vent clearances required by National code authorities. Allowable vent terminations are shown in **Figure 50**. 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. See **Figure 63** for references to vent clearances required by National code authorities. Allowable vent terminations are shown in **Figure 50**.

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. See **Figure 46** and **Figure 48**. This short inlet air pipe helps to ensure inlet air pipe away from occupants. An extra elbow and/or five feet (1.5 M) of pipe may be used to accomplish the sound attenuation function.

Figure 46 Tee at Termination Outlet

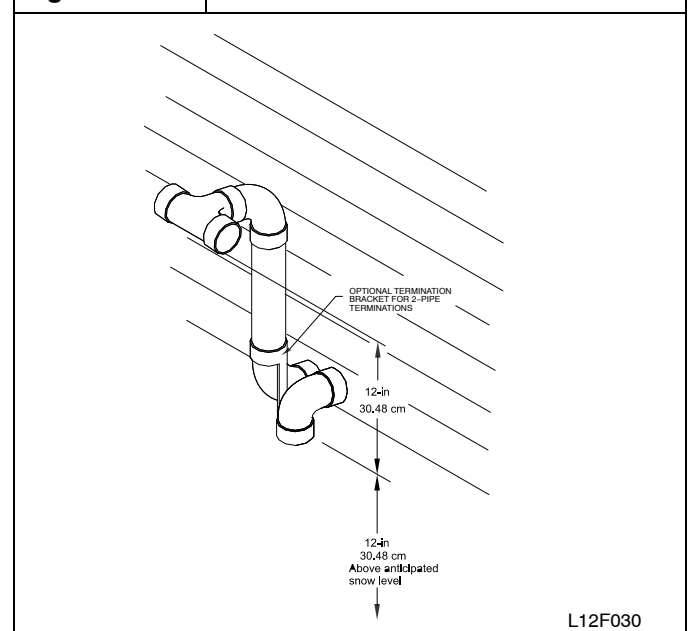
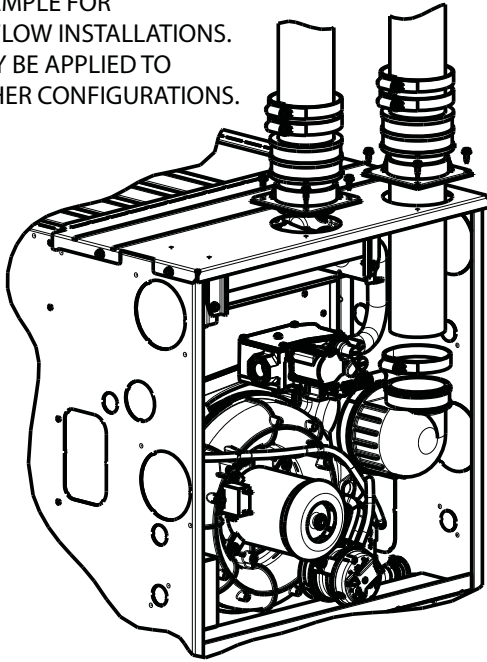


Figure 47

**Sample Inlet Air Pipe Connection
for Polypropylene Venting Systems**

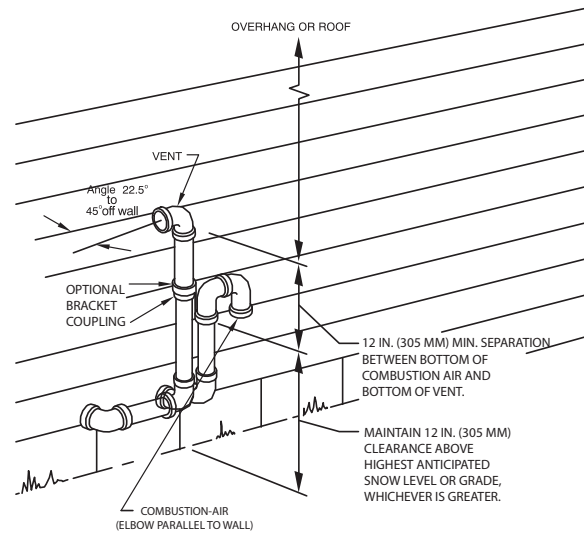
EXAMPLE FOR
UPFLOW INSTALLATIONS.
MAY BE APPLIED TO
OTHER CONFIGURATIONS.



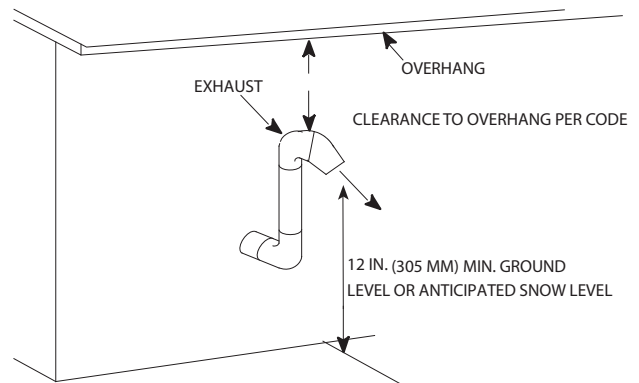
A12220

Figure 48

Vent Terminations



A13078B



A13078C

Figure 49

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

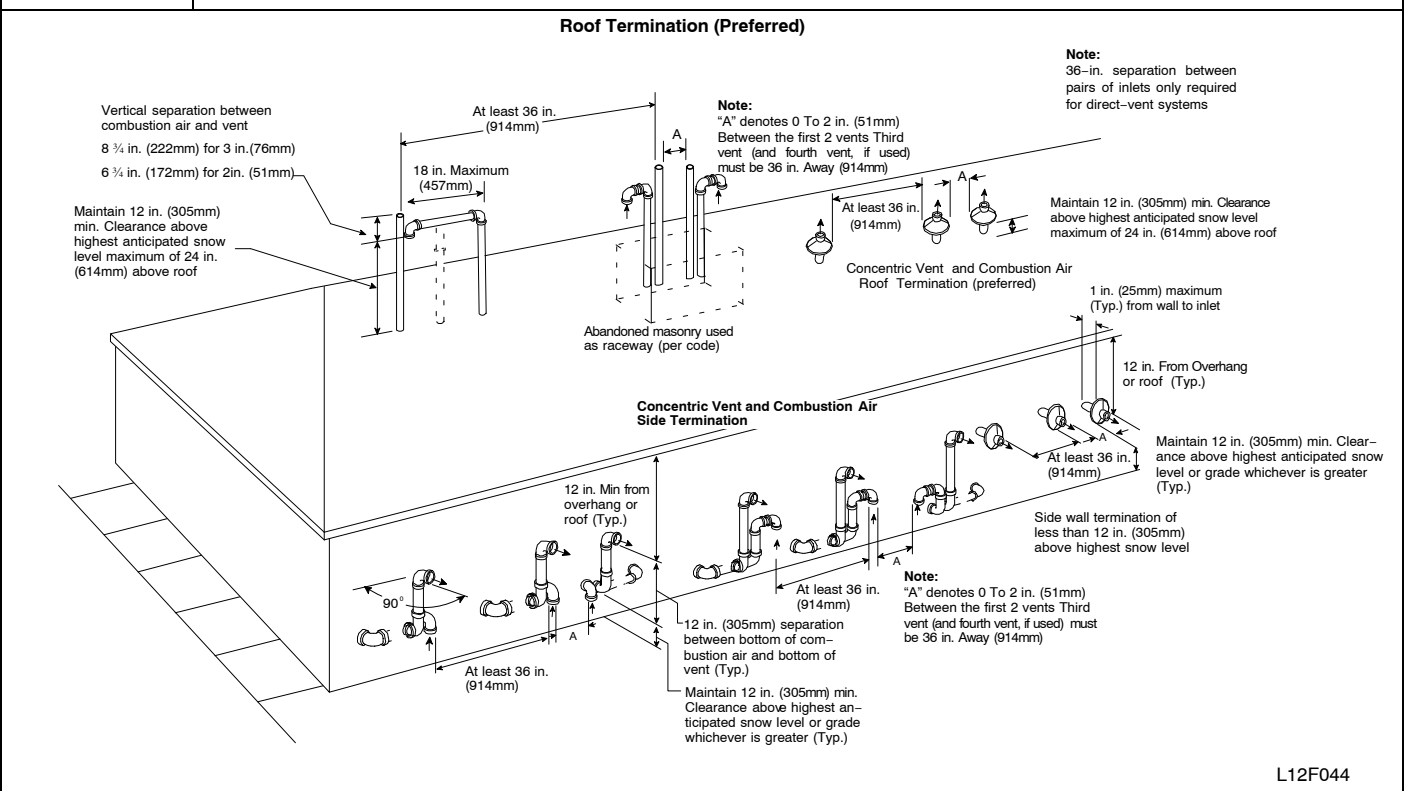
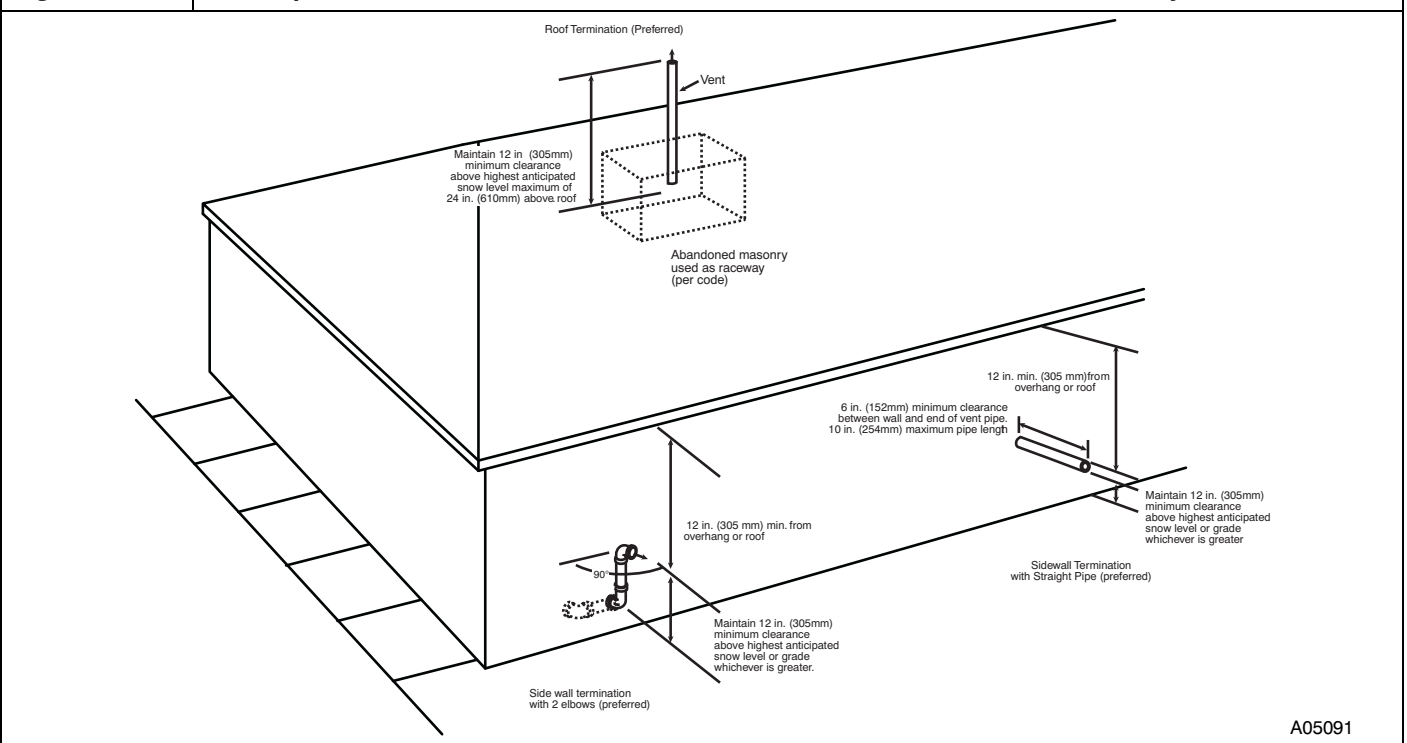


Figure 50

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



Size the Vent and Combustion Air Pipes

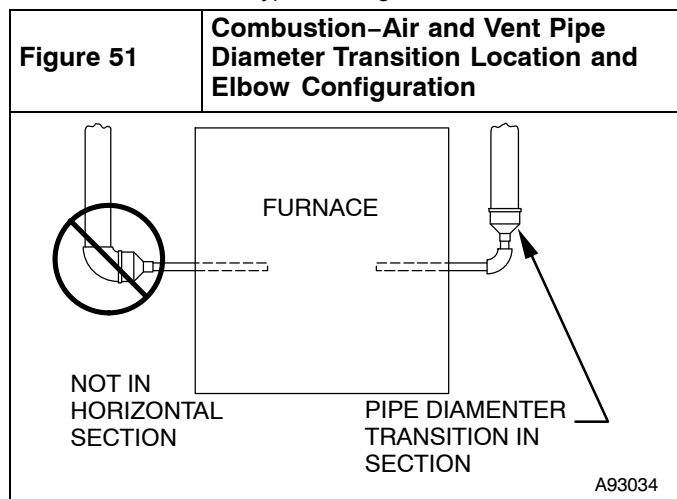
General

Vent or Combustion Air Pipe Diameters	Approved 2-pipe termination fittings		
	2-in.	3-in.	4-in.
1 1/2-in.	X	N/A	N/A
2-in.	X	N/A	N/A
2 1/2-in.	N/A	X	N/A
3-in.	N/A	X	N/A
4-in.	N/A	X	X

Note: Optional accessory 2-pipe termination brackets are sized for 2-in. and 3-in. Pipe. If a termination bracket is required for a 4-in. termination, field fabricate the necessary brackets and clamps.

Furnace combustion air and vent pipe connections are sized for 2-in. (50 mm ND) PVC/ABS DWV pipe. The combustion air and vent pipe connections also accommodate 60mm polypropylene venting systems with outside diameters of approximately 60 mm (2-3/8 inches). 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. See **Figure 51**.

The Maximum Vent Length for the vent pipe and combustion air pipe (when used) equals the Maximum Equivalent Vent Length (MEVL) in **Table 14**, minus the number of fittings multiplied by the deduction for each type of fitting used from **Table 15**.



NOTICE

OPTIONAL CONFIGURATION FOR COMBUSTION AIR INLET PIPE

In applications where there is a risk of excessive moisture entering the combustion air inlet pipe, a moisture trap may be added to the inlet pipe to help prevent moisture from entering the furnace from the combustion air inlet pipe. See **Figure 52**.

When sizing venting systems, the equivalent length of the optional moisture trap (15 feet/5 M) must be taken into account

Combustion Air Inlet Moisture Trap

To prevent moisture from trickling into the furnace vestibule, a trap can be installed in the intake air pipe near the furnace. Connecting a drain line to the trap is recommended as trace amounts of moisture will evaporate into the intake air stream. If the combustion air inlet is located near a moisture exhaust duct, or there are other concerns of excessive moisture being drawn into the combustion air inlet, it is encouraged to connect a drain line to the trap.

The trap can be constructed from a running tee of the same diameter of the intake air pipe with EITHER a removable cap attached to a 6-inch long pipe connected to the tee or the External vent Trap Kit to help prevent contaminants from entering the furnace. See **Figure 52**.

The External Vent Trap Kit accessory may be used as a trap for the combustion air inlet pipe if a large amount of moisture must be removed. The drain line may be connected to the same drain as the furnace condensate and the evaporator coil condensate line ONLY if the inlet air trap drain and the evaporator coil drain empty into an open segment of pipe above the drain. See **Figure 13**. When using the External Vent Trap Kit, refer to those instructions for proper drain connections.

The tee may also be connected to the intake air pipe on the side of the casing. See **Figure 52**.

In any configuration, it will be necessary to add the equivalent length of the tee (15 feet/5 M) to the Total Equivalent Vent Length of the venting system.

NOTICE

ADDITIONAL INFORMATION FOR POLYPROPYLENE VENTING SYSTEMS

Polypropylene venting systems include flexible vent pipe. These flexible vent pipes have a different equivalent vent length than straight sections of PVC/ABS DWV vent pipe. Be sure to make the appropriate deductions from the Maximum Equivalent Vent Length (MEVL), or additions to the Total Equivalent Vent Length (TEVL), when applying flexible vent pipes in polypropylene venting systems. See the polypropylene vent system manufacturer's installation instructions for details.

When using metric-sized venting systems, use these equivalencies for obtaining the proper MEVL from the Tables:

- Use 2" Vent Tables for 60mm (o.d.) vent systems
- Use 3" Vent Tables for 80mm (o.d.) vent systems
- Use 4" Vent Tables for 100mm (o.d.) vent systems

The measured length of pipe used in a single or 2-pipe termination is included in the total vent length. Include deductions from the Maximum Equivalent Vent Length (MEVL) contained in the Venting Tables for elbows and flexible vent pipe. Factory accessory concentric vent terminations, or pipe lengths and elbows used for "standard" vent terminations (see vent termination figures associated with **Table 14**) do not require a deduction from the Maximum Equivalent Vent Length.

NOTE: Polypropylene venting systems MAY require additional deductions from the MEVL, or additions to the TEVL, for vent terminations and flexible pipe sections. See the polypropylene venting system manufacturer's instructions for details on equivalent lengths of vent terminations and flexible vent pipes, and for calculating total vent lengths.

To calculate the Total Equivalent Vent Length (TEVL) of the venting system:

1. Measure the individual distance from the furnace to the termination for each pipe.
2. Count the number of elbows for each pipe.
3. 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.
4. If a Tee is used on the termination, record the equivalent length of the Tee used.
5. Calculate Total Equivalent Vent Length by adding the equivalent lengths of the fittings to the lengths of the individual vent and combustion air pipes.
6. When using polypropylene venting systems with flexible vent pipes, perform adjustments for the equivalent length of the flexible vent pipe to the calculated total equivalent venting system length. See the polypropylene vent system manufacturer's instructions for details.
7. Select a diameter of vent pipe from **Table 14** and note the Maximum Equivalent Vent Length (MEVL) shown for that application for that specific furnace input size. Compare the Total Equivalent Vent Length (TEVL) to the MEVL:
 - a. If the Total Equivalent Vent Length is **shorter** than the Maximum Equivalent Vent Length for the diameter of

pipe chosen, then that diameter of pipe selected may be used.

- b. If the Total Vent Length is **longer** than the Maximum Equivalent Vent Length for the diameter of pipe chosen, that diameter pipe MAY NOT be used for venting the furnace. Try the next larger diameter pipe.

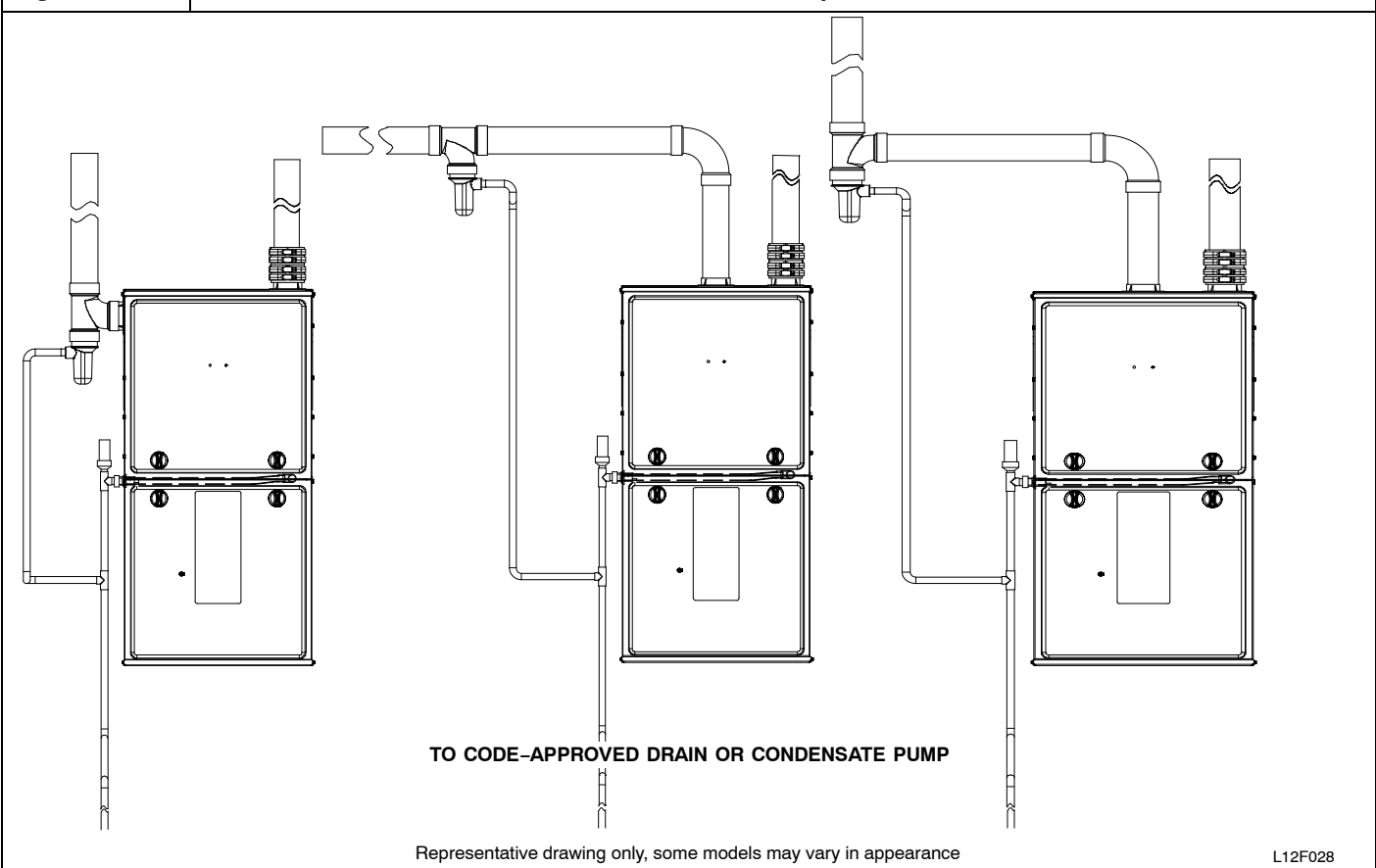
NOTE: If the calculated Total Equivalent Vent Lengths results in different diameter pipes for the vent and combustion air, select the larger diameter for both pipes.

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 fittings and terminations (TEVL), recalculate Total Equivalent Vent Length using the next smaller diameter. If the Maximum Vent Length is still longer than the longer TEVL of the vent pipe or combustion air pipe, then that diameter of pipe selected may be used.

When installing vent systems with pipe lengths of 10 ft. (3.0 M), use the smallest allowable pipe diameter. Using pipe size greater than required for short venting systems may result in loss of efficiency, incomplete combustion, flame disturbance, or flame sense lockout.

For vent systems longer than 10 ft. (3.0 M), any larger diameter shown in **Table 14** for that size model may be used.

Figure 52 Recommended Combustion Air Inlet Moisture Trap



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 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 16**) cannot exceed total allowable pipe length as calculated from **Table 14**.

Configure the Furnace



WARNING

CARBON MONOXIDE POISONING HAZARD

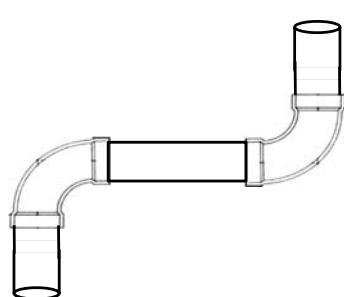
Failure to follow this warning could result in personal injury or death.

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.

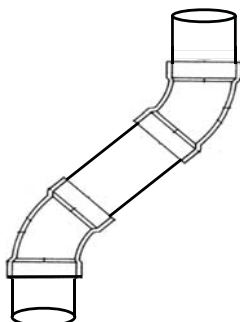
Near Furnace Vent Connections

Offsets in the vertical portion of the vent pipe should be made with 45 degree elbows instead of 90 degree elbows. Short horizontal runs of vent pipe are difficult to pitch correctly and may trap water in the vent pipe. Trapped water in the vent pipe may result in nuisance pressure switch tripping.

Figure 53 Near Furnace Vent Connections

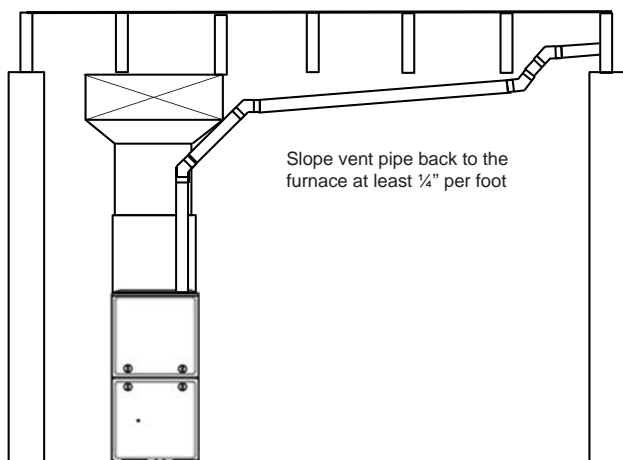


Avoid short horizontal offsets with 90 deg. Elbows. Short offsets can be difficult to slope and may trap condensate.



Use 45 deg. Elbows where possible, to ensure condensate drainage.

L14F020A



Slope vent pipe back to the furnace at least 1/4" per foot

L14F020B

Install the Vent and Combustion Air Pipes

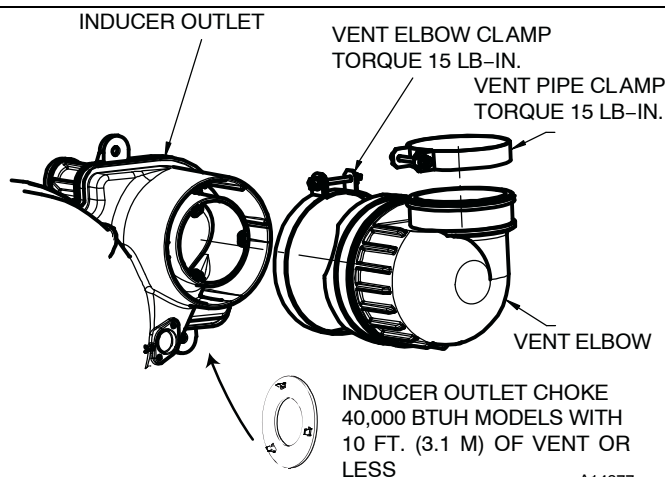
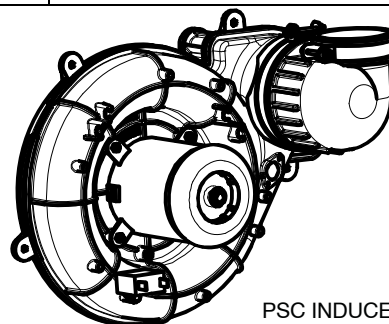
With the furnace installed in the required position, remove the desired knockouts from the casing. It will be necessary to remove one knockout for the vent pipe and the other knockout for the combustion air connection. (See **Figure 12**)

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 54** to rotate the vent elbow:

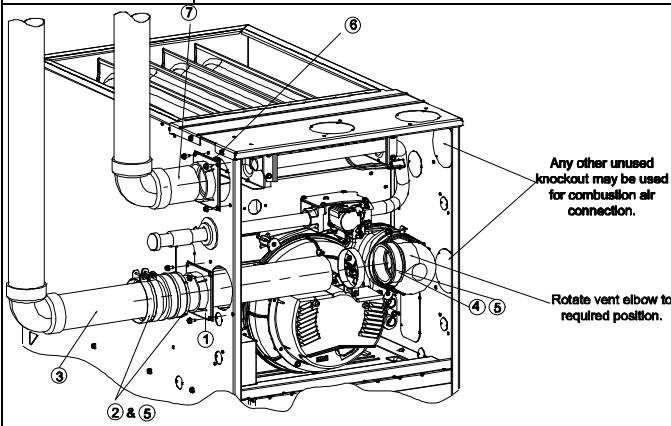
1. Loosen the clamp on the inlet of the vent elbow attached to the inducer.
2. Rotate the vent elbow to the required position. There are rounded notches in the vent elbow to align it with the inducer for each orientation.
3. Tighten the clamp around the vent elbow. Torque the clamp to 15 lb-in. See **Figure 55** through **Figure 58**.

Figure 54 Inducer Vent Elbow - PSC



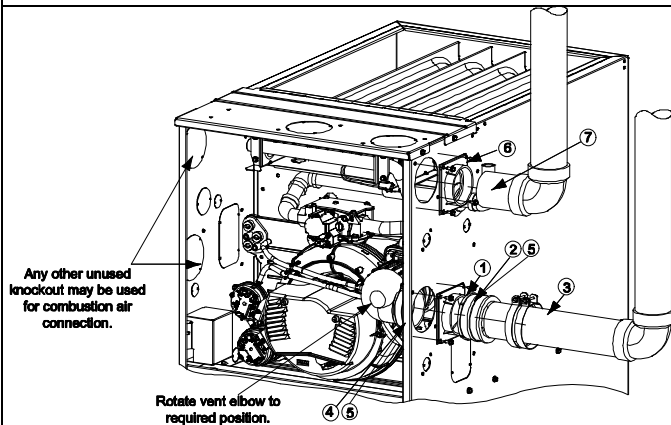
A14277

Figure 55 Upflow Configurations



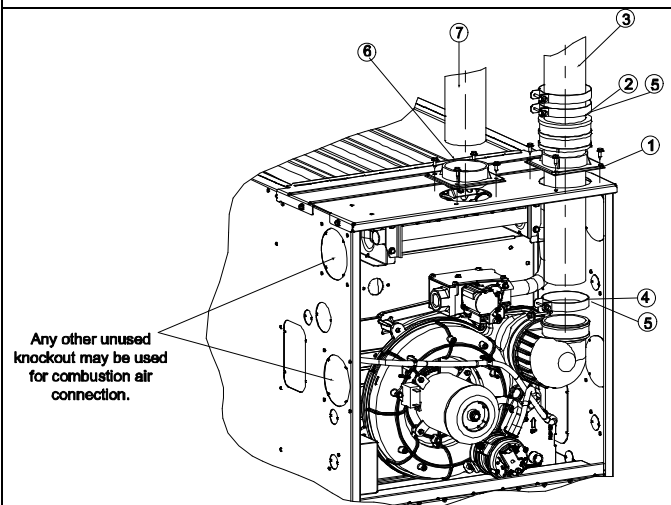
UPFLOW LEFT - VENT CONFIGURATION
Representative drawing only, some models may vary in appearance.

A11309



UPFLOW RIGHT - VENT CONFIGURATION
Representative drawing only, some models may vary in appearance.

A11308

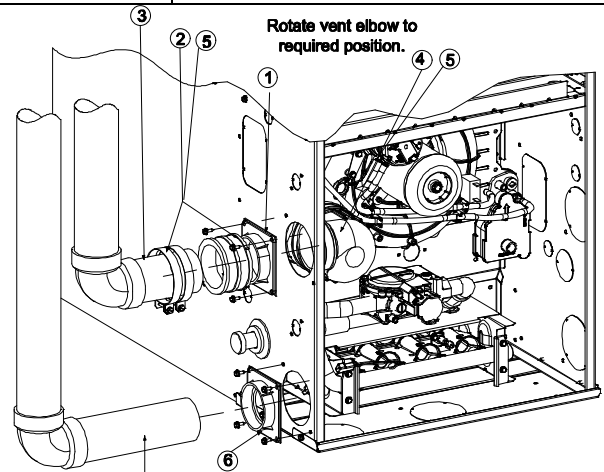


UPFLOW VERTICAL - VENT CONFIGURATION
Representative drawing only, some models may vary in appearance.

A11310

* See NOTES following figures.

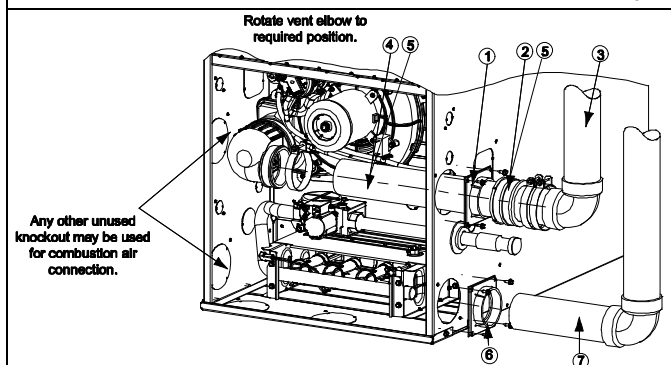
Figure 56 Downflow Configurations



DOWNFLOW LEFT - VENT CONFIGURATION

Representative drawing only, some models may vary in appearance.

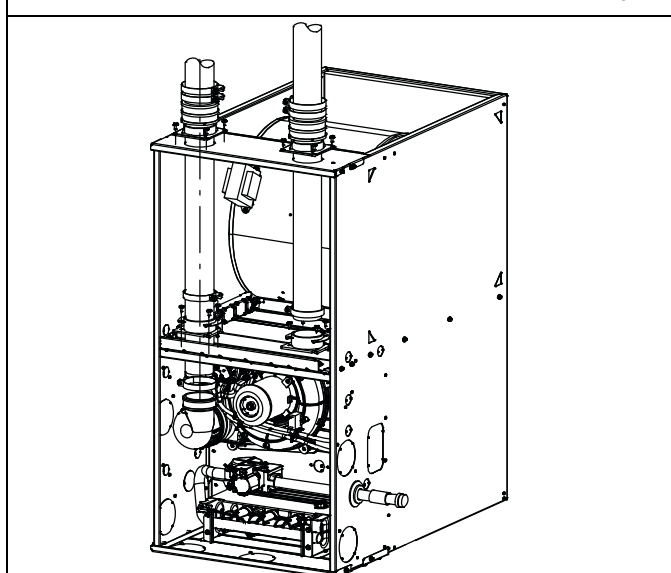
A11311



DOWNFLOW RIGHT - VENT CONFIGURATION

Representative drawing only, some models may vary in appearance.

A11312



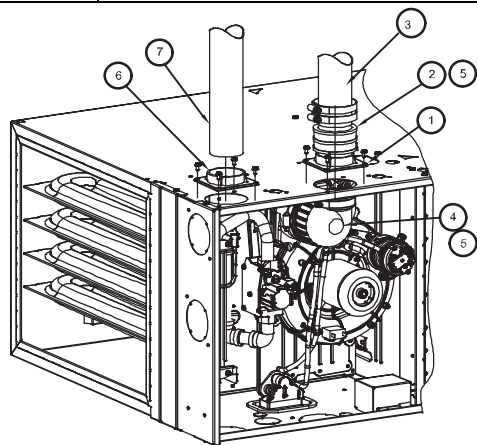
DOWNFLOW VERTICAL - VENT CONFIGURATION

Requires Accessory Internal Vent Kit
See Specification Sheets for current kit number
Representative drawing only, some models may vary in appearance.

L11F063

* See NOTES following figures.

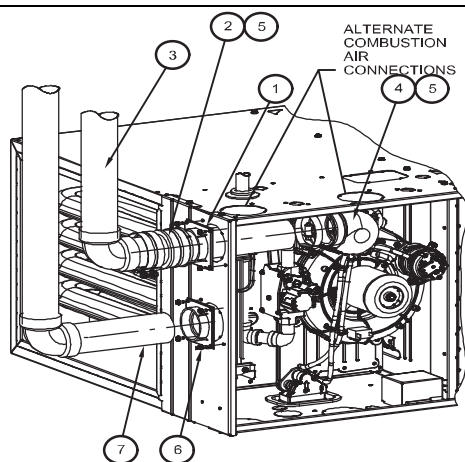
Figure 57 **Horizontal Left Configurations**



A11327

HORIZONTAL LEFT – VERTICAL VENT CONFIGURATION

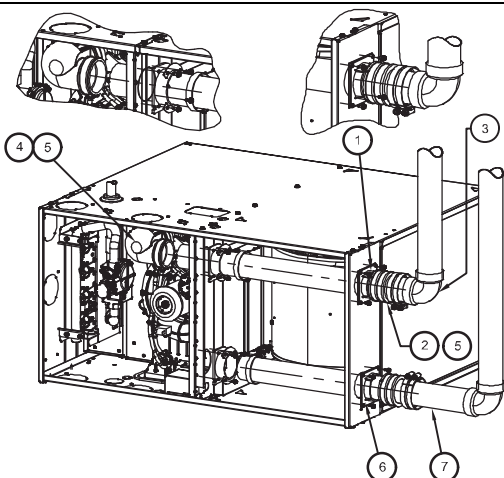
Representative drawing only, some models may vary in appearance.



A11328

HORIZONTAL LEFT – LEFT VENT CONFIGURATION

Representative drawing only, some models may vary in appearance.



A11329

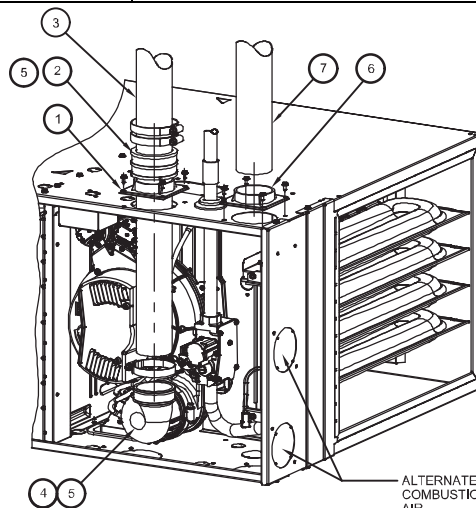
HORIZONTAL LEFT – RIGHT VENT CONFIGURATION*

* Requires accessory Internal Vent Kit

Representative drawing only, some models may vary in appearance.

* See NOTES following figures.

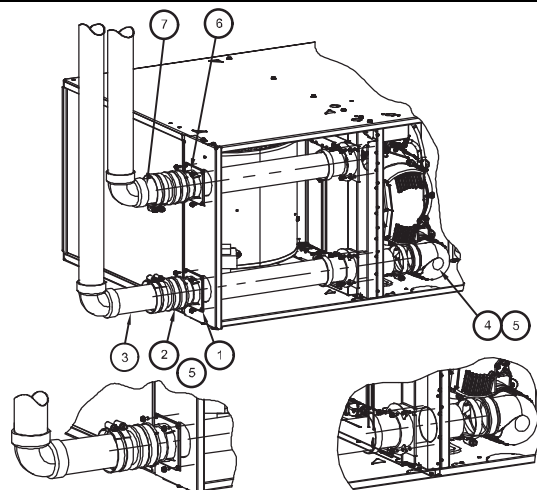
Figure 58 **Horizontal Right Configurations**



A11337

HORIZONTAL RIGHT – VERTICAL VENT CONFIGURATION

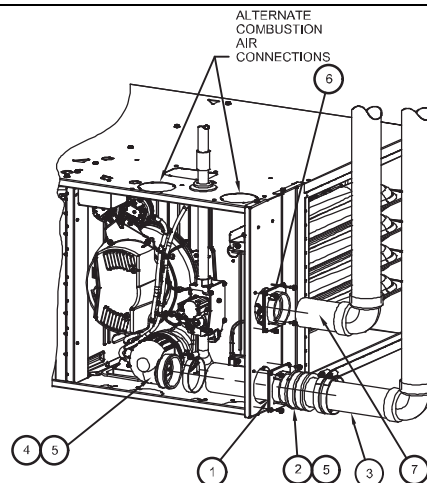
Representative drawing only, some models may vary in appearance.



A11336

HORIZONTAL RIGHT – LEFT VENT CONFIGURATION

Representative drawing only, some models may vary in appearance.



A11335

HORIZONTAL RIGHT – RIGHT VENT CONFIGURATION

Representative drawing only, some models may vary in appearance.

* See NOTES following figures.

NOTES:

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.

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.



WARNING

CARBON MONOXIDE POISONING HAZARD

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

DO NOT use cement to join polypropylene venting systems. Follow the polypropylene venting system manufacturer's instructions for installing polypropylene venting systems.

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. If supplied, remove and discard round center "slug" from interior of gasket. See **Figure 42**.

NOTE: The vent pipe adapter can be distinguished from the inlet pipe adapter by the absence of an internal pipe-stopping ring. The vent pipe can pass through the vent pipe adapter; it cannot pass through the inlet 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.

NOTICE

The following instructions are for PVC/ABS DWV vent piping, only. **DO NOT USE THESE TECHNIQUES FOR POLYPROPYLENE VENT PIPING SYSTEMS.** See the polypropylene vent system manufacturer's instructions for installing polypropylene venting systems.

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. De-burr 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. **DO NOT DRILL INTO POLYPROPYLENE VENT PIPES.** Use an optional accessory vent coupling, if needed.
11. Seal around the combustion air pipe with silicone or foil tape. **SILICONE SEALERS MAY NOT BE APPROPRIATE FOR POLYPROPYLENE VENT SYSTEMS. SEE POLYPROPYLENE VENT SYSTEM MANUFACTURER'S INSTRUCTIONS.**
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. **DO NOT CEMENT POLYPROPYLENE FITTINGS.**
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. Space combustion air piping and vent piping hangers as shown in the table below. Support pipes using perforated metal hanging strap or commercially available hangers or straps designed to support plastic pipe.

Hangar Spacing					
Material	Pipe Diameter				
	1 ½-in. (38-mm)	2-in. (51-mm)	2 ½-in. (64-mm)	3-in. (76-mm)	4-in. (102-mm)
PVC Sch 40	36-in. (914-mm)		42-in. (1067-mm)		48-in. (1219-mm)
CPVC	36-in. (914-mm)		42-in. (1067-mm)		48-in. (1219-mm)
ABS	36-in. (914-mm)		42-in. (1067-mm)		48-in. (1219-mm)
Polypropylene	40-in. (1000-mm)				
SDR 21 & 26	30-in. (762-mm)	36-in. (914-mm)			42-in. (1067-mm)



CAUTION

FURNACE RELIABILITY HAZARD

Failure to follow this caution may result in nuisance short cycling, frozen vent termination, and/or no heat.

Slope the vent and combustion air piping downward towards furnace at a minimum of 1/4-in. per linear ft. of pipe.

- Slope the vent and combustion air piping and downward towards furnace. A minimum slope of at least 1/4 in. per linear ft. (1 in. per 4 ft.) with no sags between hangers is required. See Caution Box below.
- 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 49** and **Figure 50**, **Figure 46** and **Figure 48**. For ventilated combustion air terminations, refer to **Figure 50**, **Figure 46** and **Figure 48**.
- Use appropriate methods to seal openings where combustion air pipe and vent pipe pass through roof or sidewall.



WARNING

CARBON MONOXIDE POISONING HAZARD

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

DO NOT use cement to join polypropylene venting systems. Follow the polypropylene venting system manufacturer's instructions for installing polypropylene venting systems.

Optional Installation of the Vent Pipe

NOTE: DO NOT USE THIS TECHNIQUE FOR POLYPROPYLENE VENTING SYSTEMS.

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 43** and **Figure 44**

- Insert a length of vent pipe through the casing into the outlet of the vent elbow.
- 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.
- Remove the pipe from the furnace and the adapter and cut off any excess pipe.
- 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.
- Re-insert the pipe through the casing into the vent elbow.
- Tighten the clamp around the outlet of the vent elbow. Torque the clamp to 15 lb-in.

- Apply cement to the end of the pipe and to the inside of the plastic vent adapter.
- Slide the adapter over the vent pipe and align the screw holes in the adapter with the dimples in the furnace casing.
- Pilot drill 1/8-in. screw holes for the adapter in the casing and secure the adapter to the furnace with sheet metal screws.
- Loosen the clamps on the rubber vent coupling.
- Slide the end of the coupling with notches in it over the standoffs in the vent pipe adapter.
- Tighten the clamp of the coupling over the vent pipe adapter. Torque the lower clamp around the vent pipe adapter to 15 lb-in.
- Pilot drill a 1/8-in. hole in the combustion air pipe adapter.
- Complete the vent and combustion air pipe as shown in "Install the Vent and Combustion Air Pipe"

NOTICE

FOR POLYPROPYLENE VENTING SYSTEMS

When using polypropylene venting systems, all venting materials used, including the vent terminations, must be from the same manufacturer.



WARNING

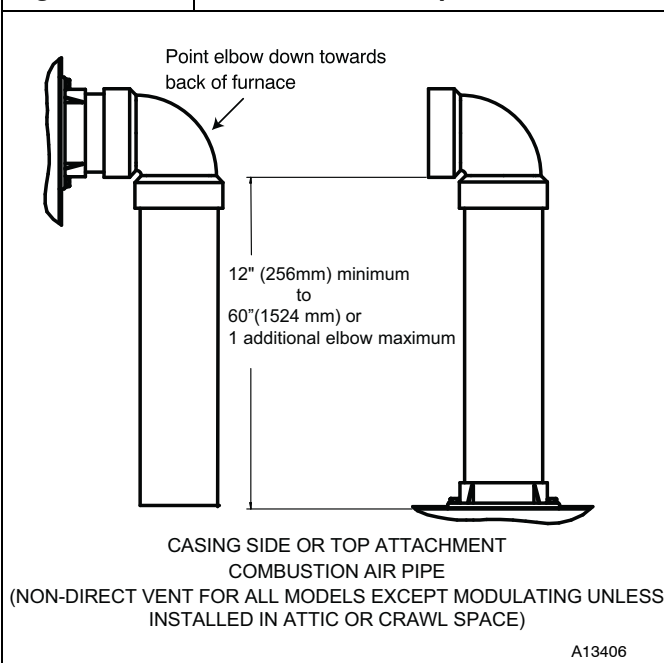
CARBON MONOXIDE POISONING HAZARD

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

DO NOT use cement to join polypropylene venting systems. Follow the polypropylene venting system manufacturer's instructions for installing polypropylene venting systems.

Figure 59

Combustion Air Pipe



Installing the Vent Termination

Roof Terminations

A roof termination of any type will require a 4-in. (102 mm) flashing for a 2-in. (50 mm ND) concentric vent or a 5-in. diameter (127 mm) flashing for a 3-in. (80 mm ND) 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 49**. Maintain the required separation distance between vents or pairs of vents as shown in **Figure 49** and all clearance shown in **Figure 62**.



WARNING

CARBON MONOXIDE POISONING HAZARD

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

DO NOT use cement to join polypropylene venting systems. Follow the polypropylene venting system manufacturer's instructions for installing polypropylene venting systems.

NOTE: Follow the instructions of the vent terminal manufacturer. These instructions are provided as a reference only.

Cut one 4-in. (102 mm) diameter hole for 2-in. (50 mm ND) kit, or one 5-in. (127 mm) diameter hole for 3-in. (80 mm ND) 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. DO NOT CEMENT POLYPROPYLENE FITTINGS.

Two-Pipe and Single-Pipe Terminations

Single and two pipe vent must be installed as shown in **Figure 49** and **Figure 50**. Maintain the required separation distance between vents or pairs of vents as shown in **Figure 49** and **Figure 50** and all clearance shown in **Figure 62** or **Figure 63**.

NOTICE

RECOMMENDED SUPPORT FOR VENT TERMINATIONS

It is recommended that rooftop vent terminations in excess of 36 inches (1.0 M) in vertical length be supported by EITHER the Direct Vent Termination Kit shown in **Table 12** or by field-supplied brackets or supports fastened to the structure.

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.

Holes in the roof for direct-vent (two-pipe) two pipe terminations should be spaced no more than 18-in. (457 mm) apart to help avoid vent gas recirculation into combustion air intake.

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

Sidewall Terminations

Concentric Vent

NOTE: Follow the instructions of the vent terminal manufacturer. These instructions are provided as a reference, only.

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 49**.
5. Disassemble loose pipe fittings. Clean and cement using same procedures as used for system piping. DO NOT CEMENT POLYPROPYLENE FITTINGS.

Two-Pipe and Single-Pipe Vent Termination

NOTE: Follow the instructions of the vent terminal manufacturer. These instructions are provided as a reference, only.

NOTICE

RECOMMENDED SUPPORT FOR VENT TERMINATIONS

It is recommended that side-wall vent terminations in excess of 24 inches (0.6 M) in vertical length be supported by EITHER the Direct Vent Termination Kit in **Table 12** or by field-supplied brackets or supports fastened to the structure.

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 in bracket (if used) and place assembly on combustion-air pipe.
3. Install bracket as shown in **Figure 46** and **Figure 48**.

NOTE: For applications using vent pipe option indicated by dashed lines in **Figure 49** and **Figure 50**, rotate vent elbow 90° from position.

4. Disassemble loose pipe fittings. Clean and cement using same procedures as used for system piping. DO NOT CEMENT POLYPROPYLENE FITTINGS.

(Direct Vent / Two-Pipe System ONLY)

When two or more furnaces are vented near each other, two vent terminations may be installed as shown in **Figure 49**, but next vent termination, or pair of vent terminations, must be at least 36-in. (914 mm) away from first two terminations. It is important that vent terminations be made as shown in **Figure 49** to avoid recirculation of gases.

Figure 60 Crawl Space Vent Termination

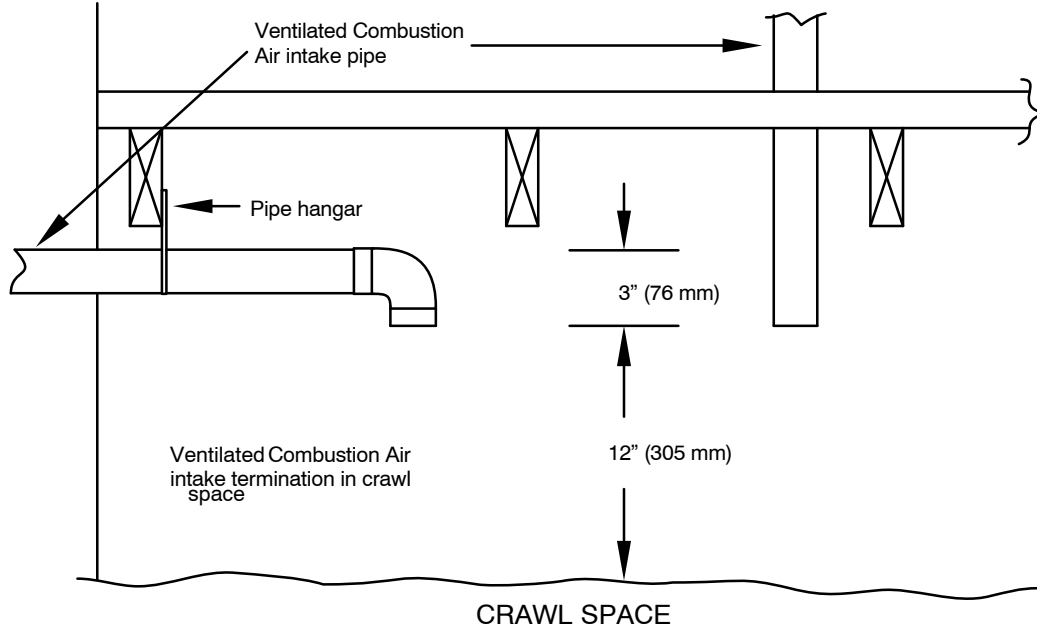
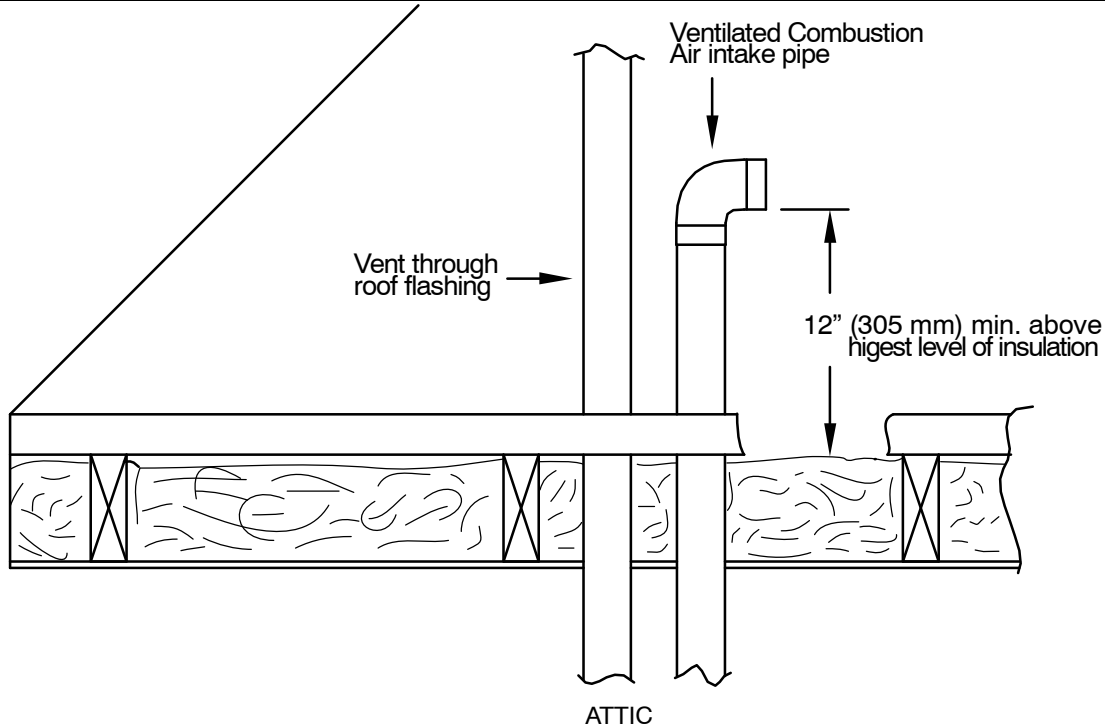
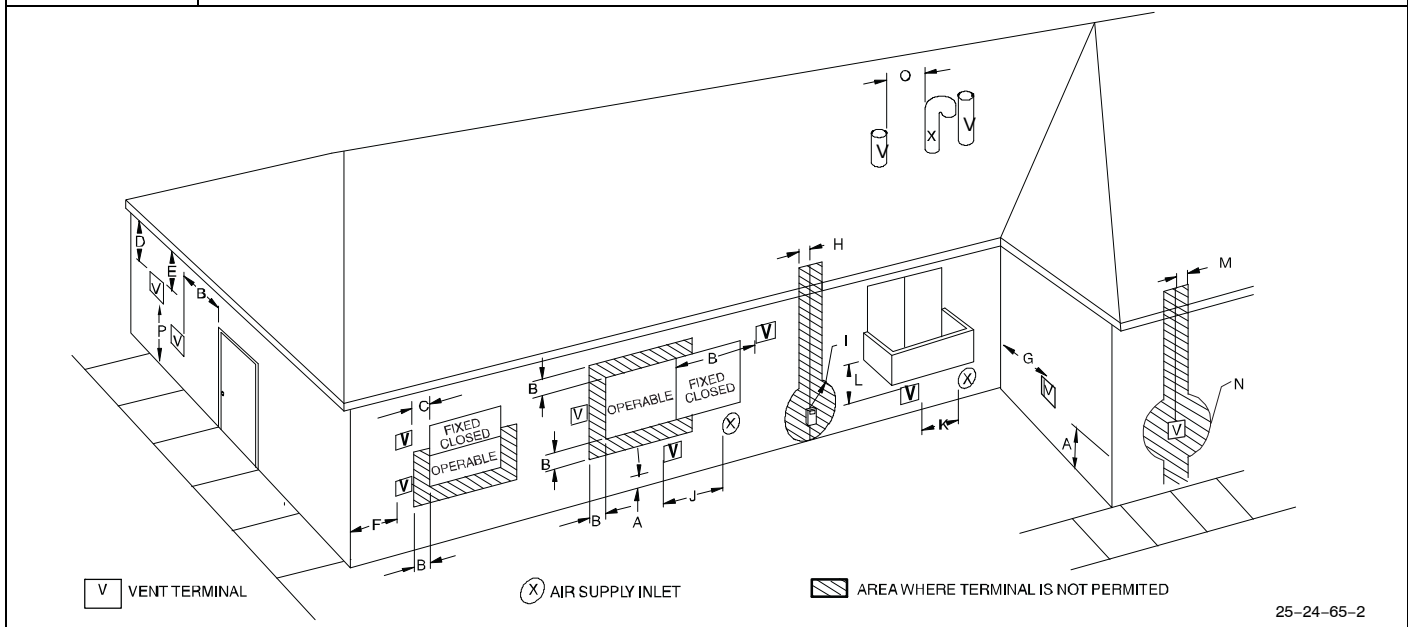


Figure 61 Attic Vent Termination



L11F016

Figure 62 Direct Vent Termination Clearance

25-24-65-2

NOTE: The following is based upon National codes for gas appliances, and is provided as a reference.

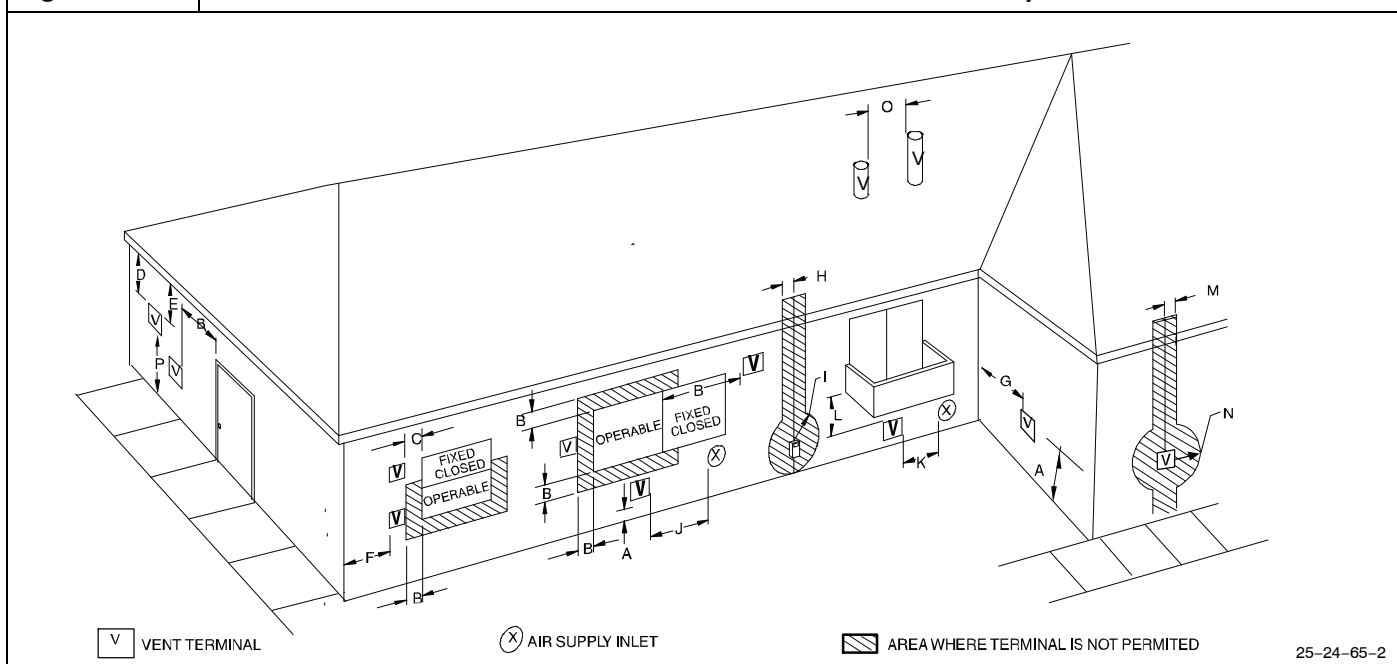
Refer to Local codes which may supersede these standards and/or recommendations.

Item	Clearance Description	U.S. Installations ⁽²⁾ (per ANSI Z223.1/NFPA 54)
A	Clearance above grade, veranda, porch, deck, balcony or anticipated snow level	12 in. (305 mm)
B	Clearance to a window or door that may be opened	9 in. (229 mm) for appliances >10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW), 12 in. (305 mm) for appliances >50,000 Btuh (15kW)
C	Clearance to a permanently closed window	For clearances not specified in ANSI Z223.1/NFPA 54, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions. Manufacturer's Recommendation: See Notes 3-8.
D	Vertical clearance to a ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) 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 15 ft. (4.6 M) above the meter/regulator assembly.
I	Clearance to service regulator vent outlet	See Note 4.
J	Clearance to non—mechanical air supply inlet to building or the combustion air inlet to any other appliance	9 in. (9 mm) for appliances >10,000 Btuh (3 kW) and ≤ 50,000 Btuh (15 kW), 12 in. (305 mm) for appliances >50,000 Btuh (15kW)
K	Clearance to a mechanical air supply inlet	3ft. (.9 M)
L	Clearance under a veranda, porch, deck, or balcony	See Note 4. Manufacturer's Recommendation: See Notes 3-8.
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 vent intake or exhaust	12 in. (305 mm)
N	Furnace combustion air intake clearance to a water heater vent, dryer vent or other types of appliance exhausts.	3 ft. (.9 M)
O	Clearance from a plumbing vent stack	3 ft. (.9 M)
P	Clearance above paved sidewalk or paved driveway located on public property	See Note 4. Manufacturer's Recommendation: See Notes 3-8.

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

Notes:

- In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code
- NOTE: This table is based upon National codes for gas appliances, and are provided as a reference. Refer to Local codes which may supersede these standards and/or recommendations.**
- For clearances not specified in ANSI Z223.1/NFPA 54, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
- 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, vent termination icing, and/or accelerated corrosion of the heat exchangers.
- Design and position vent outlets to avoid ice build-up on and moisture damage to surrounding surfaces.
- The vent for this appliance shall not terminate:
 - Near soffit vents of 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.
- Avoid venting under a deck or large overhang. Recirculation could occur and cause performance or system problems. Ice build-up may occur.

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

25-24-65-2

NOTE: The following is based upon National codes for gas appliances, and is provided as a reference.
Refer to Local codes which may supersede these standards and/or recommendations.

Item	Clearance Description	U.S. Installations ⁽²⁾ (per ANSI Z223.1/NFPA 54)
A	Clearance above grade, veranda, porch, deck, balcony or anticipated snow level	12 in. (305 mm)
B	Clearance to a window or door that may be opened	4ft. (1.2M) below or to the side of the opening, 1 ft (.3M) above the opening. Manufacturer's Recommendation: See Note 8.
C	Clearance to a permanently closed window	For clearances not specified in ANSI Z223.1/NFPA 54, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions. Manufacturer's Recommendation: See Notes 3-8.
D	Vertical clearance to a ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) 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 15 ft. (4.6 M) above the meter/regulator assembly.
I	Clearance to service regulator vent outlet	See Note 4.
J	Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance	4ft. (1.2M) below or to the side of the opening, 1 ft (.3M) above the opening. Manufacturer's Recommendation: See Note 8
K	Clearance to a mechanical air supply inlet	3ft. (.9 M)
L	Clearance under a veranda, porch, deck, or balcony	See Note 4. Manufacturer's Recommendation: See Notes 3-8.
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)
N	Clearance to a moisture exhaust duct (dryer vent, spa exhaust, etc.)	12 in. (305 mm) See Note 4.
O	Clearance from a plumbing vent stack	3 ft. (.9 M)
P	Clearance above paved sidewalk or paved driveway located on public property	7ft. (2.1M)

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

Notes:

- In accordance with the current ANSI Z223.1/NFPA 54, National Fuel Gas Code
- NOTE: This table is based upon National codes for gas appliances, and are provided as a reference. Refer to Local codes which may supersede these standards and/or recommendations.**
- For clearances not specified in ANSI Z223.1/NFPA 54, clearances shall be in accordance with local installation codes and the requirements of the gas supplier and the manufacturer's installation instructions.
- 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 condensation problems, vent termination icing, and/or accelerated corrosion of the heat exchangers.
- Design and position vent outlets to avoid ice build-up on and moisture damage to surrounding surfaces.
- The vent for this appliance shall not terminate:
 - Near soffit vents of 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.
- These National standards apply to all non-direct-vent gas appliances. Contact Local code officials for additional requirements and/or exclusions.

Table 14 MAXIMUM EQUIVALENT VENT LENGTH - Feet (Meters)

Note: Maximum Equivalent Vent Length (MEVL) does NOT include elbows
Use DEDUCTIONS **Table 15** to determine allowable vent length for each application.

Single Stage feet/inches																							
Unit Size		40,000 Outlet choke required under 10 ft. TEVL			60,000			80,000					100,000				120,000			140,000			
Altitude (feet)	Pipe Dia. (in)	1 ½	2	2 ½	1 ½	2	2 ½	3	1 ½	2	2 ½	3	4	2	2 ½	3	4	2 ½	3	4	2 ½	3	4
	0-2000	20	85	185	20	100	175	200	15	50	130	175	200	20	80	175	200	10	75	185	5	65	155
	2001-3000	15	80	175		95	165	185		45	125	165	185		75	165	185		70	175		140	
	3001-4000	10	70	160	15	90	155	175	10	40	110	150	165	15	70	155	175	5	65	165	N/A	60	120
	4001-4500		65	155		85	150	170		165	70	150	165		60	160	50		110				
	4501-5000	5	60	145	10	80	165	10	35	100	135	150	10	65	150	165	N/A	60	160	N/A	45	100	
	5001-6000		55	130		75	140		155	65	140	155		55	135	145		40	90		125	140	30
	6001-7000	5	45	120	10	70	130	145	N/A	30	90	125	140	N/A	60	135	145	N/A	50	140	N/A	30	65
	7001-8000		40	110		65	120	135		120	125	55	125		135	45	130		25	45			
	8001-9000	N/A	30	95	5	60	115	125	N/A	25	80	110	115	N/A	50	115	125	N/A	40	120	N/A	15	30
9001-10000	25		85	N/A	55	105	115	20		75	100	105	45		100	115	30		115	10		15	

Single Stage - Meters/mm																							
Unit Size		40,000 Outlet choke required under 10 ft. TEVL			60,000			80,000					100,000				120,000			140,000			
Altitude (meters)	Pipe Dia. (mm)	38	51	64	38	51	64	76	38	51	64	76	102	51	64	76	102	64	76	102	64	76	102
	0-610	6	26	57	6.5	31	54	61	2	16	40	54	61	6	25	54	61	3	23	57	1.5	21	48
	611-914	4.5	24	53		29	51	57		15	38	51	57		5	23	51		57	21		54	18
	915-1219	3	22	49	5	27	48	54	3	36	48	53	3	22	48	54	1.5	20	51	N/A	16	36	
	1220-1370		20	47		26	46	52		13	34	46		51	22	46		52	14		31		
	1371-1524	3	19	45	5	24	46	51	3	11	31	42	46	3	21	43	48	N/A	19	50	N/A	11	25
	1525-1829		17	41		82	43	47		11	31	42	46		21	43	48		14	31			
	1830-2134	1.5	15	37	3	22	40	44	N/A	10	27	39	42	N/A	19	41	45	N/A	16	43	N/A	9	20
	2135-2438		12	34		20	37	42		18	38	42	14		40	7	15						
	2439-2743	N/A	10	30	1.5	19	35	38	N/A	8	26	34	36	N/A	15	36	39	N/A	13	38	N/A	5	10
2744-3048	8		26	N/A	17	33	36	7		24	31	33	14		34	36	12		35	3.5		5	

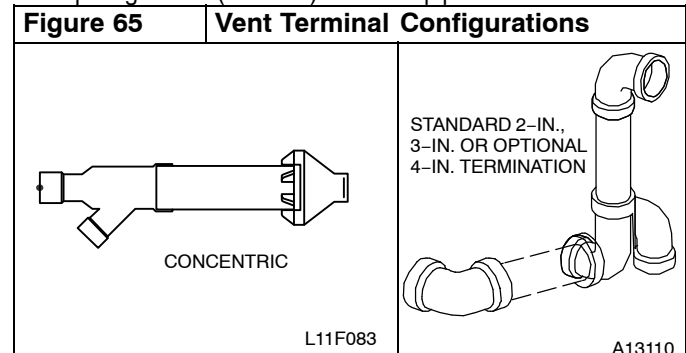
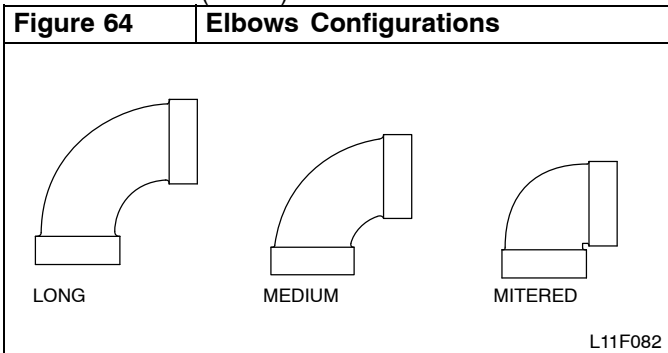
* Not all families have these models

Table 15 DEDUCTIONS FROM MAXIMUM EQUIVALENT VENT LENGTH - Feet (Meters)

Pipe Diameter (in):	1-1/2		2		2-1/2		3		4	
	feet	meters	feet	meters	feet	meters	feet	meters	feet	meters
Mitered 90° Elbow	8	(2.4)	8	(2.4)	8	(2.4)	8	(2.4)	8	(2.4)
Medium Radius 90° Elbow	5	(1.5)	5	(1.5)	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)	4	(1.2)	4	(1.2)
Medium Radius 45° Elbow	2.5	(0.8)	2.5	(0.8)	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)
Standard Vent Termination	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)

NOTES:

- Use only the smallest diameter pipe possible for venting. Over-sizing may cause flame disturbance or excessive vent terminal icing or freeze-up.
- NA = Not allowed. Pressure switch will not close, or flame disturbance may result.
- Total equivalent vent lengths under 10 ft. for 40k BTUH furnaces from 0 to 2000 ft (0 to 610m) above sea level require use of an inducer outlet choke. Failure to use an outlet choke may result in flame disturbance or flame sense lock-out.
- Not all furnace families include 140,000 BTUH input models.
- Vent sizing for Canadian installation over 4500 ft. (1370 m) above sea level are subject to acceptance by local authorities having jurisdiction.
- Size both the combustion air and vent pipe independently, then use the larger size for both pipes.
- Assume two 45° degree elbows equal one 90° degree elbow. Wide radius elbows are desirable and may be required in some cases.
- Elbow and pipe sections within the furnace casing and at the vent termination should not be included in vent length or elbow count.
- The minimum pipe length is 5 (1.5) linear feet (meters) for all applications.
- Use 3-in (76 mm) diameter vent termination kit for installations requiring a 4-in (102 mm) diameter pipe.



Venting System Length Calculations

The Total Equivalent Vent Length for EACH combustion air or vent pipe equals the length of the venting system, plus the equivalent length of elbows used in the venting system from **Table 15**.

See vent system manufacturer's data for equivalent lengths of flexible vent pipe or other termination systems. DO NOT ASSUME that one foot of flexible vent pipe equals one foot of straight PVC/ABS DWV vent pipe.

Compare the Total Equivalent Vent Length to the Maximum Equivalent Vent Lengths in **Table 14**.

Example 1

A direct-vent 140,000 BTUH furnace installed at 2100 ft. (640M). Venting system includes FOR EACH PIPE 52 feet (16 M) of vent pipe, 50 feet (15 M) of combustion air inlet pipe, (3) 90° long-radius elbows, (2) 45° long-radius elbows, and a factory accessory concentric vent kit.

Can this application use 4-in. (102 mm ND) PVC/ABS DWV vent piping?

Measure the required linear length of air inlet and vent pipe; insert the longest of the two here					52 ft (16 M)	Use length of the longer of the vent or air inlet piping system
Add equiv length of (3) 90° long-radius elbows (use the highest number of elbows for either the vent or inlet pipe)	3	x	3 ft (0.9 M)	=	9 ft. (2.7 M)	From Table 15
Add equiv length of (2) 45° long-radius elbows (use the highest number of elbows for either the vent or inlet pipe)	2	x	2 ft (0.6 M)	=	4 ft (1.2 M)	From Table 15
Add equiv length of factory concentric vent term					0 ft.	From Table 15
Add correction for flexible vent pipe, if any					0 ft.	From Vent Manufacturer's instructions; zero for PVC/ABS DWV
Total Equivalent Vent Length (TEVL)					65 ft. (20 M)	Add all of the above lines
Maximum Equivalent Vent Length (MEVL)					68 ft. (20.7 M)	For 4" pipe from Table 14
Is TEVL less than MEVL?					YES	Therefore, 4" pipe MAY be used

Example 2

A direct-vent 140,000 BTUH furnace installed at 1800 ft. (549M). Venting system includes FOR EACH PIPE 31 feet (9 M) of vent pipe, 30 feet (9 M) of combustion air inlet pipe, (3) 90° long-radius elbows, and a polypropylene concentric vent kit. Also includes 20 feet (6.1 M) of flexible polypropylene vent pipe, included within the 68 feet (21 M) of vent pipe.

Assume that one meter of flexible 3-in or 4-in polypropylene pipe equals 1.8 meters of PVC/ABS pipe. VERIFY FROM VENT MANUFACTURER'S INSTRUCTIONS.

Can this application use 3-in vent piping? If not, what size piping can be used?

Measure the required linear length of air inlet and vent pipe; insert the longest of the two here					31 ft (18.3 M)	Use length of the longer of the vent or air inlet piping system
Add equiv length of (3) 90° long-radius elbows (use the highest number of elbows for either the vent or inlet pipe)	3	x	3 ft (0.9 M)	=	9 ft. (2.7 M)	From Vent Manufacturer's instructions
Add equiv length of (2) 45° long-radius elbows (use the highest number of elbows for either the vent or inlet pipe)	0	x		=	0 ft. (0 M)	From Vent Manufacturer's instructions
Add equiv length of factory concentric vent term	9 M	x	3.3 ft/M	=	30 ft. (9 M)	From Vent Manufacturer's instructions
Add correction for flexible vent pipe, if any	1.80	x	10 ft (3 M)	=	18 ft. (5.5 M)	From Vent Manufacturer's instructions
Total Equivalent Vent Length (TEVL)					88 ft (26.8 M)	Add all of the above lines
Maximum Equivalent Vent Length (MEVL)					20 ft. (6 M)	For 3" pipe from Table 14
Is TEVL less than MEVL?					NO	Therefore, 3-in pipe may NOT be used; try 4-in
Maximum Equivalent Vent Length (MEVL)					90 ft. (27.4 M)	For 4" pipe from Table 14
Is TEVL less than MEVL?					YES	Therefore, 4-in pipe MAY be used

Table 16

Maximum Allowable Exposed Vent Lengths in Unconditioned Space

Maximum Allowable Exposed Vent Length in Unconditioned Space (Feet)

Winter Design Temp °F	Unit Size	40,000* BTUH										60,000 BTUH											
		Uninsulated			3/8-in. Insulation			1/2-in. Insulation				Uninsulated				3/8-in. Insulation				1/2-in. Insulation			
	Pipe Dia. in.	1 ½	2	2 ½	1 ½	2	2 ½	1 ½	2	2 ½		1 ½	2	2 ½	3	1 ½	2	2 ½	3	1 ½	2	2 ½	3
	20	20	20	20	20	50	45	20	60	50		20	30	30	25	20	75	65	60	20	85	75	65
	0	10	5	5	20	25	20	20	30	25		15	15	10	10	20	40	30	25	20	45	40	30
	-20	5			20	15	10	20	20	15		10	5			20	25	20	15	20	30	25	20
-40				15	10	5	15	15	10	5				20	15	15	10	20	20	15	10		
Winter Design Temp °F	Unit Size	80,000 BTUH																					
		Uninsulated						3/8-in. Insulation						1/2-in. Insulation									
	Pipe Dia. in.	1 ½		2	2 ½	3	4	1 ½	2	2 ½	3	4	1 ½	2	2 ½	3	4						
	20	15		40	40	35	30	15	50	90	75	65	15	50	70	70	70						
	0	15		20	15	10	5	15	50	45	35	30	15	50	50	40	35						
	-20	15		10	5			15	35	30	20	15	15	40	30	25	15						
-40	10		5				15	25	20	15	5	15	30	25	20	10							
Winter Design Temp °F	Unit Size	100,000 BTUH																					
		Uninsulated				3/8-in. Insulation				1/2-in. Insulation													
	Pipe Dia. in.	2		2 ½	3	4	2	2 ½	3	4	2	2 ½	3	4									
	20	20		50	40	35	20	80	95	80	20	80	105	90									
	0	20		20	15	10	20	55	45	35	20	65	55	45									
	-20	15		10	5		20	35	30	20	20	45	35	25									
-40	10		5			20	25	20	10	20	30	25	15										
Winter Design Temp °F	Unit Size	120,000 BTUH										140,000* BTUH											
		Uninsulated			3/8-in. Insulation			1/2-in. Insulation				Uninsulated			3/8-in. Insulation			1/2-in. Insulation					
	Pipe Dia. in.	2 ½	3	4	2 ½	3	4	2 ½	3	4		2 ½	3	4	2 ½	3	4	2 ½	3	4			
	20	10	50	40	10	75	95	10	75	105		5	55	50	5	65	105	5	65	125			
	0	10	20	15	10	55	45	10	65	50		5	25	15	5	65	50	5	65	60			
	-20	10	10		10	35	25	10	45	30		5	10	5	5	45	30	5	50	40			
-40	10	5		10	25	15	10	30	20	5	5		5	30	20	5	35	25					

* Not all families have these models

Maximum Allowable Exposed Vent Length in Unconditioned Space (Metric)

Winter Design Temp °C	Unit Size	40,000* BTUH									60,000 BTUH											
		Uninsulated			3/8-in. Insulation			1/2-in. Insulation			Uninsulated				3/8-in. Insulation				1/2-in. Insulation			
	Pipe Dia. mm	38	51	64	38	51	64	38	51	64	38	51	64	76	38	51	64	76	38	51	64	76
	-7	6.1	6.1	6.1	6.1	15.2	13.7	6.1	18.3	15.2	6.1	9.1	9.1	7.6	6.1	22.9	19.8	18.3	6.1	25.9	22.9	19.8
	-18	3.0	1.5	1.5	6.1	7.6	6.1	6.1	9.1	7.6	4.6	4.6	3.0	3.0	6.1	12.2	9.1	7.6	6.1	13.7	12.2	9.1
	-29	1.5			6.1	4.6	3.0	6.1	6.1	4.6	3.0	1.5			6.1	7.6	6.1	4.6	6.1	9.1	7.6	6.1
	-40				4.6	3.0	1.5	4.6	4.6	3.0	1.5				6.1	4.6	4.6	3.0	6.1	6.1	4.6	3.0
Winter Design Temp °C	Unit Size	80,000 BTUH																				
		Uninsulated					3/8-in. Insulation					1/2-in. Insulation										
	Pipe Dia. mm	38	51	64	76	102	38	51	64	76	102	38	51	64	76	102						
	-7	4.6	12.2	12.2	10.7	9.1	4.6	15.2	27.4	22.9	19.8	4.6	15.2	21.3	21.3	21.3						
	-18	4.6	6.1	4.6	3.0	1.5	4.6	15.2	13.7	10.7	9.1	4.6	15.2	15.2	12.2	10.7						
	-29	4.6	3.0	1.5			4.6	10.7	9.1	6.1	4.6	4.6	12.2	9.1	7.6	4.6						
	-40	3.0	1.5				4.6	7.6	6.1	4.6	1.5	4.6	9.1	7.6	6.1	3.0						
Winter Design Temp °C	Unit Size	100,000 BTUH																				
		Uninsulated				3/8-in. Insulation				1/2-in. Insulation												
	Pipe Dia. mm	51	64	76	102	51	64	76	102	51	64	76	102									
	-7	6.1	15.2	12.2	10.7	6.1	24.4	28.9	24.4	6.1	24.4	32.0	27.4									
	-18	6.1	6.1	4.6	3.0	6.1	16.8	13.7	10.7	6.1	19.8	16.7	13.7									
	-29	4.6	3.0	1.5		6.1	10.7	9.1	6.1	6.1	13.7	10.7	7.6									
	-40	3.0	1.5			6.1	7.6	6.1	3.0	6.1	9.1	7.6	4.6									
Winter Design Temp °C	Unit Size	120,000 BTUH									140,000* BTUH											
		Uninsulated			3/8-in. Insulation			1/2-in. Insulation			Uninsulated			3/8-in. Insulation			1/2-in. Insulation					
	Pipe Dia. mm	64	76	102	64	76	102	64	76	102	64	76	102	64	76	102	64	76	102			
	-7	3.0	15.2	12.2	3.0	22.9	28.9	3.0	22.9	32.0	1.5	16.7	15.2	1.5	19.8	32.0	1.5	19.8	38.1			
	-18	3.0	6.1	4.6	3.0	16.8	13.7	3.0	19.8	15.2	1.5	7.6	4.6	1.5	19.8	15.2	1.5	19.8	18.3			
	-29	3.0	3.0		3.0	10.7	7.6	3.0	13.7	9.1	1.5	3.0	1.5	1.5	13.7	9.1	1.5	15.2	12.2			
	-40	3.0	1.5		3.0	7.6	4.6	3.0	9.1	6.1	1.5	1.5		1.5	9.1	6.1	1.5	35	7.6			

* Not all families have these models