These high efficiency, compact units employ induced combustion, reliable hot surface ignition and high heat transfer aluminized tubular heat exchangers. The units are factory shipped for installation in upflow or horizontal applications and may be converted for downflow applications.

These furnaces are designed for residential installation in a basement, closet, alcove, attic, recreation room or garage and are also ideal for commercial applications. All units are factory assembled, wired and tested to assure safe dependable and economical installation and operation.

These units are Category IV listed and may not be common vented with another gas appliance as allowed by the National Fuel Gas Code.

**SECTION I: SAFETY**

This is a safety alert symbol. When you see this symbol on labels or in manuals, be alert to the potential for personal injury.

Understand and pay particular attention to the signal words DANGER, WARNING, or CAUTION.

DANGER indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.

CAUTION indicates a potentially hazardous situation, which, if not avoided may result in minor or moderate injury. It is also used to alert against unsafe practices and hazards involving only property damage.

---

**SPECIFIC SAFETY RULES AND PRECAUTIONS**

1. Only Natural gas or Propane (LP) gas are approved for use with this furnace.
2. Install this furnace only in a location and position as specified in these instructions.
3. A gas-fired furnace for installation in a residential garage must be installed as specified in these instructions.
4. Provide adequate combustion and ventilation air to the furnace space as specified in these instructions.
5. Combustion products must be discharged outdoors. Connect this furnace to an approved vent system only, as specified in "COMBUSTION AIR and VENT SYSTEM" of these instructions.
6. Test for gas leaks as specified in these instructions.

---

**SAFETY REQUIREMENTS**

This product must be installed in strict compliance with the installation instructions and any applicable local, state, and national codes including, but not limited to building, electrical, and mechanical codes.

- Refer to the unit rating plate for the furnace model number, and then see the dimensions page of this instruction for return air plenum dimensions in Figure 13. The plenum must be installed according to the instructions.
- Provide clearances from combustible materials as listed under Clearances to Combustibles.
- Provide clearances for servicing ensuring that service access is allowed for both the burners and blowers.
- These models ARE NOT CSA listed or approved for installation into a **HUD Approved Modular Home** or a **Manufactured (Mobile) Home**.
- This furnace is not approved for installation in trailers or recreational vehicles.

---

**DANGER**

Improper installation may create a condition where the operation of the product could cause personal injury or property damage. Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Failure to carefully read and follow all instructions in this manual can result in furnace malfunction, death, personal injury and/or property damage. Only a qualified contractor, installer or service agency should install this product.

---

**WARNING**

Failure to follow the safety warnings exactly could result in serious injury, death or property damage. Never test for gas leaks with an open flame. Use a commercially available soap solution made specifically for detection of leaks to check all connections. A fire or explosion may result causing property damage, personal injury or loss of life.

---

7. Always install the furnace to operate within the furnace’s intended temperature rise range. Only connect the furnace to a duct system which has an external static pressure within the allowable range, as specified on the furnace rating plate.
• Furnaces for installation on combustible flooring shall not be installed directly on carpeting, tile or other combustible material other than wood flooring.
• Check the rating plate and power supply to be sure that the electrical characteristics match. All models use nominal 115 VAC, 1 Phase, 60-Hz power supply. DO NOT CONNECT THIS APPLIANCE TO A 50-Hz POWER SUPPLY OR A VOLTAGE ABOVE 130 Volts.
• Furnace shall be installed so the electrical components are protected from water.
• Installing and servicing heating equipment can be hazardous due to the electrical components and the gas fired components. Only trained and qualified personnel should install, repair, or service gas heating equipment. Untrained service personnel can perform basic maintenance functions such as cleaning and replacing the air filters. When working on heating equipment, observe precautions in the manuals and on the labels attached to the unit and other safety precautions that may apply.

COMBUSTION AIR QUALITY
(LIST OF CONTAMINANTS)

![WARNING]

The furnace area must not be used as a broom closet or for any other storage purposes, as a fire hazard may be created. Never store items such as the following on, near or in contact with the furnace.
1. Spray or aerosol cans, rags, brooms, dust mops, vacuum cleaners or other cleaning tools.
2. Soap powders, bleaches, waxes or other cleaning compounds; plastic items or containers; gasoline, kerosene, cigarette lighter fluid, dry cleaning fluids or other volatile fluid.
3. Paint thinners and other painting compounds.
4. Paper bags, boxes or other paper products

Never operate the furnace with the blower door removed. To do so could result in serious personal injury and/or equipment damage.

The furnace requires OUTDOOR AIR for combustion when the furnace is located in any of the following environments.
• Buildings with indoor pools
• Chemical exposure
• Commercial buildings
• Furnaces installed in hobby or craft rooms
• Furnaces installed in laundry rooms
• Furnaces installed near chemical storage areas
• Restricted Environments

The furnace requires OUTDOOR AIR for combustion when the furnace is located in an area where the furnace is being exposed to the following substances and/or chemicals.
• Antistatic fabric softeners for clothes dryers
• Carbon tetrachloride
• Cements and glues
• Chlorine based swimming pool chemicals
• Chlorinated waxes and cleaners
• Cleaning solvents (such as perchloroethylene)
• De-icing salts or chemicals
• Halogen type refrigerants
• Hydrochloric acid
• Masonry acid washing materials
• Permanent wave solutions
• Printing inks, paint removers, varnishes, etc.
• Water softening chemicals

When outdoor air is used for combustion, the combustion air intake duct system termination must be located external to the building and in an area where there will be no exposure to the substances listed above.

CODES AND STANDARDS

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

In the United States and Canada, follow all codes and standards for the following, using the latest edition available:

STEP 1 - Safety
• CANADA: CAN/CGA-B149.1 National Standard of Canada. Natural Gas and Propane Installation Codes (NSCNGPIC)

STEP 2 - General Installation
• US: Current edition of the NFGC, and 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. Capital, N.W.
  Washington DC 20001
  or www.NFPA.org
  • CANADA: NSCNGPIC. For a copy contact:
    Standard Sales, CSA International
    178 Rexdale Boulevard
    Etobicoke, (Toronto) Ontario Canada M9W 1RS

STEP 3 - Combustion and Ventilation Air
• US: Section 5.3 of the NFGC, air for Combustion and Ventilation
• CANADA: Part 7 of NSCNGPIC, Venting Systems and Air Supply for Appliances

STEP 4 - Duct Systems

STEP 5 - Acoustical Lining and Fibrous Glass Duct
• US and CANADA: Current edition of SMACNA and NFPA 90B as tested by UL Standard 181 for Class I Rigid Air Ducts

STEP 6 - Gas Piping and Gas Pipe Pressure Testing
• US: NFPG; chapters 2, 3, 4, & 9 and National Plumbing Codes
• CANADA: NSCNGPIC Part 5

STEP 7 - Electrical Connections
• US: National Electrical Code (NEC) ANSI/NFPA 70
  • CANADA: Canadian Electrical Code CSA C22.1

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 who have not kept up with changing residential and non-HUD modular home construction practices. These instructions are required as a minimum for a safe installation.
FOR FURNACES INSTALLED IN THE COMMONWEALTH OF MASSACHUSETTS ONLY

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

1. INSTALLATION OF CARBON MONOXIDE DETECTORS. At the time of installation of the side wall horizontal vented gas fueled equipment, the installing plumber or gasfitter shall observe that a hard wired carbon monoxide detector with an alarm and battery back-up is installed on the floor level where the gas equipment is to be installed. In addition, the installing plumber or gasfitter shall observe that a battery operated or hard wired carbon monoxide detector with an alarm is installed on each additional level of the building, dwelling or structure served by the side wall horizontal vented gas fueled equipment. It shall be the responsibility of the property owner to secure the services of qualified licensed professionals for the installation of hard wired carbon monoxide detectors
   a. In the event that the side wall horizontally vented gas fueled equipment is installed in a crawl space or an attic, the hard wired carbon monoxide detector with alarm and battery back-up may be installed on the next adjacent floor level.
   b. In the event that the requirements of this subdivision can not be met at the time of completion of installation, the owner shall have a period of thirty (30) days to comply with the above requirements; provided, however, that during said thirty (30) day period, a battery operated carbon monoxide detector with an alarm shall be installed.

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

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

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

INSPECTION

As soon as a unit is received, it should be inspected for possible damage during transit. If damage is evident, the extent of the damage should be noted on the carrier's freight bill. A separate request for inspection by the carrier's agent should be made in writing. Also, before installation, the unit should be checked for screws or bolts which may have loosened in transit. There are no shipping or spacer brackets which need to be removed from the interior of this unit.

FURNACE LOCATION AND CLEARANCES

The furnace shall be located using the following guidelines:
1. Where a minimum amount of air intake/vent piping and elbows will be required.
2. As centralized with the air distribution as possible.
3. Where adequate combustion air will be available (particularly when the appliance is not using outdoor combustion air).
4. Where it will not interfere with proper air circulation in the confined space.
5. Where the outdoor vent terminal will not be blocked or restricted. Refer to “VENT CLEARANCES” located in SECTION VII of these instructions. These minimum clearances must be maintained in the installation.
6. Where the unit will be installed in a level position with no more than 1/4" (6.4 mm) slope side-to-side and front-to-back to provide proper condensate drainage.

Installation in freezing temperatures:
1. Furnace shall be installed in an area where ventilation facilities provide for safe limits of ambient temperature under normal operating conditions. Ambient temperatures must not fall below 32°F (0°C) unless the condensate system is protected from freezing.

WARNING
Improper installation in an ambient below 32°F (0°C) could create a hazard, resulting in damage, injury or death.

2. Do not allow return air temperature to be below 55°F (13°C) for extended periods. To do so may cause condensation to occur in the main heat exchanger, leading to premature heat exchanger failure.
3. If this furnace is installed in an unconditioned space and an extended power failure occurs, there will be potential damage to the internal components. Following a power failure situation, do not operate the unit until inspection and repairs are performed.

WARNING
Liquid anti-freeze will cause damage to internal plastic parts of this furnace. DO NOT attempt to winterize the furnace using liquid anti-freeze.

Clearances for access/service:
Ample clearances should be provided to permit easy access to the unit. The following minimum clearances are recommended:
1. Twenty-four (24) inches (61 cm) between the front of the furnace and an adjacent wall or another appliance, when access is required for servicing and cleaning.
2. Eighteen (18) inches (46 cm) at the side where access is required for passage to the front when servicing or for inspection or replacement of flue/vent connections.

In all cases, accessibility clearances shall take precedence over clearances for combustible materials where accessibility clearances are greater.

Installation in a residential garage:
A gas-fired furnace for installation in a residential garage must be installed so the burner(s) and the ignition source are located not less than 18" (46 cm) above the floor, and the furnace must be located or protected to avoid physical damage by vehicles.

Table 1: Unit Clearances to Combustibles

<table>
<thead>
<tr>
<th>Application</th>
<th>Upflow</th>
<th>Downflow</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td>1&quot;</td>
<td>0&quot;</td>
<td>0&quot;</td>
</tr>
<tr>
<td>Vent</td>
<td>0&quot;</td>
<td>0&quot;</td>
<td>0&quot;</td>
</tr>
<tr>
<td>Rear</td>
<td>0&quot;</td>
<td>0&quot;</td>
<td>0&quot;</td>
</tr>
<tr>
<td>Side</td>
<td>0&quot;</td>
<td>0&quot;</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Front*</td>
<td>0&quot;</td>
<td>0&quot;</td>
<td>0&quot;</td>
</tr>
<tr>
<td>Floor</td>
<td>Combustible</td>
<td>Combustible1</td>
<td>Combustible</td>
</tr>
<tr>
<td>Closet</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Line Contact</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1. For combustible floors only when used with special sub-base.
2. 24" clearance in front and 18" on side recommended for service access. All furnaces approved for alcove and attic installation.
SECTION II: DUCTWORK

DUCTWORK GENERAL INFORMATION

The duct system’s design and installation must:

1. Handle an air volume appropriate for the served space and within the operating parameters of the furnace specifications.
2. Be installed in accordance of National Fire Protection Association as outlined in NFPA standard 90B (latest editions) or applicable national, provincial, state, and local fire and safety codes.
3. Create a closed duct system. For residential and non-HUD Modular Home installations, 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 a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.
4. Complete a path for heated or cooled air to circulate through the air conditioning and heating equipment and to and from the conditioned space.

CAUTION

The cooling coil must be installed in the supply air duct, downstream of the furnace. Cooled air may not be passed over the heat exchanger.

When the furnace is used with a cooling coil, the coil must be installed parallel with, or in the supply air side of the furnace to avoid condensation in the primary heat exchanger. When a parallel flow arrangement is used, dampers or other means used to control airflow must be adequate to prevent chilled air from entering the furnace. If manually operated, the damper must be equipped with means to prevent the furnace or the air conditioner from operating unless the damper is in full heat or cool position.

When replacing an existing furnace, if the existing plenum is not the same size as the new furnace then the existing plenum must be removed and a new plenum installed that is the proper size for the new furnace. If the plenum is shorter than 12” (30.5 cm) the turbulent air flow may cause the limit controls not to operate as designed, or the limit controls may not operate at all.

The duct system is a very important part of the installation. If the duct system is improperly sized the furnace will not operate properly. The ducts attached to the furnace plenum, should be of sufficient size so that the furnace operates at the specified external static pressure and within the air temperature rise specified on the nameplate.

IMPORTANT

The minimum plenum height is 12” (30.5 cm). The furnace will not operate properly on a shorter plenum height. The minimum recommended rectangular duct height is 4” (10.1 cm) attached to the plenum.

If a matching cooling coil is used, it may be placed directly on the furnace outlet and sealed to prevent leakage. If thermoplastic evaporator ‘A’ coil drain pans are to be installed in the upflow/horizontal configuration, then extra 2” minimum spacing may be needed to ensure against drain pan distortion.

On all installations without a coil, a removable access panel is recommended in the outlet duct such that smoke or reflected light would be observable inside the casing to indicate the presence of leaks in the heat exchanger. This access cover shall be attached in such a manner as to prevent leaks.

WARNING

The duct system must be properly sized to obtain the correct airflow for the furnace size that is being installed. Refer to Table 6 or the furnace rating plate for the correct rise range and static pressures.

If the ducts are undersized, the result will be high duct static pressures and/or high temperature rises which can result in a heat exchanger OVERHEATING CONDITION. This condition can result in premature heat exchanger failure, which can result in personal injury, property damage, or death.

DUCT FLANGES

Four flanges are provided to attach ductwork to the furnace. These flanges are rotated down for shipment. In order to use the flanges, remove the screw holding an individual flange, rotate the flange so it is in the upward position and reinstall the screw then repeat this for all 4 flanges.

If the flanges are not used, they must remain in the rotated down position as shipped.

FIGURE 1: Duct Attachment

DUCTWORK INSTALLATION AND SUPPLY PLENUM CONNECTION - UPFLOW/HORIZONTAL

Attach the supply plenum to the furnace outlet. The use of an approved flexible duct connector is recommended on all installations. This connection should be sealed to prevent air leakage. The sheet metal should be crosshatched to eliminate any popping of the sheet metal when the indoor fan is energized.

FLOOR BASE AND DUCTWORK INSTALLATION - DOWNFLOW

Installations on combustible material or directly on any floors must use a combustible floor base shown in Figure 8. Follow the instructions supplied with the combustible floor base accessory. This combustible floor base can be replaced with a matching cooling coil, properly sealed to prevent leaks. Follow the instructions supplied with the cooling coil cabinet for installing the cabinet to the duct connector. Plug intake and vent pipe holes in bottom panel and move grommet to desired vent side exit.

Downflow Air Conditioning Coil Cabinet

The furnace should be installed with coil cabinet part number specifically intended for downflow application. If a matching cooling coil is used, it may be placed directly on the furnace outlet and sealed to prevent leakage. For details of the coil cabinet dimensions and installation requirements, refer to the installation instructions supplied with the coil cabinet.

Attach the air conditioning coil cabinet to the duct connector, and then position the furnace on top of the coil cabinet. The connection to the furnace, air conditioning coil cabinet, duct connector, and supply air duct must be sealed to prevent air leakage.
**COIL INSTALLATION**

**IMPORTANT**

On all installations without a coil, a removable access panel is recommended in the outlet duct such that smoke or reflected light would be observable inside the casing to indicate the presence of leaks in the heat exchanger. This access cover shall be attached in such a manner as to prevent leaks.

**COIL/FURNACE ASSEMBLY - MC/FC/PC SERIES COILS**

Position the coil casing over or under the furnace opening as shown in Figure 2 after configuring coil flanges as required see “Coil Flange” section below.

**COIL FLANGE INSTALLATION**

The coils include removable flanges to allow proper fit up with furnaces having various inlet and outlet flange configurations. The two flanges are attached to the top of the coil in the factory during production. For proper configuration of flanges refer to Figure 3.

**FURNACE ASSEMBLY - MC SERIES COILS ONLY**

MC coils are supplied ready to be installed in a horizontal position. A horizontal pan is factory installed. MC coils should be installed in all horizontal applications with the horizontal drain pan side down.

**FURNACE ASSEMBLY - MC & FC SERIES COILS**

These coils are factory shipped for installation in either upflow or downflow applications with no conversion.

**FURNACE ASSEMBLY - PC SERIES COILS**

These upflow coils are designed for installation on top of upflow furnaces only.

If the coil is used with a furnace of a different size, use a 45° transition to allow proper air distribution through the coil.

1. Position the coil casing over the furnace opening as shown in Figure 6.
2. Place the ductwork over the coil casing flange and secure.
3. Check for air leakage between the furnace and coil casing and seal appropriately.

**CAUTION**

Do not drill any holes or drive any screws into the front duct flange on the coil in order to prevent damaging coil tubing. See Figure 6.

---

**FIGURE 2:** Vertical Applications

**FIGURE 3:** Coil Flange

**FIGURE 4:** Horizontal Right Application

**FIGURE 5:** Horizontal Left Application
Dimension “C” should be at least 2/3 of dimension “D”. See Figure 6.

CRITICAL COIL PROJECTION
The coil assembly must be located in the duct such that a minimum distance is maintained between the top of the coil and the top of the duct. Refer to Table 2.

COIL / FURNACE ASSEMBLY - HC SERIES COILS
These coils are supplied ready to be installed in a right hand position or a left hand position. When used in conjunction with a horizontal furnace (blow through) application, the coil should be oriented with the opening of the “A” coil closest to the furnace. See Figure 7.

DOWNFLOW DUCT CONNECTORS
All downflow installations must use a suitable duct connector approved by the furnace manufacturer for use with this furnace. The duct connectors are designed to be connected to the rectangular duct under the floor and sealed. Refer to the instructions supplied with the duct connector for proper installation. Refer to the separate accessory parts list at the end of these instructions for the approved accessory duct connectors.

Table 2: Coil Projection Dimensions - PC Series Coils

<table>
<thead>
<tr>
<th>COIL SIZE</th>
<th>DIMENSION “C” INCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC18</td>
<td>3-1/2</td>
</tr>
<tr>
<td>PC24</td>
<td>4-1/2</td>
</tr>
<tr>
<td>PC30, PC32, PC35</td>
<td>4-1/2</td>
</tr>
<tr>
<td>PC42, PC43, PC36, PC37</td>
<td>5-1/2</td>
</tr>
<tr>
<td>PC48</td>
<td>6-1/2</td>
</tr>
<tr>
<td>PC60</td>
<td>9</td>
</tr>
</tbody>
</table>

Dimension “C” should be at least 2/3 of dimension “D”. See Figure 6.

RESIDENTIAL AND MODULAR HOME UPFLOW RETURN PLENUM CONNECTION
Return air may enter the furnace through the side(s) or bottom depending on the type of application. Return air may not be connected into the rear panel of the unit.

BOTTOM RETURN AND ATTIC INSTALLATIONS
Bottom return applications normally pull return air through a base platform or return air plenum. Be sure the return platform structure or return air plenum is suitable to support the weight of the furnace. The internal bottom panel must be removed for this application. Attic installations must meet all minimum clearances to combustibles and have floor support with required service accessibility.

HORIZONTAL APPLICATION

FIGURE 7: Horizontal Left or Right application (Right Shown)
ATTIC INSTALLATION

This appliance is certified for line contact when the furnace is installed in the horizontal left or right position. The line contact is only permissible between lines that are formed by the intersection of the top and two sides of the furnace and the building joists, studs or framing. This line may be in contact with combustible material. Refer to Figure 10.

When moving or handling this furnace prior to installation, always leave the doors on the furnace to provide support and to prevent damage or warping of the cabinet. When lifting the furnace, support the ends of the furnace rather than lifting by the cabinet flanges at the return air openings (bottom or sides) or supply air opening.

It is acceptable to use the primary heat exchanger tubes as a lifting point provided that the tubes are lifted at the front of the heat exchangers where attached to the vestibule panel. Do not use the top return bend of the heat exchangers as lifting points as the tubes may shift out of position or their location brackets/baffles.

SUSPENDED FURNACE / CRAWL SPACE INSTALLATION

The furnace can be hung from floor joists or installed on suitable blocks or pads. Blocks or pad installations shall provide adequate height to ensure that the unit will not be subject to water damage.

Units may also be suspended from rafters or floor joists using rods, pipe angle supports or straps. In all cases, the furnace should be supported with rods, straps, or angle supports at three locations to properly support the furnace. Place one support at the supply end of the furnace, one support located approximately in the center of the furnace near the blower shelf, and the third support should be at the return end of the furnace. Maintain a 6" (15.2 cm) minimum clearance between the front of the furnace and the support rods or straps.

All six suspension points must be level to ensure proper and quiet furnace operation. When suspending the furnace, use a secure platform constructed of plywood or other building materials secured to the floor or ceiling joists. Refer to Figure 11 for details and additional information.

When moving or handling this furnace prior to installation it is recommended to leave the doors on the furnace to provide support and to prevent damage or warping of the cabinet. When lifting the furnace, support the ends of the furnace rather than lifting by the cabinet flanges at the return air openings (bottom or sides) or supply air opening.

It is acceptable to use the primary heat exchanger tubes as a lifting point provided that the tubes are lifted at the front of the heat exchangers where attached to the vestibule panel. Do not use the top return bend of the heat exchangers as lifting points as the tubes may shift out of position or their location brackets/baffles.

DOWNFLOW APPLICATION

To apply the furnace in a downflow position, it will be necessary to rotate the vent blower 90° left or right so that the vent pipe passes through the side of the furnace casing. See Figure 12.
SECTION III: FILTERS

FILTER INSTALLATION

All applications require the use of a field installed filter. All filters and mounting provision must be field supplied.

Filters must be installed external to the furnace cabinet. **DO NOT** attempt to install filters inside the furnace.

**NOTICE**

Single side return above 1800 CFM is approved as long as the filter velocity does not exceed filter manufacturer’s recommendation and a transition is used to allow use on a 20x25 filter.

### Table 3: Cabinet and Duct Dimensions

<table>
<thead>
<tr>
<th>BTUH (kW) Input</th>
<th>Nominal CFM (m³/min)</th>
<th>Cabinet Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 (11.7)</td>
<td>800 (22.7)</td>
<td>A</td>
</tr>
<tr>
<td>60 (17.6)</td>
<td>1000 (28.3)</td>
<td>A</td>
</tr>
<tr>
<td>60 (17.6)</td>
<td>1200 (34.0)</td>
<td>B</td>
</tr>
<tr>
<td>80 (23.4)</td>
<td>1200 (34.0)</td>
<td>B</td>
</tr>
<tr>
<td>80 (23.4)</td>
<td>1600 (45.3)</td>
<td>C</td>
</tr>
<tr>
<td>80 (23.4)</td>
<td>2200 (62.3)</td>
<td>C</td>
</tr>
<tr>
<td>100 (29.3)</td>
<td>1600 (45.3)</td>
<td>C</td>
</tr>
<tr>
<td>100 (29.3)</td>
<td>2000 (56.6)</td>
<td>C</td>
</tr>
<tr>
<td>120 (35.1)</td>
<td>1600 (45.3)</td>
<td>D</td>
</tr>
<tr>
<td>120 (35.1)</td>
<td>2000 (56.6)</td>
<td>D</td>
</tr>
<tr>
<td>130 (38.1)</td>
<td>2000 (56.6)</td>
<td>D</td>
</tr>
</tbody>
</table>

### Table 4: Recommended Filter Sizes (High Velocity 600 FPM)

<table>
<thead>
<tr>
<th>CFM (m³/min)</th>
<th>Cabinet Size</th>
<th>Side (in)</th>
<th>Bottom (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 (22.7)</td>
<td>A</td>
<td>16 x 25</td>
<td>14 x 25</td>
</tr>
<tr>
<td>1000 (28.3)</td>
<td>A</td>
<td>16 x 25</td>
<td>14 x 25</td>
</tr>
<tr>
<td>1200 (34.0)</td>
<td>A</td>
<td>16 x 25</td>
<td>14 x 25</td>
</tr>
<tr>
<td>1200 (34.0)</td>
<td>B</td>
<td>16 x 25</td>
<td>16 x 25</td>
</tr>
<tr>
<td>1600 (45.3)</td>
<td>B</td>
<td>16 x 25</td>
<td>16 x 25</td>
</tr>
<tr>
<td>1600 (45.3)</td>
<td>C</td>
<td>16 x 25</td>
<td>20 x 25</td>
</tr>
<tr>
<td>2000 (56.6)</td>
<td>C (2)</td>
<td>16 x 25</td>
<td>20 x 25</td>
</tr>
<tr>
<td>2200 (62.3)</td>
<td>C (2)</td>
<td>16 x 25</td>
<td>20 x 25</td>
</tr>
<tr>
<td>2000 (56.6)</td>
<td>D (2)</td>
<td>16 x 25</td>
<td>22 x 25</td>
</tr>
</tbody>
</table>

1. Air velocity through throwaway type filters may not exceed 300 feet per minute (91.4 m/min). All velocities over this require the use of high velocity filters.

2. Do not exceed 1800 CFM using a single side return and a 16x25 filter. For CFM greater than 1800, you may use two side returns or one side and the bottom or one side return with a transition to allow use of a 20x25 filter.
SIDE RETURN
Locate the “L” shaped corner locators. These indicate the size of the cut-out to be made in the furnace side panel. Refer to Figure 14.

Install the side filter rack following the instructions provided with that accessory. If a filter(s) is provided at another location in the return air system, the ductwork may be directly attached to the furnace side panel.

HORIZONTAL APPLICATION

Horizontal Filters

Any branch duct (rectangular or round duct) attached to the plenum must attach to the vertical plenum before the filter. The use of straps and/or supports is required to support the weight of the external filter box.

Downflow Filters

Downflow furnaces typically are installed with the filters located above the furnace, extending into the return air plenum or duct. Any branch duct (rectangular or round duct) attached to the plenum must attach to the vertical plenum above the filter height.

Filter(s) may be located in the duct system external to the furnace using an external duct filter box attached to the furnace plenum or at the end of the duct in a return filter grille(s). The use of straps and/or supports is required to support the weight of the external filter box.

SECTION IV: GAS PIPING

GAS SAFETY

An overpressure protection device, such as a pressure regulator, must be installed in the gas piping system upstream of the furnace and must act to limit the downstream pressure to the gas valve so it does not exceed 0.5 psig [14” w.c. (3.48 kPa)]. Pressures exceeding 0.5 psig [14” w.c. (3.48 kPa)] at the gas valve will cause damage to the gas valve, resulting in a fire or explosion or cause damage to the furnace or some of its components that will result in property damage and loss of life.

GAS PIPING INSTALLATION

Properly sized wrought iron, approved flexible or steel pipe must be used when making gas connections to the unit. If local codes allow the use of a flexible gas appliance connection, always use a new listed connector. Do not use a connector that has previously serviced another gas appliance.

Some utility companies or local codes require pipe sizes larger than the minimum sizes listed in these instructions and in the codes. The furnace rating plate and the instructions in this section specify the type of gas approved for this furnace - only use those approved gases. The installation of a drip leg and ground union is required. Refer to Figure 16.
The furnace must be isolated from the gas supply piping system by closing its individual external manual shutoff valve during any pressure testing of the gas supply piping system at pressures equal to or less than 0.5 psig (3.5 kPa).

Gas piping may be connected from either side of the furnace using any of the gas pipe entry knockouts on both sides of the furnace. Refer to Figure 13.

Table 5: Nominal Manifold Pressure - High Fire

<table>
<thead>
<tr>
<th>Gas Heating Value (BTU/ cu ft.)</th>
<th>Manifold Pressures (in. w.c.)</th>
<th>Manifold Pressures (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>0-7999</td>
<td>8000-8999</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>850</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>900</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>950</td>
<td>3.5</td>
<td>3.3</td>
</tr>
<tr>
<td>1000</td>
<td>3.5</td>
<td>2.9</td>
</tr>
<tr>
<td>1050</td>
<td>3.5</td>
<td>2.7</td>
</tr>
<tr>
<td>1100</td>
<td>3.2</td>
<td>2.4</td>
</tr>
<tr>
<td>2500 (LP)</td>
<td>9.8</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.5</td>
</tr>
</tbody>
</table>

The gas valve body is a very thin casting that cannot take any external pressure. Never apply a pipe wrench to the body of the gas valve when installing piping. A wrench must be placed on the octagon hub located on the gas inlet side of the valve. Placing a wrench to the body of the gas valve will damage the valve causing improper operation and/or the valve to leak.

GAS ORIFICE CONVERSION FOR PROPANE (LP)
This furnace is constructed at the factory for natural gas-fired operation, but may be converted to operate on propane (LP) gas by using a factory-supplied LP conversion kit. Follow the instructions supplied with the LP kit.

HIGH ALTITUDE GAS ORIFICE CONVERSION
This furnace is constructed at the factory for natural gas-fired operation at 0 – 7,999 feet (0 – 2,438 m) above sea level. The manifold pressure must be changed in order to maintain proper and safe operation when the furnace is installed in a location where the altitude is greater than 7,999 feet (2,438 m) above sea level. Refer to Table 5 for proper manifold pressure settings.

HIGH ALTITUDE PRESSURE SWITCH CONVERSION
For installation where the altitude is less than 5,000 feet (1,524 m), it is not required that the pressure switch be changed unless you are in an area subject to low pressure inversions.

SECTION V: ELECTRICAL POWER

ELECTRICAL POWER CONNECTIONS
Field wiring to the unit must be grounded. Electric wires that are field installed shall conform to the temperature limitation for 63°F (35°C) rise wire when installed in accordance with instructions. Refer to Table 6 in these instructions for specific furnace electrical data.
SUPPLY VOLTAGE CONNECTIONS

1. Provide a power supply separate from all other circuits. Install overcurrent protection and disconnect switch per local/national electrical codes. The switch should be close to the unit for convenience in servicing. With the disconnect or fused switch in the OFF position, check all wiring against the unit wiring label. Refer to the wiring diagram in this instruction.

2. Remove the wiring box cover screws. Route all power wiring through a conduit connector or other proper bushing that has been installed into the unit opening and the junction box. In the junction box there is a black wire, a white wire and a green ground screw. Connect the power supply as shown on the unit’s wiring label on the inside of the blower compartment door or the wiring schematic in this section. Connect the black wire to L1 (hot) from the power supply. Connect the white wire to neutral. Connect the ground wire (installer-supplied) to the green (equipment ground) screw.

3. The furnace’s control system requires correct polarity of the power supply and a proper ground connection. Refer to Figure 17.

Table 6: Ratings & Physical / Electrical Data

<table>
<thead>
<tr>
<th>Input MBH</th>
<th>Output MBH</th>
<th>Nominal Airflow CFM</th>
<th>m³/min</th>
<th>AFUE %</th>
<th>Air Temp. Rise °F</th>
<th>°C</th>
<th>Max. Outlet Air Temp °F</th>
<th>°C</th>
<th>Blower Size</th>
<th>HP</th>
<th>Amps</th>
<th>Max Over-Current Protect</th>
<th>Total Unit Amps</th>
<th>Min. wire Size (awg) @ 75 ft one way</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>11.7</td>
<td>38</td>
<td>11.1</td>
<td>800</td>
<td>22.7</td>
<td>95.5</td>
<td>30-60</td>
<td>17-33</td>
<td>160</td>
<td>71.1</td>
<td>1/3</td>
<td>4.8</td>
<td>11x8</td>
<td>15</td>
</tr>
<tr>
<td>60</td>
<td>17.6</td>
<td>57</td>
<td>16.7</td>
<td>1000</td>
<td>28.3</td>
<td>95.5</td>
<td>30-60</td>
<td>19-36</td>
<td>160</td>
<td>71.1</td>
<td>1/2</td>
<td>7.07</td>
<td>11x8</td>
<td>15</td>
</tr>
<tr>
<td>60</td>
<td>17.6</td>
<td>57</td>
<td>16.7</td>
<td>1200</td>
<td>34.0</td>
<td>95.5</td>
<td>30-60</td>
<td>19-36</td>
<td>160</td>
<td>71.1</td>
<td>1/2</td>
<td>7.07</td>
<td>11x8</td>
<td>15</td>
</tr>
<tr>
<td>80</td>
<td>23.4</td>
<td>76</td>
<td>22.3</td>
<td>1200</td>
<td>34.0</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>1/2</td>
<td>7.07</td>
<td>11x8</td>
<td>15</td>
</tr>
<tr>
<td>80</td>
<td>23.4</td>
<td>76</td>
<td>22.3</td>
<td>1600</td>
<td>45.3</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>3/4</td>
<td>8.8</td>
<td>11x10</td>
<td>15</td>
</tr>
<tr>
<td>80</td>
<td>23.4</td>
<td>76</td>
<td>22.3</td>
<td>2200</td>
<td>62.3</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>1</td>
<td>14.5</td>
<td>11x11</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>29.3</td>
<td>95</td>
<td>27.8</td>
<td>1600</td>
<td>45.3</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>3/4</td>
<td>8.8</td>
<td>11x10</td>
<td>15</td>
</tr>
<tr>
<td>100</td>
<td>29.3</td>
<td>95</td>
<td>27.8</td>
<td>2000</td>
<td>56.6</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>1</td>
<td>14.5</td>
<td>11x11</td>
<td>20</td>
</tr>
<tr>
<td>120</td>
<td>35.1</td>
<td>114</td>
<td>33.4</td>
<td>1600</td>
<td>45.3</td>
<td>95.5</td>
<td>40-70</td>
<td>22-39</td>
<td>170</td>
<td>76.7</td>
<td>3/4</td>
<td>8.8</td>
<td>11x10</td>
<td>15</td>
</tr>
<tr>
<td>120</td>
<td>35.1</td>
<td>114</td>
<td>33.4</td>
<td>2000</td>
<td>56.6</td>
<td>95.5</td>
<td>35-65</td>
<td>19-36</td>
<td>165</td>
<td>73.9</td>
<td>1</td>
<td>14.5</td>
<td>11x11</td>
<td>20</td>
</tr>
<tr>
<td>130</td>
<td>38.1</td>
<td>123.5</td>
<td>36.2</td>
<td>2000</td>
<td>56.6</td>
<td>95.5</td>
<td>45-75</td>
<td>28-44</td>
<td>175</td>
<td>79.4</td>
<td>1</td>
<td>14.5</td>
<td>11x11</td>
<td>20</td>
</tr>
</tbody>
</table>

Annual Fuel Utilization Efficiency (AFUE) numbers are determined in accordance with DOE Test procedures.
Wire size and over current protection must comply with the National Electrical Code (NFPA-70-latest edition) and all local codes.
The furnace shall be installed so that the electrical components are protected from water.

LOW VOLTAGE CONTROL WIRING CONNECTIONS

Install the field-supplied thermostat by following the instructions that come with the thermostat. With the thermostat set in the OFF position and the main electrical source disconnected, connect the thermostat wiring from the wiring connections on the thermostat to the terminal board on the ignition module, as shown in Figure 17. Electronic thermostats may require the common wire to be connected. Apply strain relief to thermostat wires passing through cabinet. If air conditioning equipment is installed, use thermostat wiring to connect the Y and C terminals on the furnace control board to the proper wires on the condensing unit (unit outside).

The power connection leads and wiring box may be relocated to the left side of the furnace. Remove the screws and cut wire tie holding excess wiring. Reposition on the left side of the furnace and fasten using holes provided.

Set the heat anticipator in the room thermostat to 0.4 amps. Setting it lower will cause short cycles. Setting it higher will cause the room temperature to exceed the set points.

Some electronic thermostats do not have adjustable heat anticipators. They should be set to six cycles per hour. Follow the thermostat manufacturer’s instructions.

The 24-volt, 40 VA transformer is sized for the furnace components only, and should not be connected to power auxiliary devices such as humidifiers, air cleaners, etc. The transformer may provide power for an air conditioning unit contactor.
For additional connection diagrams for all UPG equipment refer to “Low Voltage System Wiring” document available on-line at www.upgnet.com in the Product Catalog Section.

**FIGURE 18:** Thermostat Chart - Single Stage AC with Single Stage PSC Furnaces

**AC 5D** Single Stage Air Conditioner – Single Stage PSC Furnace

- **THERMOSTAT**
  - *PP11C70224

- **SINGLE STAGE PSC FURNACE**
  - **ID MODELS**
    - G*(8/9)S
    - GF*(8/9)
    - G’9F
    - LF8
    - LY(8)M(8)S
    - (G,T)G(8/9)S
    - URC
    - (G,T)G(4/3)S

- **SINGLE STAGE AIR CONDITIONER**
  - C
  - 24 – Volt Common

- **Y**
  - Full Stage Compressor
  - RH
  - 24 – Volt Hot
  - (Heat XFMR)

- **G**
  - Fan

- **RC**
  - 24 – Volt Hot
  - (Cool XFMR)

- **W**
  - Full Stage Heat

- **HM1 Humidistat**

- **24VAC Humidifier** (Optional)

- Clipping jumper W914 for electric heat on thermostat is not necessary

- **Other Part Numbers:**
  - SAP = Legacy
  - 265901 = 031-09166

*Johnson Controls Unitary Products*
**FIGURE 19:** Thermostat Chart - Single Stage HP with Single Stage PSC Furnaces

<table>
<thead>
<tr>
<th>THERMOSTAT</th>
<th>THERMOSTAT</th>
<th>THERMOSTAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>*DN22U00124</td>
<td>*BP21H50124</td>
<td>*DP32H70124</td>
</tr>
</tbody>
</table>

### ID MODELS

<table>
<thead>
<tr>
<th>ID MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>G*(8/9)S</td>
</tr>
<tr>
<td>G*9F</td>
</tr>
<tr>
<td>L(Y/M)8S</td>
</tr>
<tr>
<td>(G,T)G*(8/9)S</td>
</tr>
<tr>
<td>GBC</td>
</tr>
<tr>
<td>(G,T)GLS</td>
</tr>
</tbody>
</table>

### OD MODELS

<table>
<thead>
<tr>
<th>OD MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>E<em>R</em></td>
</tr>
<tr>
<td>*RHS</td>
</tr>
<tr>
<td>E*2D</td>
</tr>
<tr>
<td>HP*</td>
</tr>
<tr>
<td>E<em>B</em></td>
</tr>
<tr>
<td>*HGD</td>
</tr>
</tbody>
</table>

---

- **Part Numbers:**
  - SAP = Legacy
  - 265901 = 031-09166
  - 67297 = 031-01975

---

**HP 2C** Single Stage Heat Pump - Single Stage PSC Furnace

**SINGLE STAGE PSC FURNACE**

- **24 – Volt Common:** C
- **24 – Volt Hot:** R
- **Fan:** G
- **Emergency Heat:** E
- **Malfunction Light:** L
- **Reversing Valve:** O
- **Auxiliary Heat:** W
- **First Stage Compressor:** Y1
- **Second Stage Compressor:** Y2

**SINGLE STAGE HEAT PUMP**

- **24 – Volt Common:** C
- **24 – Volt Hot:** R
- **Fan:** G
- **Emergency Heat:** E
- **Malfunction Light:** L
- **Reversing Valve:** O
- **Auxiliary Heat:** W

**DEMAND DEFROST CONTROL**

- **24 – Volt Common:** C
- **24 – Volt Hot:** R
- **Malfunction Light:** L
- **Reversing Valve:** O
- **Auxiliary Heat:** W

---

**Step 1 of Thermostat Installer / Configuration Menu must be set to Heat Pump 1**

**Step 9 of Thermostat Installer / Configuration Menu must be set to Pump OFF**

**External Humidistat (Optional)**

- **Open on Humidity Rise:** 3

**24VAC Humidifier (Optional)**

- **Part Number:** S1-2HU16700124
ACCESSORY CONNECTIONS
The furnace control will allow power-switching control of various accessories.

ELECTRONIC AIR CLEANER CONNECTION
Two 1/4" (6.4 mm) spade terminals (EAC and NEUTRAL) for electronic air cleaner connections are located on the control board. The terminals provide 115 VAC (1.0 amp maximum) during circulating blower operation.

HUMIDIFIER CONNECTION
Two 1/4" (6.4 mm) spade terminals (HUM and NEUTRAL) for humidifier connections are located on the control board. The terminals provide 115 VAC (1.0 amp maximum) during heating system operation. A mounting hole is provided on the control panel next to the furnace control board for mounting a humidifier transformer if required.

SECTION VI: TWINNING AND STAGING
In applications where more heating capacity or more airflow capacity is needed than what one furnace can deliver, twinning can be used to make two furnaces operate in tandem. When two furnaces are installed using the same duct system, it is very important that the two furnace circulating air blowers operate in unison. If one blower starts before the second blower, the duct system will become pressurized and the blower on the second furnace will turn backwards causing the second furnace to overheat, resulting in damage to the furnace. Twinning is used to make two furnaces operate in tandem, using one duct system, one room thermostat and causing both furnaces to turn on and off simultaneously.

WARNING
Before installing the relay and wiring, disconnect electrical power to both furnaces. Failure to cut power could result in electrical shock or equipment damage.

CAUTION
The relay must not be installed in any location where it could be exposed to water. If the relay has been exposed to water in any way, it must not be used.

TWINNING DUCT SYSTEM
Twinned furnaces must only be applied on a common duct system. A single air supply plenum must be used for both furnaces and coil(s). Separate plenums and supply ducts systems cannot be utilized. A single return air plenum, common to both furnaces must be used. It is suggested that a return platform be utilized, with bottom air entrance into each furnace. If a side entrance returns system is used, the common return duct must be divided equally so as to supply each furnace with an equal amount of return air.

Both furnaces must be identical models in both heating capacity and CFM capacity. Both furnaces must be operated on the same motor speed tap. See typical application, Figure 20.

If furnace staging is desired with two single stage furnaces on a common duct, where the gas burner on the first furnace operates on W1 and the gas burner on the second furnace operates on W2, then the use of an air-mixing device in the plenum to mix the air from both furnaces is strongly recommended. The mixing device must be installed before any ducts that supply air to occupied spaces. Twinning causes both indoor fans to operate simultaneously. If a mixing device is not used, any ducts that are connected down stream from the furnace that operates on W2, will be supplying cold air in the Heating mode to the occupied spaces unless W2 is energized.

FIGURE 20: Typical Twinned Furnace Application

[IMPORTANT]
When two furnaces are twinned, typical system total airflow will be approximately 85% of additive individual furnaces, i.e., two 2000 CFM units will yield a total 3400 CFM.

[CAUTION]
If a return duct is connected to only one furnace (with a connection between the two furnaces) an imbalance in the airflow will occur and the furnace furthest from the return plenum will overheat.

GAS PIPING
Furnace gas supplies must be provided as specified with these instructions. Since the furnaces are side by side, with no space between, gas supplies must enter on the right and left respectively. All gas piping must be in accordance with the national fuel gas code, ANSI Z223.1, latest edition, and/or all local code or utility requirements.

TWINNING
In applications where more heating capacity or more airflow capacity is needed than what one furnace can deliver, twinning can be used to make two furnaces operate in tandem, using one duct system and one room thermostat. When one duct system is used for two furnaces, it is necessary that the two blowers operate in unison. The twinning function of the board in this furnace ensures that both blowers turn on and off simultaneously, and operate on the same blower speed.

Single-Wire Twinning
The control in the furnace has the single-wire twinning feature. With this feature, a single wire is connected between the TWIN terminal on one furnace board to the TWIN terminal on the second furnace board. The board then communicates the blower status from one furnace to the other along this wire. This communication makes the second furnace blower come on at the same time, and on the same speed, as the first furnace blower. To ensure stable communication, the common terminal of each control must be connected.

Single-Wire Twinning Instructions
Connect the control wiring as shown in Figure 21.
1. Connect the low voltage wiring from the wall thermostat to the terminal strip on the control board of Furnace #1.
2. Connect a wire from the TWIN terminal of Furnace #1 to the TWIN terminal of Furnace #2.
3. Install a separate 24V relay as shown in the diagram below. Use of this relay is required, as it ensures that the transformers of the two furnaces are isolated, thus preventing the possibility of any safety devices being bypassed.
4. Connect the common wires of furnace #1 to the common terminal of furnace #2.
Single-Wire Twinning Operation
Heating - On a call for heat (W signal) from the wall thermostat, both furnaces will start the ignition sequence and the burners on both furnaces will light. About thirty seconds after the burners light, the blowers on both furnaces will come on in heating speed. When the thermostat is satisfied, the burners will all shut off and, after the selected blower off delay time, both blowers will shut off at the same time. The twinning control ensures that both blowers come on and shut off at the same time.

Cooling - On a call for cooling (Y signal) from the wall thermostat, both furnace blowers will come on at the same time in cooling speed. When the thermostat is satisfied, both blowers will stay on for 60 seconds, then will shut off at the same time.

Continuous Fan - On a thermostat call for continuous fan (G signal), both furnace blowers will come on at the same time in cooling speed and will stay on until the G signal is removed.

Single-Wire Staging Operation
Heating - On a call for first-stage heat (W1 signal) from the wall thermostat, Furnace #1 will start the ignition sequence and the burners will light. About thirty seconds after the burners light, the blowers on both furnaces will come on in heating speed. When the thermostat is satisfied, the burners will shut off and, after the selected blower off delay time, both blowers will shut off at the same time. On a call for second stage of heat, the burners of Furnace #2 will also light and both blowers will run. The twinning control ensures that both blowers come on and shut off at the same time.

Cooling - On a call for cooling (Y signal) from the wall thermostat, both furnace blowers will come on at the same time. When the thermostat is satisfied, both blowers will stay on for 60 seconds, then will shut off at the same time.

Continuous Fan - On a thermostat call for continuous fan (G signal), both furnace blowers will come on at the same time in cooling speed and will stay on until the G signal is removed.

---

**FIGURE 21: Single Wire Twinning Wiring Diagram**

**FIGURE 22: Single Wire Staging Wiring Diagram**

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**STAGING**

This control can also be used along with a two-stage wall thermostat to stage two twinned furnaces, making them operate like a single two-stage furnace. This allows only one furnace to supply heat during times when the heat output from one furnace is sufficient to satisfy the demand. When one duct system is used for two furnaces, it is necessary that the two blowers operate in unison. The twinning function of this board ensures that both blowers turn on and off simultaneously, and operate on the same blower speed. Even when only one furnace is supplying heat, both furnace blowers must run.

**Single-Wire Staging**

The single-wire twinning feature of this board can also be used for staging of two furnaces. With this feature, a single wire is connected between the TWIN terminal on one furnace board to the TWIN terminal on the second furnace board. The board then communicates the blower status from one furnace to the other along this wire. This communication makes the second furnace blow come on at the same time, and on the same speed, as the first furnace blower. To ensure stable communication, the common terminal of each control must be connected.

**Single-Wire Staging Instructions**

Connect the control wiring as shown in Figure 22.

1. Connect the low voltage wiring from the wall thermostat to the terminal strip on the control board of Furnace #1. For staging applications, the wire from thermostat W1 is connected to the W connection on the board on Furnace #1. The wire from thermostat W2 is connected to Furnace #2 through a separate relay, as described below.
2. Connect a wire from the TWIN terminal of Furnace #1 to the TWIN terminal of Furnace #2.
3. Install a separate 24V relay as shown in the diagram below. Use of this relay is required, as it ensures that the transformers of the two furnaces are isolated, thus preventing the possibility of any safety devices being bypassed.
4. Connect the common between furnace #1 and furnace #2.
The condensate will flow to the drain better if an open stand pipe is installed in the drain line. See Figure 23.

If an external vent tee is being installed, then it must have its own condensate trap before it is disposed into an open or vented drain. This is not to be considered as a second trap as referenced elsewhere in this document.

A loop has been added to the pressure switch vacuum hose. However, ensure that all pressure switch hoses are routed such that they prevent any condensate from entering the pressure switch.

Liquid anti-freeze will cause damage to internal plastic parts of this furnace. DO NOT attempt to winterize the furnace using liquid anti-freeze.

CONJECTIVE DRAIN TERMINATION

A condensate sump pump MUST be used if required by local codes, or if no indoor floor drain is available. The condensate sump pump must be approved for use with acidic condensate.

DO NOT terminate the condensate drain in a chimney, or where the drain line may freeze. If the drain line will be exposed to temperatures below freezing, adequate measures must be taken to prevent the drain line from freezing. Failure to provide proper protection from freezing can result in improper operation or damage to the equipment and possible property damage. When exposed to temperatures below freezing, use of a 3 to 6 watt per foot at 115 VAC, 40°F (4.4°C) self-regulating, shielded and waterproof heat tape is recommended on the drain line outside the furnace. DO NOT trap the drain line at any other location than at the condensate drain trap supplied with the furnace.

It is possible for condensation to form inside the combustion air (intake) pipe in the summer months if significant length of combustion air pipe passed through conditioned space. This problem can be averted by the addition of a simple drain tee, or a drain tee with a drain on the combustion air pipe as close to the furnace as possible, as shown in Figure 24. This is true for all long horizontal venting in any furnace configuration. This will prevent the condensate from entering the furnace.
When drain hose routing changes are required, be sure to cap all un-used openings. If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.

For 040, 060 & 080K input furnaces, the condensate drain is plumbed toward the right casing outlet from the factory. For 100, 120 & 130K input furnaces, the condensate drain may exit cabinet on either side. 130 K Model does not have provisions for top venting, it must be vented through a side opening.

For 040, 060 & 080K input furnaces, the condensate drain is plumbed toward the right casing outlet from the factory. For 100, 120 & 130K input furnaces, the condensate drain may exit cabinet on either side. 130 K Model does not have provisions for top venting, it must be vented through a side opening.

FIGURE 25: Upflow Configuration
When drain hose routing changes are required, be sure to cap all un-used openings. If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.

1. Move pressure switch hose to this position. NOTE: May require the longer hose that is provided with wider cabinets.
2. Move rain gutter hose to this position.
3. Move condensate drain hose to this position (May exit either side of the cabinet).

FIGURE 26: Downflow Configuration
When drain hose routing changes are required, be sure to cap all un-used openings.

If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.

When drain hose routing changes are required, be sure to cap all un-used openings.

FIGURE 27: Horizontal Left Configuration
When drain hose routing changes are required, be sure to cap all un-used openings. If rerouting hoses - excess length should be cut off so that no sagging loops will collect and hold condensate, which will cause the furnace to not operate.
SECTION VIII: COMBUSTION AIR AND VENT SYSTEM

COMBUSTION AIR AND VENT SAFETY

This Category IV, dual certified direct vent furnace is designed for residential application. It may be installed without modification to the condensate system in a basement, garage, equipment room, alcove, attic or any other indoor location where all required clearance to combustible and other restrictions are met. The combustion air and the venting system must be installed in accordance with Section 5.3. Air for Combustion and Ventilation, of the National Fuel Gas Code Z223.1/NFPA 54 (latest edition), or Sections 7.2, 7.3 or 7.4 of CSA B149.1, National Gas and Propane Codes (latest edition) or applicable provisions of the local building code and these instructions.

The “VENT SYSTEM” must be installed as specified in these instructions for Residential and non-HUD Modular Homes. The direct vent system is the only configuration that can be installed in a non-HUD Modular Home.

This furnace may not be common vented with any other appliance, since it requires separate, properly sized air intake and vent lines. The furnace shall not be connected to any type of B, BW or L vent or vent connector, and not connected to any portion of a factory-built or masonry chimney
The furnace shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

When combustion air pipe is installed above a suspended ceiling or when it passes through a warm and humid space, the pipe must be insulated with 1/2” Armaflex or other heat resistant type insulation if two feet or more of pipe is exposed.
Vent piping must be insulated if it will be subjected to freezing temperatures such as routing through unheated areas or through an unused chimney.

COMBUSTION AIR/VENT PIPE SIZING

The size of pipe required will be determined by the furnace model, the total length of pipe required and the number of elbows required.

Table 7 lists the maximum equivalent length of pipe allowed for each model of furnace. The equivalent length of elbows is shown in Table 9. The equivalent length of the vent system is the total length of straight pipe PLUS the equivalent length of all of the elbows.

The following rules must also be followed:
1. Long radius (sweep) elbows are recommended. Standard elbows may be used, but since they have a longer equivalent length, they will reduce the total length of pipe that will be allowed. Short radius (plumbing vent) elbows are not allowed. The standard dimensions of the acceptable elbows are shown below.
2. The maximum equivalent length listed in Table 7 is for the vent piping and the air intake piping separately. For example, if the table allows 65 equivalent feet for a particular model, then the vent can have 65 equivalent feet of pipe, AND the combustion air intake can have another 65 equivalent feet of pipe.
3. Three vent terminal elbows (two for the vent and one for the combustion air intake) are already accounted for and need not be included in the equivalent length calculation.
4. All combustion air and vent pipe must conform to American National Standards Institute (ANSI) and American Society for Testing and Materials (ASTM) standards D1785 (Schedule 40 PVC), D2665 (PVC-DWV), F891 (PVC-DWV Cellular Core), D2261 (ABS-DWV) or F628 (Schedule 40 ABS). Pipe cement and primer must conform to ASTM Standard D2546 (PVC) or D2235 (ABS). If ABS pipe is to be used, any joint where ABS pipe is joined to PVC pipe must be glued with cement that is approved for use with BOTH materials. Metallic materials must not be used for venting or air intake.
5. If a flexible connector is used in the vent system, it must be made of a material that is resistant to acidic exposure and to at least 225°F (107°C) temperature. Flexible connectors are also allowed in the combustion air pipe.
6. All models are supplied with 2" (5.1 cm) vent connections. When the pipe must be increased to 3” (7.6 cm) diameter, the transition from 2” to 3” must be done as close to the furnace as possible. For upflow models, the transition from 2” to 3” should be done immediately above the furnace. For downflow or horizontal models, the transition from 2” to 3” pipe should be done immediately after exiting the furnace.
7. In Canada, vents shall be certified to ULC S636, Standard for Type BH Gas Venting Systems.
8. In Canada, the first three feet (91.4 cm) of the vent must be readily accessible for inspection.
9. For single pipe systems it is recommended to install the combustion air coupling provided and install approximately 18” (46 cm) of PVC pipe on the furnace.
10. Minimum vent length for all models is 5 feet (1.5 m).

TABLE 7: Maximum Equivalent Pipe Length

<table>
<thead>
<tr>
<th>Model Input BTUH (kW)</th>
<th>Pipe Size Inches (cm)</th>
<th>Maximum Equivalent Pipe Length Feet (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40,000 (11.7)</td>
<td>2 (5.1)</td>
<td>65 (19.8)</td>
</tr>
<tr>
<td>40,000 (11.7)</td>
<td>3 (7.6)</td>
<td>90 (27.4)</td>
</tr>
<tr>
<td>60,000 (17.6)</td>
<td>2 (5.1)</td>
<td>65 (19.8)</td>
</tr>
<tr>
<td>60,000 (17.6)</td>
<td>3 (7.6)</td>
<td>90 (27.4)</td>
</tr>
<tr>
<td>80,000 (23.4)</td>
<td>2 (5.1)</td>
<td>65 (19.8)</td>
</tr>
<tr>
<td>80,000 (23.4)</td>
<td>3 (7.6)</td>
<td>90 (27.4)</td>
</tr>
<tr>
<td>100,000 (29.3)</td>
<td>2 (5.1)</td>
<td>65 (19.8)</td>
</tr>
<tr>
<td>100,000 (29.3)</td>
<td>3 (7.6)</td>
<td>90 (27.4)</td>
</tr>
<tr>
<td>120,000 (35.1)</td>
<td>2 (5.1)</td>
<td>65 (19.8)</td>
</tr>
<tr>
<td>120,000 (35.1)</td>
<td>3 (7.6)</td>
<td>90 (27.4)</td>
</tr>
<tr>
<td>130,000 (38.1)</td>
<td>3 (7.6)</td>
<td>85 (25.9)</td>
</tr>
</tbody>
</table>

FIGURE 29: Dimensions

TABLE 8: Elbow Dimensions

<table>
<thead>
<tr>
<th>Elbow “A” Dimension</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; Standard</td>
<td>2-5/16&quot;</td>
</tr>
<tr>
<td>3&quot; Standard</td>
<td>3-1/16&quot;</td>
</tr>
<tr>
<td>2&quot; Sweep</td>
<td>3-1/4&quot;</td>
</tr>
<tr>
<td>3&quot; Sweep</td>
<td>4-1/16&quot;</td>
</tr>
</tbody>
</table>

Dimensions are those required in Standard ASTM D-3311.
Example:
An 80,000 BTUH furnace requires 32 feet of pipe and five 90° elbows. Using 2" pipe and standard elbows, the total equivalent length will be:

\[
\text{32 feet of 2\" pipe = 32 equivalent feet}
\]
\[
5 \text{ - 90° standard 2\" elbows = (5 x 7) = 35 equivalent feet}
\]
\[
\text{Total = 67 equivalent feet of 2\" pipe}
\]

This exceeds the 65 foot maximum equivalent length of 2" pipe allowed for that model and is thus not acceptable.

By using sweep elbows, the total equivalent length will be:

\[
\text{32 feet of 2\" pipe = 32 equivalent feet}
\]
\[
5 \text{ - 90° sweep 2\" elbows = (5 x 5) = 25 equivalent feet}
\]
\[
\text{Total = 57 equivalent feet of 2\" pipe}
\]

This is less than the 65 foot maximum equivalent length of 2" pipe allowed for that model and is thus acceptable.

Alternatively, using 3" pipe and standard elbows, the total equivalent length will be:

\[
\text{32 feet of 3\" pipe = 32 equivalent feet}
\]
\[
5 \text{ - 90° standard 3\" elbows = (5 x 7) = 35 equivalent feet}
\]
\[
\text{Total = 67 equivalent feet of 3\" pipe}
\]

This is less than the 90 foot maximum equivalent length of 3" pipe allowed for that model and is thus acceptable.

### TABLE 9: Equivalent Length of Fittings

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Equivalent Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; 90° sweep elbow</td>
<td>5 feet of 2&quot; pipe</td>
</tr>
<tr>
<td>2&quot; 45° sweep elbow</td>
<td>2-1/2 feet of 2&quot; pipe</td>
</tr>
<tr>
<td>2&quot; 90° standard elbow</td>
<td>7 feet of 2&quot; pipe</td>
</tr>
<tr>
<td>2&quot; 45° standard elbow</td>
<td>3-1/2 feet of 2&quot; pipe</td>
</tr>
<tr>
<td>3&quot; 90° sweep elbow</td>
<td>5 feet of 3&quot; pipe</td>
</tr>
<tr>
<td>3&quot; 45° sweep elbow</td>
<td>2-1/2 feet of 3&quot; pipe</td>
</tr>
<tr>
<td>3&quot; 90° standard elbow</td>
<td>7 feet of 3&quot; pipe</td>
</tr>
<tr>
<td>3&quot; 45° standard elbow</td>
<td>3-1/2 feet of 3&quot; pipe</td>
</tr>
<tr>
<td>2&quot; corrugated connector</td>
<td>10 feet of 2&quot; pipe</td>
</tr>
<tr>
<td>3&quot; corrugated connector</td>
<td>10 feet of 3&quot; pipe</td>
</tr>
</tbody>
</table>

### TABLE 10: Combustion Air Intake and Vent Connection Size at Furnace (All Models)

<table>
<thead>
<tr>
<th>Furnace Input</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake Pipe Size</td>
<td>2&quot; (5.1 cm)</td>
</tr>
<tr>
<td>Vent Pipe Size</td>
<td>2&quot; (5.1 cm)</td>
</tr>
</tbody>
</table>

**Furnace**

Furnace vent pipe connections are sized for 2\" (5.1 cm) pipe. Any pipe size change must be made outside the furnace casing in a vertical pipe section to allow proper drainage of condensate. An offset using two 45° (degree) elbows will be required for plenum clearance when the vent is increased to 3\" (7.6 cm).

**Accessory**

Accessory concentric vent / intake termination kits 1CT0302 and 1CT0303, and for Canadian applications 1CT0302-636 and 1CT0303-636 are available and approved for use with these furnaces. Horizontal sidewall vent terminations kits 1HT0901 & 1HT0902 are also approved for use with these furnaces.

**Combustion Air and Vent Piping Assembly**

The final assembly procedure for the combustion air and vent piping is as follows:

1. Cut piping to the proper length beginning at the furnace.
2. Deburr the piping inside and outside.
3. Chamfer (bevel) the outer edges of the piping.
4. Dry-fit the vent piping assembly from the furnace to the outside termination checking for proper fit and slope.
5. Dry-fit the combustion air piping assembly checking for proper fit, support and slope on the following systems:
   a. Sealed combustion air systems from the furnace to the outside termination.
   b. Ventilated combustion air systems from the furnace to the attic or crawl space termination.

**CAUTION**

Solvent cements are flammable and must be used in well-ventilated areas only. Keep them away from heat, sparks and open flames. Do not breathe vapors and avoid contact with skin and eyes.

6. Disassemble the combustion air and vent piping, apply cement primer and the cement per the manufactures instructions. Primer and cement must conform to ASTM D2564 for PVC, or ASTM D2235 for ABS piping.
7. All joints must provide a permanent airtight and watertight seal.
8. Support the combustion air and vent piping such that it is angled a minimum of 1/4" per foot (21 mm/m) so that condensate will flow back towards the furnace. Piping should be supported with pipe hangers to prevent sagging.
9. Seal around the openings where the combustion air and / or vent piping pass through the roof or sidewalls.

**Combustion Air / Venting**

The vent must be installed with the minimum required clearances, and must comply with local codes and requirements.
VENT CLEARANCES

**FIGURE 30: Home Layout**

<table>
<thead>
<tr>
<th>Direct Vent Terminal Clearances</th>
<th>Canadian Installations(^{1,3})</th>
<th>US Installation(^{2,3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Clearance above grade, veranda, porch, deck, or balcony</td>
<td>12” (30.5 cm) for models ≤100,000 BTUH (30 kW).</td>
<td>12” (30.5 cm)</td>
</tr>
<tr>
<td>B. Clearance to window or door that may be opened</td>
<td>12” (30.5 cm) for models ≤100,000 BTUH (30 kW).</td>
<td>Two-pipe (direct vent) applications: 12” (30.5 cm)(^†). Single-pipe applications: 4 feet (1.2 m).</td>
</tr>
<tr>
<td>C. Clearance to permanently closed window</td>
<td>12” (30.5 cm)</td>
<td>12” (30.5 cm)</td>
</tr>
<tr>
<td>D. Vertical clearance to ventilated soffit located above the terminal within a horizontal distance of 2 feet (61 cm) from the center line of the terminal</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
<tr>
<td>E. Clearance to unventilated soffit</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
<tr>
<td>F. Clearance to outside corner</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
<tr>
<td>G. Clearance to inside corner</td>
<td>3 feet (91.4 cm)</td>
<td>3 feet (91.4 cm)</td>
</tr>
<tr>
<td>H. Clearance to each side of center line extended above meter/regulator assembly</td>
<td>Above a meter/regulator assembly within 3 feet (91.4 cm) horizontally of the vertical center-line of the regulator vent outlet to a maximum vertical distance of 15 feet (4.5 m) above the meter/regulator assembly.</td>
<td>Above a meter/regulator assembly within 3 feet (91.4 cm) horizontally of the vertical center-line of the regulator vent outlet to a maximum vertical distance of 15 feet (4.5 m) above the meter/regulator assembly.</td>
</tr>
<tr>
<td>I. Clearance to service regulator vent outlet</td>
<td>3 feet (91.4 cm)</td>
<td>3 feet (91.4 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
<tr>
<td>J. Clearance to non-mechanical air supply inlet to building or the combustion air inlet to any other appliance</td>
<td>12” (30.5 cm) for models ≤100,000 BTUH (30 kW).</td>
<td>Two-pipe (direct vent) applications: 12” (30.5 cm) Single-pipe applications: 4 feet (1.2 m).</td>
</tr>
<tr>
<td>K. Clearance to a mechanical supply inlet</td>
<td>6 feet (1.83 m)</td>
<td>3 feet (91.4 cm) above if within 10 feet (3 m) horizontally.</td>
</tr>
<tr>
<td>L. Clearance above paved sidewalk or paved driveway located on public property</td>
<td>7 feet (2.13 m)(^††)</td>
<td>7 feet (2.13 m) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
<tr>
<td>M. Clearance under veranda, porch, deck, or balcony</td>
<td>12” (30.5 cm)(^††)</td>
<td>12” (30.5 cm) or in accordance with local installation codes and the requirements of the gas supplier.</td>
</tr>
</tbody>
</table>

1. In accordance with the current CSA B149.1-00, Natural Gas and Propane Installation Code.
2. In accordance with the current ANSI Z223.1 / NFPA 54, National Gas Code.

\(^†\) A vent shall not terminate directly above a sidewalk or paved driveway that is located between two single family dwellings and serves both dwellings.

\(^††\) 12” (30.5 cm) up from the bottom edge of the structure for Two-pipe (direct vent) applications per ANSI Z223.1 / NFPA 54, National Gas Code.

\(^††\) Permitted only if veranda, porch, deck, or balcony is fully open on a minimum of two sides beneath the floor and the distance between the top of the vent termination and the underside of the veranda, porch, or deck is greater than 12” (30.5 cm) as specified in CSA B149.1-00.

A vent shall not terminate less than 12” (30.5 cm) above a grade level. Any fresh air or make up inlet for dryer or furnace area is considered to be forced air inlet. Avoid areas where condensate drainage may cause problems such as above planters, patios, or adjacent to windows where steam may cause fogging. A terminus of a vent shall be fitted with a cap in accordance with the vent manufacturer’s installation instructions, or in accordance with the installation instructions for a special venting system.

Responsibility for the provision of proper adequate venting and air supply for application shall rest with the installer. Vent shall extend high enough above building, or a neighboring obstruction, so that wind from any direction will not create a positive pressure in the vicinity of the vent.

**IMPORTANT**

Consideration must be given for degradation of building materials by flue gases. Sidewall termination may require sealing or shielding of building surfaces with a corrosion resistant material to protect against combustion product corrosion. Consideration must be given to wind direction in order to prevent flue products and/or condensate from being blown against the building surfaces. If a metal shield is used it must be a stainless steel material at a minimum dimension of 20 inches (51 cm). It is recommended that a retaining type collar be used that is attached to the building surface to prevent movement of the vent pipe.
VENT SYSTEM
This furnace is certified to be installed with one of two possible vent configurations.
1. Horizontal vent system. This vent system can be installed completely horizontal or combinations of horizontal, vertical, or offset using elbows.
2. Vertical vent system. This vent system can be installed completely vertical or a combination of horizontal, vertical, or offset using elbows.

VENT APPLICATIONS AND TERMINATION
When selecting the location for a combustion air / vent termination, the following should be considered:
1. Observe all clearances listed in vent clearances in these instructions.
2. Termination should be positioned where vent vapors will not damage plants or shrubs or air conditioning equipment.
3. Termination should be located where it will not be affected by wind gusts, light snow, airborne leaves or allow recirculation of flue gases.
4. Termination should be located where it will not be damaged or exposed to flying stones, balls, etc.
5. Termination should be positioned where vent vapors are not objectionable.
6. Horizontal portions of the vent system must slope upwards and be supported to prevent sagging.
7. Direct vent systems must be installed so the vent and the combustion air pipes terminate in the same atmospheric zone. Refer to Figures 32 or 33.

VENTING MULTIPLE UNITS
Multiple units can be installed in a space or structure as either a single pipe configuration or a two-pipe configuration.

The combustion air side of the single pipe configuration shown in Figure 31 is referred to in these instructions as ambient combustion air supply. Follow the instructions for ambient combustion air installations, paying particular attention to the section on air source from inside the building. The vent for a single pipe system must be installed as specified in the venting section of these instructions with the vent terminating as shown in Figure 31. Each furnace must have a separate vent pipe. Under NO circumstances can the two vent pipes be tied together.

The combustion air side of the two-pipe configuration shown in Figure 32 can be installed so the combustion air pipes terminate as described in outdoor combustion air or ventilated combustion air sections in these instructions. Follow the instructions for outdoor combustion air or ventilated combustion air and the instructions for installing the vent system with the vent terminating as shown in Figures 34 or 35. The two-pipe system must have a separate combustion air pipe and a separate vent pipe for each furnace. Under NO circumstances can the two combustion air or vent pipes be tied together. The combustion air and vent pipes must terminate in the same atmospheric zone.
All installations must comply with Section 5.3, Air for Combustion and Ventilation of the National Fuel Gas Code, ANSI Z223.1 or Sections 7.2, 7.3 or 7.4 of CAN/CGA B149.1 or .2 Installation Code - latest editions.

This furnace is certified to be installed with one of three possible combustion air intake configurations.

1. **OUTDOOR COMBUSTION AIR:** This is a direct vent configuration where the combustion air is supplied through a PVC or ABS pipe that is connected to the PVC coupling attached to the furnace and is terminated in the same atmospheric zone as the vent. This type of installation is approved on all models. Refer to Figure 36.

2. **AMBIENT COMBUSTION AIR:** Combustion air is supplied from the area surrounding the furnace through openings in the furnace casing. The combustion air and the vent pipes are not terminated in the same atmospheric zone. Refer to Figure 31 for vent terminations. Refer to "Ambient Combustion Air Supply" for proper installation. Refer to Figure 37.

3. **VENTILATED COMBUSTION AIR:** Combustion air is supplied through a PVC or ABS pipe that is connected to the PVC coupling attached to the burner box and is terminated in a ventilated attic or crawl space. The combustion air and the vent pipes are not terminated in the same atmospheric zone. Refer to Figure 39 for attic and crawl space termination. Only the combustion air intake may terminate in the attic. The vent must terminate outside.

**Outdoor Combustion Air**

**Combustion Air Intake/Vent Connections**

This installation requires combustion air to be brought in from outdoors. This requires a properly sized pipe (Shown in Figure 36) that will bring air in from the outdoors to the furnace combustion air intake collar on the burner box. The second pipe (Shown in Figure 36) is the furnace vent pipe.

The combustion air intake pipe should be located either through the wall (horizontal or side vent) or through the roof (vertical vent). Care should be taken to locate side vented systems where trees or shrubs will not block or restrict supply air from entering the terminal.

Also, the terminal assembly should be located as far as possible from a swimming pool or a location where swimming pool chemicals might be stored. Be sure the terminal assembly follows the outdoor clearances listed in Section #1 “Outdoor Air Contaminants.”

**Ambient Combustion Air Supply**

This type installation will draw the air required for combustion from within the space surrounding the appliance and from areas or rooms adjacent to the space surrounding the appliance. This may be from within the space in a non-confined location or it may be brought into the furnace area from outdoors through permanent openings or ducts. It is not piped directly into the furnace. A single, properly sized pipe from the furnace vent connector to the outdoors must be provided. It is recommended that the supplied intake coupling & 18” of pipe be attached to the furnace to prevent accidental blockage of the combustion air intake.

This type of installation requires that the supply air to the appliance(s) be of a sufficient amount to support all of the appliance(s) in the area. Operation of a mechanical exhaust, such as an exhaust fan, kitchen ventilation system, clothes dryer or fireplace may create conditions requiring special attention to avoid unsatisfactory operation of gas appliances. A venting problem or a lack of supply air will result in a hazardous condition, which can cause the appliance to soot and generate dangerous levels of CARBON MONOXIDE, which can lead to serious injury, property damage and/or death.
An **unconfined space** is not less than 50 cu.ft (1.42 m³) per 1,000 Btu/hr (0.293 kWh) input rating for all of the appliances installed in that area.

Rooms communicating directly with the space containing the appliances are considered part of the unconfined space, if doors are furnished with openings or louvers.

A **confined space** is an area with less than 50 cu.ft (1.42 m³) per 1,000 Btu/hr (0.293 kWh) input rating for all of the appliances installed in that area. The following must be considered to obtain proper air for combustion and ventilation in confined spaces.

**Combustion Air Source From Outdoors**

The blocking effects of louvers, grilles and screens must be given consideration in calculating free area. If the free area of a specific louver or grille is not known, Refer to Table 11, to estimate free area.

**Table 11: Estimated Free Area**

<table>
<thead>
<tr>
<th>Wood or Metal Louver or Grille</th>
<th>Wood 20-25%*</th>
<th>Metal 60-70% *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screens+</td>
<td>1/4” (6.4 mm) mesh or larger 100%</td>
<td></td>
</tr>
</tbody>
</table>

* Do not use less than 1/4” (6.4 mm) mesh
+ Free area of louvers and grille varies widely; the installer should follow louver or grille manufacturer’s instructions.

**Dampers, Louvers and Grilles (Canada Only)**

1. The free area of a supply air opening shall be calculated by subtracting the blockage area of all fixed louvers, grilles or screens from the gross area of the opening.
2. Apertures in a fixed louver, grille, or screen shall have no dimension smaller than 1/4” (6.4 mm).
3. A manually operated damper or manually adjustable louvers are not permitted for use.
4. A automatically operated damper or automatically adjustable louvers shall be interlocked so that the main burner cannot operate unless either the damper or the louver is in the fully open position.

**Air Supply Openings and Ducts**

1. An opening may be used in lieu of a duct to provide to provide the outside air supply to an appliance unless otherwise permitted by the authority having jurisdiction. The opening shall be located within 12” (30.5 cm) horizontally from, the burner level of the appliance. Refer to “AIR SOURCE FROM OUTDOORS AND VENT AND SUPPLY AIR SAFETY CHECK” in these instructions for additional information and safety check procedure.
2. The duct shall be either metal, or a material meeting the class 1 requirements of CAN4-S110 Standard for Air Ducts.
3. The duct shall be located not less than 12” (30.5 cm) above the outside grade level.
4. The duct shall terminate within 12” (30.5 cm) above, and within 24” (61 cm) horizontally from, the burner level of the appliance having the largest input.
5. A square or rectangular shaped duct shall only be used when the required free area of the supply opening is 9 in² (58.06 cm²) or larger. When a square or rectangular duct is used, its small dimension shall not be less than 3” (7.6 cm).
6. An air inlet supply from outdoors shall be equipped with a means to prevent the direct entry of rain and wind. Such means shall not reduce the required free area of the air supply opening.
7. An air supply inlet opening from the outdoors shall be located not less than 12” (30.5 cm) above the outside grade level.

**Table 12: Unconfined Space Minimum Area**

<table>
<thead>
<tr>
<th>BTUH Input Rating</th>
<th>Minimum Free Area Required for Each Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>40,000</td>
<td>40 in² (258 cm²)</td>
</tr>
<tr>
<td>60,000</td>
<td>60 in² (387 cm²)</td>
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<tr>
<td>80,000</td>
<td>80 in² (516 cm²)</td>
</tr>
<tr>
<td>100,000</td>
<td>100 in² (645 cm²)</td>
</tr>
<tr>
<td>120,000</td>
<td>120 in² (742 cm²)</td>
</tr>
<tr>
<td>130,000</td>
<td>130 in² (838 cm²)</td>
</tr>
</tbody>
</table>

**Table 13: Free Area**

<table>
<thead>
<tr>
<th>BTUH Input Rating</th>
<th>Minimum Free Area Required for Each Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Horizontal Duct (2,000 BTUH)</td>
</tr>
<tr>
<td></td>
<td>Vertical Duct or Opening to Outside (4,000 BTUH)</td>
</tr>
<tr>
<td></td>
<td>Round Duct (4,000 BTUH)</td>
</tr>
<tr>
<td>40,000</td>
<td>20 in² (129 cm²)</td>
</tr>
<tr>
<td>60,000</td>
<td>30 in² (193 cm²)</td>
</tr>
<tr>
<td>80,000</td>
<td>40 in² (258 cm²)</td>
</tr>
<tr>
<td>100,000</td>
<td>50 in² (322 cm²)</td>
</tr>
<tr>
<td>120,000</td>
<td>60 in² (387 cm²)</td>
</tr>
<tr>
<td>130,000</td>
<td>65 in² (419 cm²)</td>
</tr>
</tbody>
</table>

**EXAMPLE: Determining Free Area.**

Appliance 1 Appliance 2 Total Input
100,000 + 30,000 = (130,000 ÷ 4,000) = 32.5 Sq. In. Vertical Appliance 1 Appliance 2 Total Input
100,000 + 30,000 = (130,000 ÷ 2,000) = 65 Sq. In. Horizontal

**FIGURE 38: Outside and Ambient Combustion Air**
Combustion Air Source from Outdoors

1. Two permanent openings, one within 12" (30.5 cm) of the top and one within 12" (30.5 cm) of bottom of the confined space. Two permanent openings, shall communicate directly or by means of ducts with the outdoors, crawl spaces or attic spaces.

2. One permanent opening, commencing within 12" (30.5 cm) of the top of the enclosure shall be permitted where the equipment has clearances of at least 1" (2.54 cm) from the sides and back and 6" (15.2 cm) from the front of the appliance. The opening shall communicate directly with the outdoors and shall have a minimum free area of:
   a. 1 square inch per 3000 BTU per hour (322 cm² per 0.879 kW) of the total input rating of all equipment located in the enclosure.
   b. Not less than the sum of all vent connectors in the confined space.

3. The duct shall be least the same cross-sectional area as the free area of the air supply inlet opening to which it connects.

4. The blocking effects of louvers, grilles and screens must be given consideration in calculating free area. If the free area of a specific louver or grille is not known. Refer to Table 11.

Ventilated Combustion Air

The ventilated attic space or a crawl space from which the combustion air is taken must comply with the requirements specified in “AIR SOURCE FROM OUTDOORS” in this instruction or in Section 5.3, Air for Combustion and Ventilation of the National Fuel Gas Code, ANSI Z223.1 (latest edition). This type installation requires two properly sized pipes. One brings combustion air from a properly ventilated attic space or crawl space and a second pipe that extends from the furnace vent connection (top right of unit) to the exterior of the building. Refer to Table 7 for intake pipe sizing, allowable length and elbow usage. Follow all notes, procedures and required materials in the “COMBUSTION AIR/VENT PIPE SIZING” section in these instructions when installing the combustion air pipe from the unit and into a ventilated attic space or crawl space. DO NOT terminate vent pipe in an Attic or Crawl Space.

Ventilated Combustion Air Termination

Refer to Figure 39 for required attic termination for the combustion air intake pipe. For attic termination, use two 90 elbows with the open end in a downward position. Be sure to maintain 12" (30.5 cm) clearance above any insulation, flooring or other material.

A crawl space combustion air installation consists of a straight pipe from the PVC coupling on the burner box that extends into the crawl space and terminates with a 1/4" (6.4 mm) mesh screen and no elbows.

**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.

The following steps shall be followed for each appliance connected to the venting system being placed into operation, while all other appliances connected to the venting system are not in operation:

1. Inspect the venting system for proper size and horizontal pitch. Determine that there is no blockage, restriction, leakage, corrosion or other deficiencies, which could cause an unsafe condition.

2. Close all building doors and windows and all doors.

3. Turn on clothes dryers and TURN ON any exhaust fans, such as range hoods and bathroom exhausts, so they shall operate at maximum speed. Open the fireplace dampers. Do not operate a summer exhaust fan.

4. Follow the lighting instructions. Place the appliance being inspected in operation. Adjust thermostat so the appliance shall operate continuously.

5. Test each appliance (such as a water heater) equipped with a draft hood for spillage (down-draft or no draft) at the draft hood relief opening after 5 minutes of main burner operation. Appliances that do not have draft hoods need to be checked at the vent pipe as close to the appliance as possible. Use a combustion analyzer to check the CO₂ and CO levels of each appliance. Use a draft gauge to check for a downdraft or inadequate draft condition.

6. After it has been determined that each appliance properly vents when tested as outlined above, return doors, windows, exhaust fans, fireplace dampers and any other gas burning appliance to their normal condition.

7. If improper venting is observed during any of the above tests, a problem exists with either the venting system or the appliance does not have enough combustion air (Supply Air from outside) to complete combustion. This condition must be corrected before the appliance can function safely.

**NOTE:** An unsafe condition exists when the CO reading exceeds 40 ppm and the draft reading is not in excess of -0.1” w.c. (-25 kPa) with all of the appliance(s) operating at the same time.

8. Any corrections to the venting system and / or to the supply (outside) air system must be in accordance with the National Fuel Gas Code Z223.1 or CAN/CGA B149.1 Natural Gas and Propane Installation Code (latest editions). If the vent system must be resized, follow the appropriate tables in Appendix G of the above codes or for this appliance.

**Specially Engineered Installations**

The above requirements shall be permitted to be waived where special engineering, approved by the authority having jurisdiction, provides an adequate supply of air for combustion and ventilation.

**VENT BLOWER ROTATION**

For ease of venting, the vent blower may be rotated 90° in either direction. For upflow installations the vent may exit through the top or either side of the cabinet. For downflow installations, the vent blower must be rotated so that the vent exits through either side of the cabinet. See Figures 25-28 for details.

**WARNING**

Be sure to instruct the owner not to block this intake pipe.

**FIGURE 39:** Attic and Crawl Space Combustion Air Termination
SECTION IX: START-UP AND ADJUSTMENTS

The initial start-up of the furnace requires the following additional procedures:

IMPORTANT
All electrical connections made in the field and in the factory should be checked for proper tightness.

When the gas supply is initially connected to the furnace, the gas piping may be full of air. In order to purge this air, it is recommended that the ground union be loosened until the odor of gas is detected. When gas is detected, immediately retighten the union and check for leaks. Allow five minutes for any gas to dissipate before continuing with the start-up procedure. Be sure proper ventilation is available to dilute and carry away any vented gas.

GAS PIPING LEAK CHECK

WARNING

FIRE OR EXPLOSION HAZARD
Failure to follow the safety warnings exactly could result in serious injury, death or property damage. 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.

IMPORTANT

Burner ignition may not be satisfactory on first startup due to residual air in the gas line or until gas manifold pressure is adjusted. The ignition control will make three attempts to light before locking out.

It is recommended that when the gas supply is first connected to the furnace, the ground union be loosened until the odor of gas is detected. When gas is detected, immediately tighten the union and check for gas leaks. Allow five minutes for any gas to dissipate before continuing with the start-up procedure. Be sure that proper ventilation is available to dilute and carry away any vented gas.

With furnace in operation, check all of the pipe joints, gas valve connections and manual valve connections for leakage using an approved gas detector, a non-corrosive leak detection fluid or other leak detection methods. Take appropriate action to stop any leak. If a leak persists, replace the faulty component.

The furnace and its equipment shutoff valve must be disconnected from the gas supply during any pressure testing of that system at test pressures in excess of 0.5 psig (3.45 kPa).

The furnace must be isolated from the gas supply piping system by closing the equipment shutoff valve during any pressure testing of the gas supply system.

IGNITION SYSTEM SEQUENCE

1. Turn the gas supply ON at external valve and main gas valve.
2. Set the thermostat above room temperature to call for heat.
3. System start-up will occur as follows:
   a. The induced draft blower motor will start and come up to speed. Shortly after inducer start-up, the hot surface igniter will glow for about 17 seconds.
   b. After this warm up, the ignition module will energize (open) the main gas valve.
   c. After flame is established, the supply air blower will start in about 30 seconds.

CALCULATING THE FURNACE INPUT (NAT. GAS)

Burner orifices are sized to provide proper input rate using natural gas with a heating value of 1030 BTU/Ft$^3$ (38.4 MJ/m$^3$). If the heating value of your gas is significantly different, it may be necessary to replace the orifices.

Verify natural gas input rate by clocking meter.
1. Turn off all other gas appliances and pilots.
2. Run furnace for a minimum of 3 minutes in heating operation.
3. Measure time (in sec) for gas meter to complete 1 revolution and note reading. The 2 cubic feet dial provides a more accurate measurement of gas flow.
4. Refer to Table 14 for cubic feet of gas per hour.
5. Multiply cubic feet per hour by heating value (BTU/cu ft) to obtain input.

If clocked rate does not match the input rate from the unit nameplate, follow steps in next section to adjust the manifold pressure. Repeat steps 2 - 5 until correct input is achieved.

CAUTION

Be sure to relight any gas appliances that were turned off at the start of this input check.
### Table 14: Gas Rate (CU FT/HR) at Full Input

<table>
<thead>
<tr>
<th>Seconds For 1 Revolution</th>
<th>Size of Test Dial</th>
<th>Seconds For 1 Revolution</th>
<th>Size of Test Dial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Cu Ft</td>
<td>2 Cu Ft</td>
<td>5 Cu Ft</td>
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<tr>
<td>10</td>
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<td>1800</td>
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<tr>
<td>11</td>
<td>327</td>
<td>655</td>
<td>1636</td>
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<tr>
<td>12</td>
<td>300</td>
<td>600</td>
<td>1500</td>
</tr>
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<td>13</td>
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<tr>
<td>54</td>
<td>67</td>
<td>133</td>
<td>333</td>
</tr>
</tbody>
</table>
ADJUSTMENT OF MANIFOLD GAS PRESSURE & INPUT RATE

Inlet and manifold gas pressure may be measured by connecting the "U" tube manometer to the gas valve with a piece of tubing. Follow the appropriate section in the instructions below. Refer to Figure 40 for a drawing of the locations of the pressure ports on the gas valve.

Turn gas off at the ball valve or gas cock on gas supply line before the gas valve. Find the pressure ports on the gas valve marked Out P and In P.

1. The manifold pressure must be taken at the port marked OUT P.
2. The gas line pressure must be taken at the port marked IN P.
3. Using a 3/32" (2.4 mm) Allen wrench, loosen the set screw by turning it 1 turn counter clockwise. DO NOT REMOVE THE SET SCREW FROM THE PRESSURE PORT.

Read the inlet gas pressure

Connect the positive side of the manometer to the IN P Tap on the gas valve. Do not connect any tubing to the negative side of the manometer, as it will reference atmospheric pressure. Refer to Figure 41 for connection details.

1. Turn gas and electrical supplies on and follow the operating instructions to place the unit back in operation.
2. Once the correct gas inlet pressure has been established, see Table 15, turn the gas valve to OFF and turn the electrical supply switch to OFF; then remove the flexible tubing from the gas valve pressure tap and tighten the pressure tap plug using the 3/32" (2.4 mm) Allen wrench.
3. Turn the electrical and gas supplies back on, and with the burners in operation, check for gas leakage around the gas valve pressure port for leakage using an approved non-corrosive gas leak detection fluid, or other non-flammable leak detection methods.

Read the manifold gas pressure

Connect the positive side of the manometer to the adapter previously installed in the OUT P Tap on the gas valve. Do not connect any tubing to the negative side of the manometer, as it will reference atmospheric pressure. Refer to Figure 41 for connection details.

1. Refer to Figure 40 for location of pressure regulator adjustment cap and adjustment screws on main gas valve.
2. Turn gas and electrical supplies on and follow the operating instructions to place the unit back in operation.
3. Adjust manifold pressure by adjusting gas valve regulator screw for the appropriate gas per the following:

   - Natural Gas: 3.5" w.c. (0.87 kPa)
   - Propane (LP) Gas: 10.0" w.c. (2.488 kPa)

4. After the manifold pressure has been adjusted, re-calculate the furnace input to make sure you have not exceeded the specified input on the rating plate. Refer to "CALCULATING THE FURNACE INPUT (NATURAL GAS)".
5. Once the correct BTU (kW) input has been established, turn the gas valve to OFF and turn the electrical supply switch to OFF; then remove the flexible tubing from the gas valve pressure tap and tighten the pressure tap plug using the 3/32" (2.4 mm) Allen wrench.
6. Turn the electrical and gas supplies back on, and with the burners in operation, check for gas leakage around the gas valve pressure port for leakage using an approved non-corrosive gas leak detection fluid, or other non-flammable leak detection methods.
After about 5 minutes of operation, determine the furnace temperature rise. Take readings of both the return air and the heated air in the ducts, about six feet (1.8 m) from the furnace where they will not be affected by radiant heat. Increase the blower speed to decrease the temperature rise; decrease the blower speed to increase the rise.

All direct-drive blowers have multi-speed motors. The blower motor speed taps are located on the furnace control board in the blower compartment. Refer to Figure 42, and the unit-wiring label to change the blower speed. To use the same speed tap for heating and cooling, the heat terminal and cool terminal must be connected using a jumper wire and connected to the desired motor lead. Place all unused motor leads on Park terminals. Two park terminals are provided.

**CAUTION**

Do not energize more than one motor speed at a time or damage to the motor will result.

**ADJUSTMENT OF FAN CONTROL SETTINGS**

This furnace is equipped with a time-on/time-off heating fan control. The fan on delay is fixed at 30 seconds. The fan off delay has 4 settings (60, 90, 120 and 180 seconds). The fan off delay is factory set to 120 seconds. The fan-off setting must be long enough to adequately cool the furnace, but not so long that cold air is blown into the heated space. The fan-off timing may be adjusted by positioning the jumper on two of the four pins as shown in Figure 42.

**DANGER**

The temperature rise, or temperature difference between the return air and the supply (heated) air from the furnace, must be within the range shown on the furnace rating plate and within the application limitations shown in Table 6. The supply air temperature cannot exceed the “Maximum Supply Air Temperature” specified in these instructions and on the furnace rating plate. Under NO circumstances can the furnace be allowed to operate above the Maximum Supply Air Temperature. Operating the furnace above the Maximum Supply Air Temperature will cause premature heat exchanger failure, high levels of Carbon Monoxide, a fire hazard, personal injury, property damage, and/or death.
### Table 17: Blower Performance CFM - Any Position (without filter) - Bottom Return

<table>
<thead>
<tr>
<th>Models Input/Airflow/Cabinet</th>
<th>Speed</th>
<th>Bottom Airflow Data (SCFM)</th>
<th>Ext. Static Pressure (in. H2O)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>40/800/A</td>
<td>High</td>
<td>1128</td>
<td>1077</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>934</td>
<td>909</td>
</tr>
<tr>
<td></td>
<td>Medium Low</td>
<td>746</td>
<td>735</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>676</td>
<td>652</td>
</tr>
<tr>
<td>60/1000/A</td>
<td>High</td>
<td>1360</td>
<td>1290</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1251</td>
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<td>Medium Low</td>
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<tr>
<td></td>
<td>Low</td>
<td>909</td>
<td>900</td>
</tr>
<tr>
<td>60/1200/B</td>
<td>High</td>
<td>1492</td>
<td>1442</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1236</td>
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<td>Medium Low</td>
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<td>Low</td>
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<td>80/1200/B</td>
<td>High</td>
<td>1597</td>
<td>1537</td>
</tr>
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<td></td>
<td>Medium High</td>
<td>1338</td>
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</tr>
<tr>
<td></td>
<td>Medium Low</td>
<td>1113</td>
<td>1094</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>937</td>
<td>916</td>
</tr>
<tr>
<td>80/1600/C</td>
<td>High</td>
<td>1919</td>
<td>1865</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1532</td>
<td>1533</td>
</tr>
<tr>
<td></td>
<td>Medium Low</td>
<td>1232</td>
<td>1313</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>826</td>
<td>821</td>
</tr>
<tr>
<td>80/2200/C</td>
<td>High</td>
<td>2529</td>
<td>2435</td>
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<tr>
<td></td>
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<td></td>
<td>Low</td>
<td>1383</td>
<td>1377</td>
</tr>
<tr>
<td>100/1600/C</td>
<td>High</td>
<td>1909</td>
<td>1880</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1465</td>
<td>1463</td>
</tr>
<tr>
<td></td>
<td>Medium Low</td>
<td>1190</td>
<td>1222</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>787</td>
<td>834</td>
</tr>
<tr>
<td>100/2000/C</td>
<td>High</td>
<td>2284</td>
<td>2205</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1967</td>
<td>1905</td>
</tr>
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<td></td>
<td>Medium Low</td>
<td>1610</td>
<td>1563</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1326</td>
<td>1304</td>
</tr>
<tr>
<td>120/1600/D</td>
<td>High</td>
<td>2020</td>
<td>1994</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>1551</td>
<td>1559</td>
</tr>
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<td>Medium Low</td>
<td>1270</td>
<td>1267</td>
</tr>
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<td></td>
<td>Low</td>
<td>932</td>
<td>916</td>
</tr>
<tr>
<td>120/2000/D</td>
<td>High</td>
<td>2341</td>
<td>2245</td>
</tr>
<tr>
<td></td>
<td>Medium High</td>
<td>2002</td>
<td>1952</td>
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<td></td>
<td>Medium Low</td>
<td>1615</td>
<td>1579</td>
</tr>
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<td>Low</td>
<td>1352</td>
<td>1295</td>
</tr>
<tr>
<td>130/2000/D</td>
<td>High</td>
<td>2412</td>
<td>2329</td>
</tr>
<tr>
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<td>Medium High</td>
<td>2040</td>
<td>2004</td>
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<td></td>
<td>Medium Low</td>
<td>1614</td>
<td>1591</td>
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<tr>
<td></td>
<td>Low</td>
<td>1327</td>
<td>1294</td>
</tr>
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</table>

**NOTES:**
1. Airflow expressed in standard cubic feet per minute (CFM).
2. Motor voltage at 115 V.
### Table 18: Blower Performance CFM - Any Position (without filter) - Left Side Return

<table>
<thead>
<tr>
<th>Models Input/Airflow/Cabinet</th>
<th>Speed</th>
<th>Ext. Static Pressure (in. H2O)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Medium High</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

#### Left Side Airflow Data (SCFM)

1. Airflow expressed in standard cubic feet per minute (CFM).
2. Return air is through side opposite motor (left side).
3. Motor voltage at 115 V.
4. Airflow through motor side (right side) may be slightly less than the data shown above.

**NOTES:**

1. Airflow expressed in standard cubic feet per minute (CFM).
2. Return air is through side opposite motor (left side).
3. Motor voltage at 115 V.
4. Airflow through motor side (right side) may be slightly less than the data shown above.
SECTION X: SAFETY CONTROLS

CONTROL CIRCUIT FUSE
A 3-amp fuse is provided on the control circuit board to protect the 24-volt transformer from overload caused by control circuit wiring errors. This is an ATO 3, automotive type fuse and is located on the control board.

BLOWER DOOR SAFETY SWITCH

**CAUTION**

Main power to the unit must still be interrupted at the main power disconnect switch before any service or repair work is to be done on the unit. Do not rely upon the interlock switch as a main power disconnect. Blower and burner must never be operated without the blower panel in place.

This unit is equipped with an electrical interlock switch mounted in the burner compartment. This switch interrupts all power at the unit when the panel covering the blower compartment is removed.

Electrical supply to this unit is dependent upon the panel that covers the blower compartment being in place and properly positioned.

ROLLOUT SWITCH CONTROLS
These controls are mounted on the burner assembly. If the temperature in the area surrounding burner exceeds its set point, the gas valve is de-energized. The operation of this control indicates a malfunction in the combustion air blower, heat exchanger or a blocked vent pipe connection. Corrective action is required. These are manual reset controls that must be reset before operation can continue.

PRESSURE SWITCHES
This furnace is supplied with two pressure switches, which monitor the flow through the combustion air/vent piping and condensate drain system. These switches de-energize the gas valve if any of the following conditions are present. Refer to "CONDENSATE PIPING AND FURNACE VENTING CONFIGURATION" for tubing connections.

1. Blockage of vent piping or terminal.
2. Failure of combustion air blower motor.
3. Blockage of combustion air piping or terminals.
4. Blockage of condensate drain piping.

LIMIT CONTROLS
There is a high temperature limit control located on the furnace vestibule panel near the gas valve. This is an automatic reset control that provides over temperature protection due to reduced airflow. This may be caused by:

1. A dirty filter.
2. If the indoor fan motor should fail.
3. Too many supply or return registers closed or blocked off.

The control module will lockout if the limit trips 5 consecutive times. If this occurs, control will reset & try ignition again after 1 hour.

SECTION XI: NORMAL OPERATION AND DIAGNOSTICS

NORMAL OPERATION SEQUENCE
The following describes the sequence of operation of the furnace. Refer to Owners Manual for component location.

Continuous Blower
Cooling/heating thermostats have a fan switch that has an ON and AUTO position. In the ON position the thermostat circuit is completed between terminals R and G when there is a call for cooling. The motor will operate on the speed tap wire that is connected to the "HI COOL" cooling terminal on the control board. To obtain a constant air circulation at lower flow rate, change the high-speed wire to another lower speed wire.

Intermittent Blower - Cooling
Cooling/heating thermostats have a fan switch that has an ON and AUTO position. In the AUTO position the thermostat circuit is completed between terminals R and G when there is a call for cooling. The motor will operate on the speed tap wire that is connected to the "HI COOL" cooling terminal on the control board. The fan off setting is fixed at 60 seconds to improve cooling efficiency.

Heating Cycle
When the thermostat switch is set on HEAT and the fan is set on AUTO, and there is a call for heat, a circuit is completed between terminals R and W of the thermostat. When the proper amount of combustion air is being provided, the pressure switch will close, the ignition control provides a 17-second ignitor warm-up period, the gas valve then opens, the gas starts to flow, ignition occurs and the flame sensor begins its sensing function. The blower motor will energize 30 seconds after the gas valve opens, if a flame is detected. Normal furnace operation will continue until the thermostat circuit between R and W is opened, which causes the ignition system and gas valve to de-energize and the burner flames to be extinguished. The vent motor will operate for 15 seconds and the blower motor will operate for the amount of time set by the fan-off delay jumper located on the control board. See Figure 42. The heating cycle is now complete, and ready for the start of the next heating cycle.

If the flame is not detected within 7 seconds of the gas valve opening, the gas valve is shut off and a retry operation begins. Also, if the flame is lost for 2 seconds during the 10-second stabilization period, the gas valve is shut off and a retry operation begins. During a retry operation, the vent motor starts a 15 second inter-purge and the ignitor warm-up time is extended to 27 seconds. If the flame is established for more than 10 seconds after ignition during a retry, the control will clear the ignition attempt (retry) counter. If three retries occur during a call for heat, the furnace will shut down for one hour. If at the end of the one hour shut down there is a call for heat, the furnace will initiate a normal start cycle. If the problem has not been corrected the furnace will again lockout after three retries.

A momentary loss of gas supply, flame blowout, or a faulty flame probe circuit will result in a disruption in the flame and be sensed within 1.0 seconds. The gas valve will de-energize and the control will begin a recycle operation. A normal ignition sequence will begin after a 15 second inter-purge. If during the five recycles the gas supply does not return, or the fault condition is not corrected the ignition control will lock-out for 60 minutes.

During burner operation, a momentary loss of power for 50 milliseconds or longer will de-energize the gas valve. When the power is restored, the gas valve will remain de-energized and the ignition sequence will immediately restart.

TROUBLESHOOTING
The following visual checks should be made before troubleshooting:

1. Check to see that the power to the furnace and the ignition control module is ON.
2. The manual shut-off valves in the gas line to the furnace must be open.
3. Make sure all wiring connections are secure.
4. Review the sequence of operation. Start the system by setting the thermostat below the room temperature. Observe the system's response. Then use the troubleshooting section in this manual to check the system's operation.

**WARNING**

Never bypass any safety control to allow furnace operation. To do so will allow furnace to operate under potentially hazardous conditions.

Do not try to repair controls. Replace defective controls with UPG Source 1 Parts.

Never adjust pressure switch to allow furnace operation.
FURNACE CONTROL DIAGNOSTICS

The furnace has built-in, self-diagnostic capability. If a system problem occurs, a blinking LED can flash red, green or amber to indicate various conditions.

The control continuously monitors its own operation and the operation of the system. If a failure occurs, the LED will indicate the failure code. If the failure is internal to the control, the light will stay on continuously. In this case, the entire control should be replaced, as the control is not field repairable.

Flash sequence codes 1 through 11 are as follows: LED will turn ON for 1/4 second and OFF for 1/4 second. This pattern will be repeated the number of times equal to the code. For example, six ON flashes equals a number 6 fault code. All flash code sequences are broken by a 2 second OFF period.

SLOW GREEN FLASH: Normal operation.
SLOW AMBER FLASH: Normal operation with call for heat.
RAPID RED FLASH: Twinning error, incorrect 24V phasing. Check twinning wiring.
RAPID AMBER FLASH: Flame sense current is below 1.5 microamps. Check and clean flame sensor. Check for proper gas flow. Verify that current is greater than 1.5 microamps at flame current test pad.
4 AMBER FLASHES: The control is receiving a “Y” signal from the thermostat without a “G” signal, indicating improper thermostat wiring.
1 RED FLASH: This indicates that flame was sensed when there was not a call for heat. The control will turn off on both the inducer motor and supply air blower. A gas valve that leaks or is slow closing would typically cause this fault.
2 RED FLASHES: This indicates that the normally open pressure switch contacts are stuck in the closed position. The control confirms these contacts are open at the beginning of each heat cycle. This would indicate a faulty pressure switch or miswiring.
3 RED FLASHES: This indicates the normally open pressure switch contact did not close after the inducer was energized. This could be caused by a number of problems: faulty inducer, blocked vent pipe, broken pressure switch hose or faulty pressure switch.
4 RED FLASHES: This indicates that the main limit switch has opened its normally closed contacts. The control will operate the supply air blower and inducer. This condition may be caused by: dirty filter, improperly sized duct system, incorrect blower speed setting, incorrect firing rate or faulty blower motor. Also, this fault code could be caused by a blown fuse located on the control board.
5 RED FLASHES: This fault is indicated if the normally closed contacts in the rollout switch opens. The rollout control is manually reset. If it has opened, check for proper combustion air, proper inducer operation, and primary heat exchanger failure or burner problem. Be sure to reset the switch and cycle power (24 VAC) to the control after correcting the failure condition. Also, this fault code could be caused by a blown fuse located on the control board.
6 RED FLASHES: This indicates that after the unit was operating, the pressure switch opened 4 times during the call for heat. If the main blower is in a “Delay on” mode, it will complete it, and any subsequent delay off period. The furnace will lock out for one hour and then restart.
7 RED FLASHES: This fault code indicates that the flame could not be established. This no-light condition occurred 3 times (2 retries) during the call for heat before locking out. Low gas pressure, faulty gas valve, dirty or faulty flame sensor, faulty hot surface ignitor or burner problem may cause this. The furnace will lock out for one hour and then restart.
8 RED FLASHES: This fault is indicated if the flame is lost 5 times (4 recycles) during the heating cycle. This could be caused by low gas pressure, dirty or faulty flame sensor or faulty gas valve. The furnace will lock out for one hour and then restart.
9 RED FLASHES: Indicates reversed line voltage polarity or grounding problem. Both heating and cooling operations will be affected. Check polarity at furnace and branch. Check furnace grounding. Check that flame probe is not shorted to chassis.
10 RED FLASHES: Flame sensed with no call for heat. Check gas valve and gas valve wiring.
11 RED FLASHES: This indicates that a primary or auxiliary limit switch has opened its normally-closed contacts and has remained open for more than five minutes. This condition is usually caused by a failed blower motor or blower wheel. Cycle power (24 VAC) to the control to reset the hard lockout condition after correcting the failure condition.

DIAGNOSTIC FAULT CODE STORAGE AND RETRIEVAL

The control in this furnace is equipped with memory that will store up to five error codes to allow a service technician to diagnose problems more easily. This memory will be retained even if power to the furnace is lost. This feature should only be used by a qualified service technician.

If more than five error codes have occurred since the last reset, only the five most recent will be retained. The furnace control board has a button, labeled “LAST ERROR” that is used to retrieve error codes. This function will only work if there are no active thermostat signals. So any call for heating, cooling or continuous fan must be terminated before attempting to retrieve error codes.

To retrieve the error codes, push the LAST ERROR button. The LED on the control will then flash the error codes that are in memory, starting with the most recent. There will be a two-second pause between each flash code. After the error codes have all been displayed, the LED will resume the normal slow green flash after a five second pause. To repeat the series of error codes, push the button again.

If there are no error codes in memory, the LED will flash two green flashes. To clear the memory, push the LAST ERROR button and hold it for more than five seconds. The LED will flash three green flashes when the memory has been cleared, then will resume the normal slow green flash after a five-second pause.

If a flame is detected the control flashes the LED for 1/8 of a second and then enters a flame stabilization period.

IGNITION CONTROL FLAME SENSE LEVELS
Normal flame sense current is approximately
3.7 microamps DC (µa)
Low flame signal warning starts at 1.5 microamps.
Low flame signal control lockout point is
0.1 microamps DC (µa)
SECTION XII: REPLACEMENT PARTS LIST

**FIGURE 43:** Furnace Control Event Schedule

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTOR</td>
<td>FABRICATED PARTS (Continued)</td>
</tr>
<tr>
<td>MOTOR, DIRECT DRIVE BLOWER</td>
<td>MANIFOLD, GAS</td>
</tr>
<tr>
<td>BLOWER, COMBUSTION</td>
<td>PAN, BOTTOM</td>
</tr>
<tr>
<td>ELECTRICAL</td>
<td>PANEL, TOP</td>
</tr>
<tr>
<td>CAPACITOR, RUN</td>
<td>PANEL, DOOR (2 Req’d)</td>
</tr>
<tr>
<td>SWITCH, LIMIT</td>
<td>PANEL, BLOCKOFF</td>
</tr>
<tr>
<td>CONTROL, FURNACE</td>
<td>MISCELLANEOUS</td>
</tr>
<tr>
<td>IGNITER</td>
<td>ORIFICE, BURNER (Natural #45)</td>
</tr>
<tr>
<td>SENSOR, FLAME</td>
<td>SIGHT GLASS, OVAL (2 Req’d)</td>
</tr>
<tr>
<td>SWITCHES, PRESSURE</td>
<td>GASKET, FOAM (Door) (1.5 ft req’d)</td>
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<tr>
<td>SWITCH, DOOR</td>
<td>PAN, CONDENSATE</td>
</tr>
<tr>
<td>TRANSFORMER</td>
<td>BRACKET, DOOR</td>
</tr>
<tr>
<td>VALVE, GAS</td>
<td>HARNESS, WIRING</td>
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<tr>
<td>CONTROL, TEMPERATURE</td>
<td>FERRULE (3 Req’d)</td>
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<tr>
<td>AIR MOVING</td>
<td>GROMMET (3 Req’d)</td>
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<tr>
<td>HOUSING, BLOWER</td>
<td>MOTOR MOUNT</td>
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<tr>
<td>WHEEL, BLOWER</td>
<td>TUBING, SILICON</td>
</tr>
<tr>
<td>FABRICATED PARTS</td>
<td>HOSE, RAIN GUTTER</td>
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<tr>
<td>RESTRICTOR, COMBUSTION BLOWER</td>
<td>HOSE, CONDENSATE</td>
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<td>BURNER, MAIN GAS</td>
<td>PLUG, SEAL, 7/8”</td>
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<tr>
<td>BRACKET, IGNITER</td>
<td>PLUG, SEAL, 2-3/8”</td>
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<tr>
<td>SHELF, BLOWER</td>
<td>PLUG, VENT PIPE</td>
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<tr>
<td>RAIL, BLOWER (2 Req’d)</td>
<td>BAG, PARTS</td>
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<tr>
<td>BRACKET, BLOWER TRACK (2 Req’d)</td>
<td>KNOB, QUARTER TURN (4 Req’d)</td>
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<tr>
<td>HEAT EXCHANGER ASS’Y</td>
<td>DIAGRAM, WIRING</td>
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**REPLACEMENT PART CONTACT INFORMATION**

This is a generic parts list. To request a complete parts list, refer to the contact information below:

- Visit our website at www.source1parts.com for the following information:
  1. Search for a part or browse the catalog.
  2. Find a dealer or distributor.
  3. Customer Service contact information.
     a. Click on the “Brand Links” button
     b. Click on the “Customer Service” button

- You can contact us by mail. Just send a written request to:
  Johnson Controls Unitary Products
  Consumer Relations
  5005 York Drive
  Norman, OK 73069