

Modular In-Direct Fired Heaters and Inserts

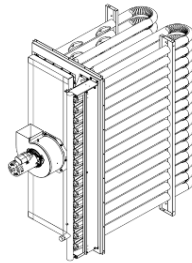
Installation, Operation, and Maintenance Manual



Modular In-Direct Fired Heater



In-Direct Fired Module



In-Direct Fired Furnace

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish any open flames.
4. Immediately call your gas supplier.

FOR YOUR SAFETY

The use and storage of gasoline or other flammable vapors and liquids in open containers in the vicinity of this appliance is hazardous.

RECEIVING AND INSPECTION

Upon receiving unit, check for any interior and exterior damage, and if found, report it immediately to the carrier. Also check that all accessory items are accounted for and are damage free. Turn the blower wheel by hand to verify free rotation and check the damper (if supplied) for free operation.

WARNING!!

Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment. ALWAYS disconnect power and gas prior to working on heater.

Save these instructions. This document is the property of the owner of this equipment and is required for future maintenance. Leave this document with the owner when installation or service is complete.

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WARRANTY

This equipment is warranted to be free from defects in materials and workmanship, under normal use and service, for a period of 12 months from date of shipment. All Heat Exchangers have a standard 10 year Pro-rated manufacturer-backed warranty. This warranty shall not apply if:

1. The equipment is not installed by a qualified installer per the MANUFACTURER'S installation instructions shipped with the product,
2. The equipment is not installed in accordance with federal, state and local codes and regulations,
3. The equipment is misused or neglected,
4. The equipment is not operated within its published capacity,
5. The invoice is not paid within the terms of the sales agreement.

The MANUFACTURER shall not be liable for incidental and consequential losses and damages potentially attributable to malfunctioning equipment. Should any part of the equipment prove to be defective in material or workmanship within the 12-month warranty period, upon examination by the MANUFACTURER, such part will be repaired or replaced by MANUFACTURER at no charge. The BUYER shall pay all labor costs incurred in connection with such repair or replacement. Equipment shall not be returned without MANUFACTURER'S prior authorization and all returned equipment shall be shipped by the BUYER, freight prepaid to a destination determined by the MANUFACTURER.

INSTALLATION

It is imperative that this unit is installed and operated with the designed airflow, gas, and electrical supply in accordance with this manual. If there are any questions about any items, please call the service department at **1-866-784-6900** for warranty and technical support issues.

Mechanical

WARNING: DO NOT RAISE VENTILATOR BY THE INTAKE HOOD, BLOWER OR MOTOR SHAFT, OR BEARINGS – USE LIFTING LUGS PROVIDED OR A SLING

Site Preparation

1. Provide clearance around installation site to safely rig and lift equipment into its final position. Supports must adequately support equipment. Refer to manufacturer's estimated weights.
2. Consider general service and installation space when locating unit.
3. Locate unit close to the space it will serve to reduce long, twisted duct runs.
4. Do not allow air intake to face prevailing winds. Support unit above ground or at roof level high enough to prevent precipitation from being drawn into its inlet. The inlet must also be located at least 10 feet away from any exhaust vents. The heater inlet shall be located in accordance with the applicable building code provisions for ventilation air.

CLEARANCES

The top, back, and front surfaces of this heater may not be installed less than 6" from combustible materials. The heater base may be installed on combustible surfaces. Allow 24" minimum service clearance on both sides of this heater.

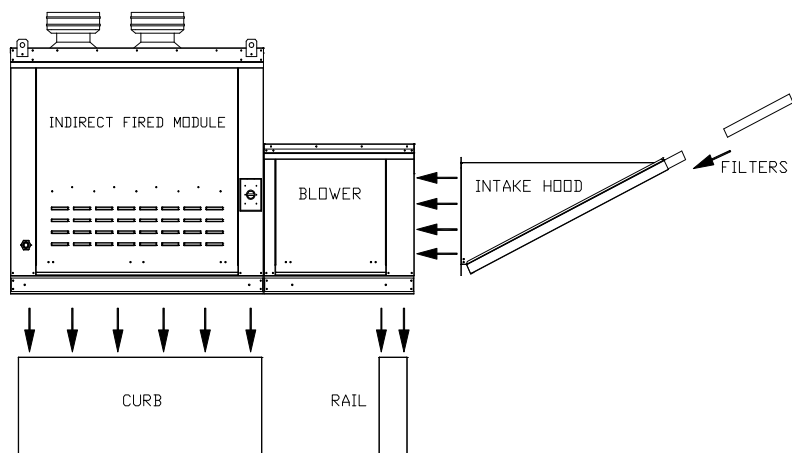
IMPORTANT

To prevent premature heat exchanger failure, do not locate any gas fired unit in areas where chlorinated, halogenated, or acid vapors are present in the atmosphere.

Assembly

Intakes and curbs are shipped unassembled to heater module. Upon unit arrival, use the following procedure to assemble the intake to the heater.

1. Apply silicone or weather-proof gasket on the back side of the flanges of the intake hood or v-bank intake.
2. Screw the flanges of the intake hood or v-bank to the unit with the supplied sheet metal screws. Place caulk on the outside of the screws to prevent water leaks. If the unit is a modular unit with a v-bank or evaporative cooler section, the v-bank or evaporative cooler will bolt to the heater with the bolts provided.



Curb and Ductwork

This fan was specified for a specific CFM and static pressure. The ductwork attached to this unit will significantly affect the airflow performance. Flexible ductwork

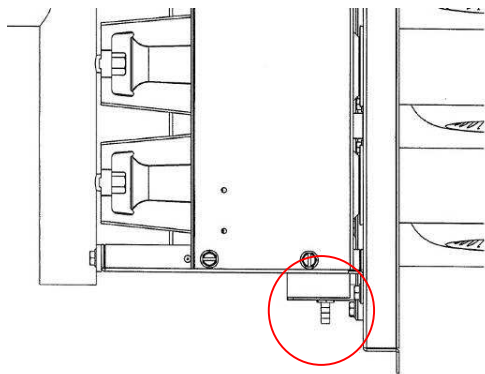
and square elbows should not be used. Also, transitions and turns in ductwork near the fan outlet will cause system effect and will drastically increase the static pressure and reduce airflow. The chart below shows the minimum fan outlet duct sizes and straight lengths recommended for optimal fan performance. **Follow SMACNA guides and recommendations for the remaining duct run.** Fans designed for rooftop installation should be installed on a prefabricated or factory built roof curb. Follow curb manufacturer's instructions for proper curb installation. The unit should be installed on a curb and/or rail elevated not less than 20" above any surface. Be sure duct connection and fan outlet are properly aligned and sealed. Secure fan to curb through vertical portion of the ventilator base assembly flange using a minimum of eight (8) lug screws, anchor bolts, or other suitable fasteners (not furnished). Shims may be required depending upon curb installation and roofing material. Check all fasteners for tightness. The diagrams below show different mechanical installation configurations.

Recommended Supply Ductwork Sizes

Blower Size	Duct Size	Straight Duct Length
10	14 x 14	48 in.
12	16 x 16	54 in.
15	20 x 20	72 in.
18	24 x 24	86 in.
20	26 x 26	108 in.
25	32 x 32	168 in.

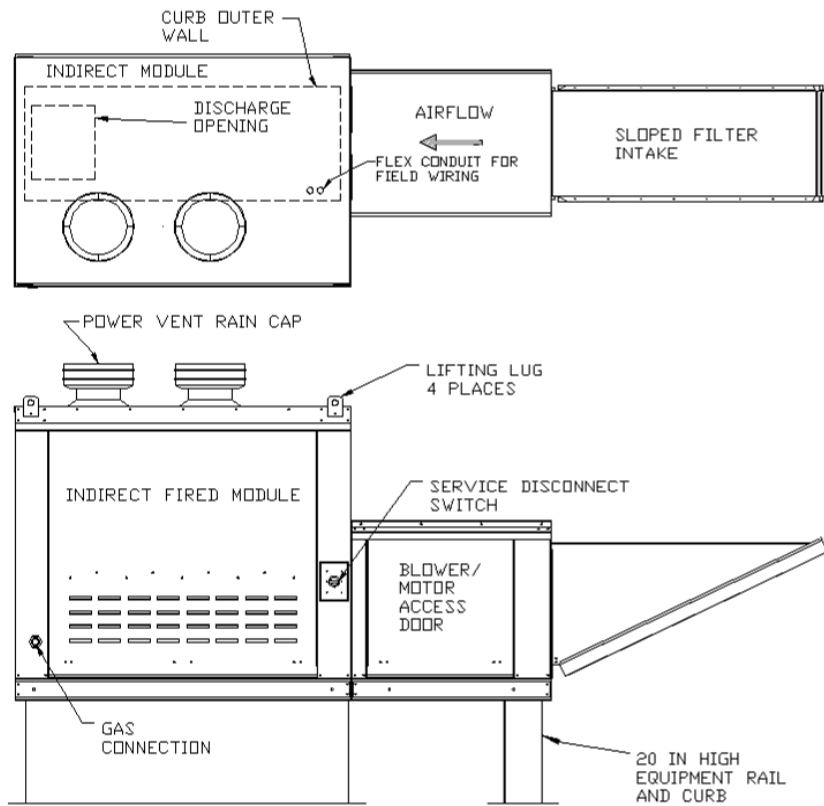
Condensation Drain

In some applications, condensation can form in the flue collection box, especially when furnaces are located downstream of cooling coils. In the event that condensation occurs in the flue collection boxes, there are barbed fittings in the bottom of the flue collection boxes to drain condensation out of the boxes. Each burner in the unit is provided with a burner drain pan located underneath this fitting for the condensation to collect and evaporate. In the event that the condensation out of the burners exceeds the pan capacity, flexible tubing should be run from these barbed fittings to outdoors. 0.25 inch holes may be drilled in the exterior of the unit or through the floor of the unit to provide a convenient exit for the tubing. Tubing should be .25 inch OD and .125 inch ID silicone and rated for 400°F minimum. Tubing part number 90416 is sold per foot and meets the requirements above.

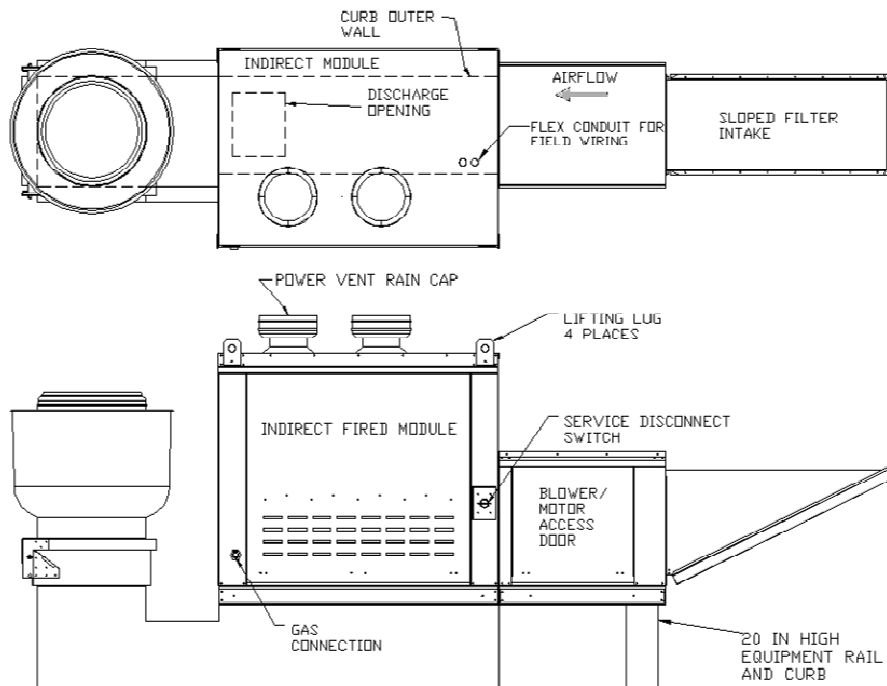


Barbed Fitting shown circled above (located on bottom of flue collection box, below induced draft blowers)

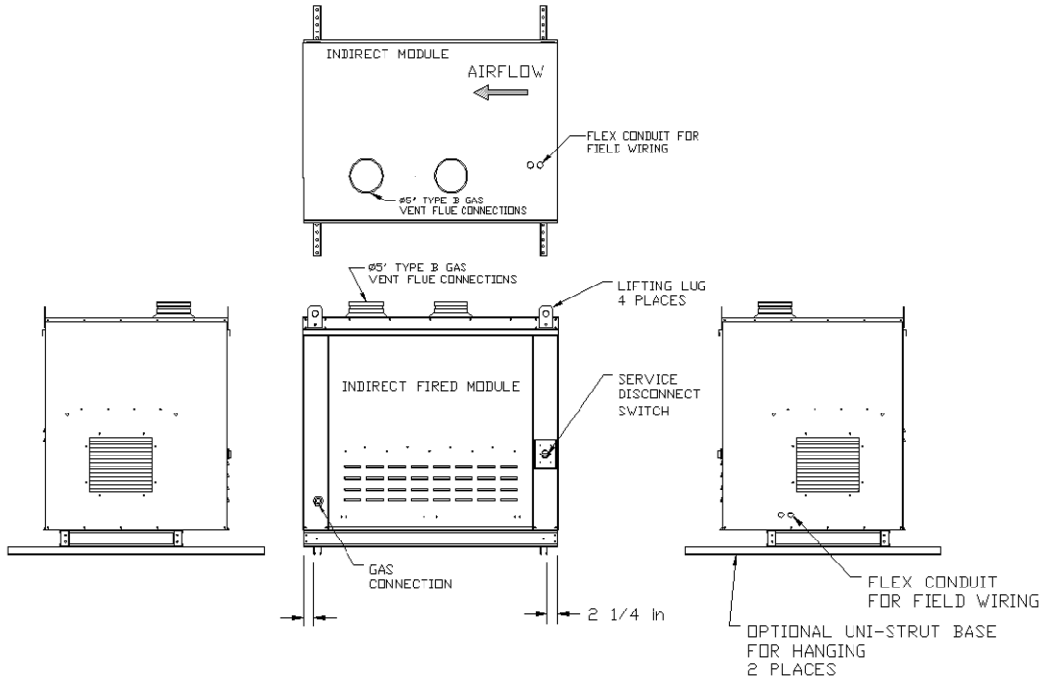
Roof Mount Installation



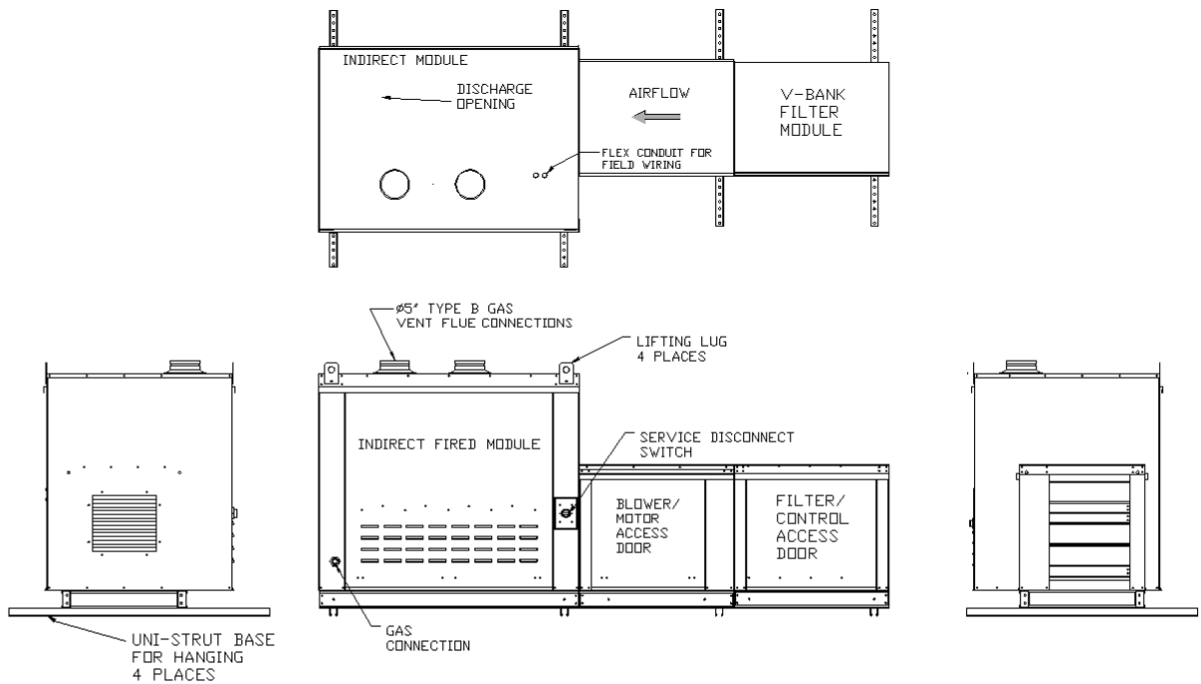
Installation with Exhaust Fan



Indirect Fired Module Installation



Indoor (INLINE) Installation



Indoor Flue Venting

Indoor gas fired heating equipment must be vented. **Do not operate un-vented.** Gas fired heating equipment which has been improperly vented, or which experiences a blocked vent condition may emit flue gases into heated spaces.

IMPORTANT
Furnace Only Modules must be installed in a positive pressure airstream. Do not install in a duct on the suction side of a fan.

General Venting Guidelines

1. Installation of venting must conform with local building codes, or in the absence of local codes, with the National Fuel Gas Code.
2. **On Units with multiple furnaces, each furnace must be ducted to the outside using its own isolated duct run. Ducts used on each single furnace must Not be Connected together in any fashion. Failure to adhere to this may result in a build-up of Carbon-Monoxide in the space when the furnace is operating with less than all of its furnaces powered.**
3. Do not use a vent pipe smaller than the size of the outlet on the heater.
4. Limit lengths of horizontal runs to 75% of vertical height. Install with a minimum upward slope from unit of ¼ inch per foot and suspend from overhead structure at points no greater than 3 feet apart. For best venting, put as much vertical vent as close to the unit as possible.
5. Fasten individual lengths of vent together with at least three corrosion resistant sheet metal screws.
6. Vent pipes should be fitted with a tee with a drip leg and clean out tap at the low point in the vent run. This should be inspected and cleaned out periodically during the heating season.
7. Do NOT use dampers or other devices in the vent or combustion air pipes.
8. Use a vent terminal to reduce downdrafts and moisture in the vent line.

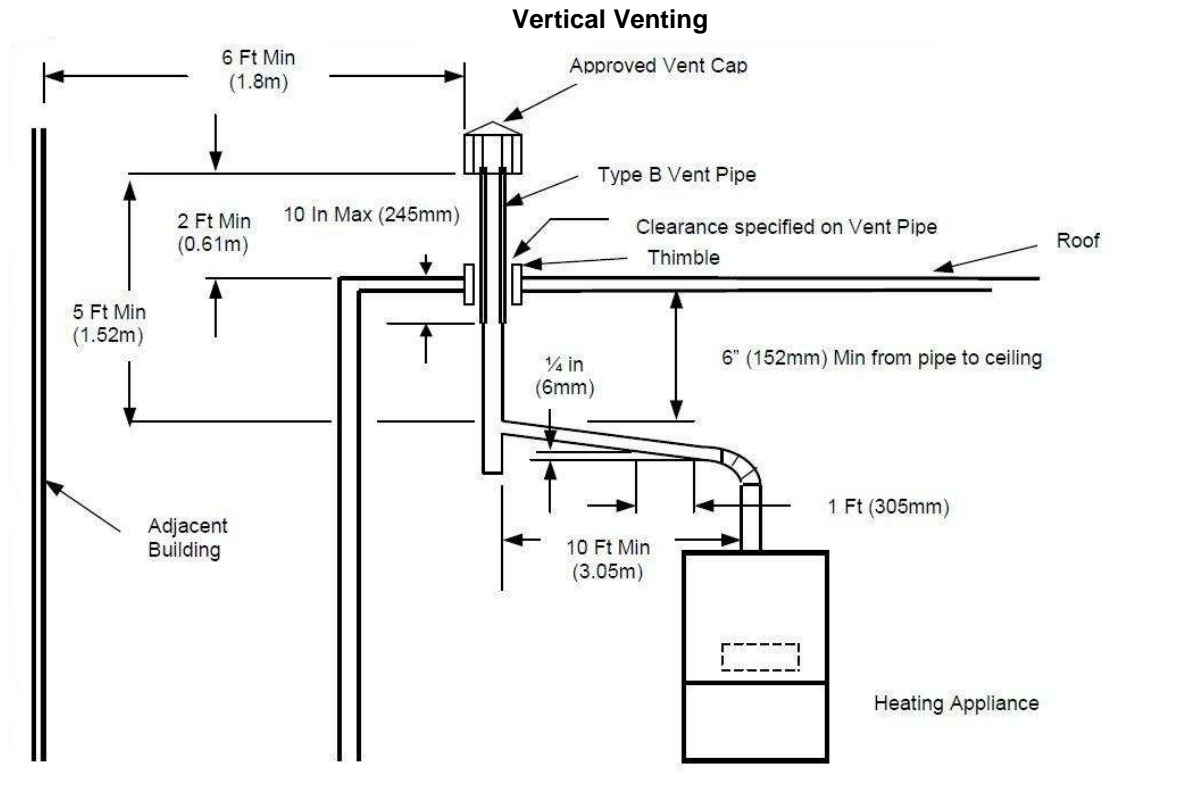
Vertically Vented Furnaces – Category I

1. Use single wall or double wall (Type B) vent pipe of a diameter listed in the following table for the appropriate model.
2. Maximize the height of the vertical run of vent pipe. A minimum of five (5) feet (1.5m) of vertical pipe is required. The top of the vent pipe must extend at least two (2) feet (0.61m) above the highest point on the roof. Use Listed Type B vent for external runs. An approved weatherproof vent cap must be installed on the vent termination.
3. Horizontal runs must not exceed 75% of the vertical height of the vent pipe, up to a maximum of ten (10) feet (3m). Horizontal runs should be pitched upward ¼ in. per foot (21mm/m) and should be supported at three (3) foot (1m) maximum intervals.
4. Design vent pipe runs to minimize the use of elbows. Each 90° elbow is equivalent to five (5) feet (1.5m) of straight vent pipe.
5. Vent pipe should not be run through unheated spaces. If such runs cannot be avoided, insulate the vent pipe to prevent condensation. Insulation should be a minimum of ½ in. (12.7mm) thick foil faced fiberglass minimum of 1½ # density.
6. Dampers must not be used in vent piping runs, as spillage of flue gases into the occupied space could result.
7. Vent connectors serving Category 1 heaters must not be connected into any portion of a mechanical draft system operating under positive pressure.

IMPORTANT
Furnace Only Modules must be installed in a positive pressure airstream. Do not install in a duct on the suction side of a fan.

National Fuel Gas Code Venting Pipe requirement

75,000-149,999	Use 5-inch pipe
150,000-400,000	Use 6-inch pipe



Horizontally Vented Furnaces – Category III

Pressures in Category III venting systems are positive and therefore care must be taken to prevent flue products from entering the heated space. Use only venting materials and components that are UL listed and approved for Category III venting systems.

WARNING: Do not use Type B vent within a building on horizontally vented units.

All vent pipe joints must be sealed to prevent leakage. Follow the instructions provided with the approved venting materials.

Vent pipe shall be sized as follows:

- Input ratings of 150,000 Btuh (43,960 W) to 400,000 Btuh (117,228 W) 6 in. diameter (152mm)
- Input ratings of 75,000 Btuh (21,980 W) to 149,999 Btuh (43,958 W) 5 in. diameter (126mm)

The total equivalent length of vent pipe must not exceed 50 ft. (15.25m). Equivalent length is the total length of straight sections, plus 5 ft. (1.52m) for each 90° elbow and 2.5 ft. (0.76m) for each 45° elbow.

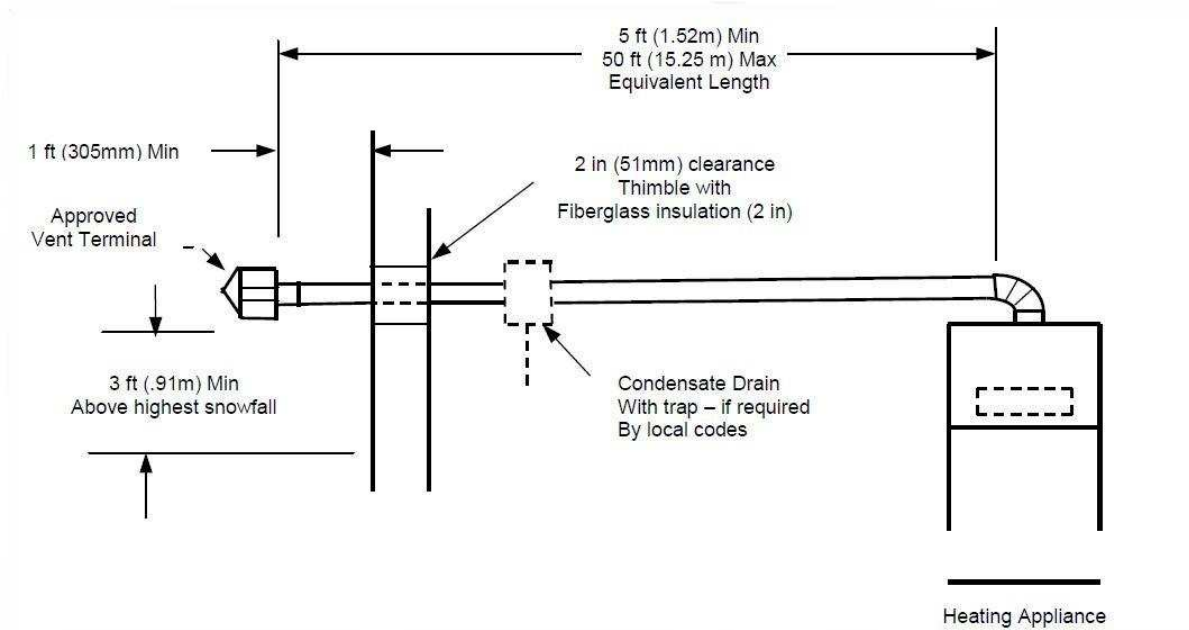
The vent system must also be installed to prevent collection of condensate. Pitch horizontal pipe runs downward ¼ in. per foot (21mm per meter) toward the outlet to permit condensate drainage. Insulate vent pipe exposed to cold air or routed through unheated areas. Insulate vent pipe runs longer than 10 ft. (3m). Insulation should be a minimum of ½ in. (12mm) thick foil faced fiberglass of 1 ½ # density. Maintain 6 in. (152mm) clearance between vent pipe and combustible materials.

An approved Breidert Type L, Field Starkap or equivalent vent cap must be provided. Vent cap inlet diameter must be the same as the vent pipe diameter. The vent terminal must be at least 12 in. (305mm) from the exterior wall that it passes through to prevent degradation of building material by flue gases. The

vent terminal must be located at least 12 in. (305mm) above grade, or in snow areas, at least 3 ft. (1m) above snow line to prevent blockage. Additionally, the vent terminal must be installed with a minimum horizontal clearance of 4 ft. (1.2m) from electric meters, gas meters, regulators or relief equipment. Through-the-wall vents shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard. Provide vent termination clearances to building or structure features as follows:

<u>Structure Minimum</u>	<u>Clearance</u>
Door, Window or gravity inlet	4 ft. (1.2 m) below 4 ft. (1.2 m) horizontally 1 ft. (305 mm) above
Forced air inlet within 10 ft. (3m)	3 ft. (.91 m) above
Adjoining building or parapet	6 ft. (1.8 m)
Adjacent public walkways	7 ft. (2.1 m) above grade

Horizontal Venting



EACH APPLIANCE MUST HAVE ITS OWN INDIVIDUAL VENT PIPE AND TERMINAL. Do not connect vent system from horizontally vented units to other vent systems or a chimney

Gas

Installation of gas piping must conform with local building codes, or in the absence of local codes, with the National Fuel Gas Code, ANSI Z223.1 (NFPA 54) – latest edition. In Canada, installation must be in accordance with CAN/CGA-B149.1 for natural gas units and CAN/CGA-B149.2 for propane units.

WARNING: INLET GAS PRESSURE MUST NOT EXCEED 14 IN. W.C. SEE UNIT RATING PLATE FOR PROPER GAS SUPPLY PRESSURE AND GAS TYPE.

1. Always **disconnect power** before working on or near a heater. Lock and tag the disconnect switch or breaker to prevent accidental power up.
2. Piping to the unit should conform with local and national requirements for type and volume of gas handled, and pressure drop allowed in the line. Refer to the Gas Engineer's Handbook for gas line capacities.
3. The incoming pipe near the heater should be sized to match the connection on the

Cabinet Size	# of Furnaces	Module 1 Gas Pipe Size (NPT)	Module 2 Gas Pipe Size (NPT)
1	1	3/4"	N/A
1	2	3/4"	N/A
2	1	1"	N/A
2	2	1"	N/A
3	1	1"	N/A
3	2	1"	N/A
3	3	1"	1"
4	2	1"	N/A
4	3	1"	1"
4	4	1"	1"
5	2	1"	N/A
5	3	1"	1"
5	4	1"	1"

3. The incoming pipe near the heater should be sized to match the connection on the outside of the unit. Unit inlet sizes are shown in the table to the right. Avoid multiple taps in the gas supply so the unit has a steady supply of gas at all times.
4. Install a ground joint union with brass seat and a manual shut-off valve external to the unit casing, as shown below, adjacent to the unit for emergency shut-off and easy servicing of controls.
5. Provide a sediment trap, as shown below, before each unit and where low spots in the pipe line cannot be avoided.
6. Blow out the gas line to remove debris before making connections. Purge line to remove air before attempting to start unit. Purging of air from gas lines should be performed as described in ANSI Z223.1-latest edition "National Fuel Gas Code", or in Canada in CAN/CGA-B149.
7. All field gas piping must be pressure/leak tested prior to unit operation. Use a non-corrosive bubble forming solution or equivalent for leak testing. The heater and its individual shut-off valve must be disconnected from the gas supply piping system during any pressure testing of that system at test

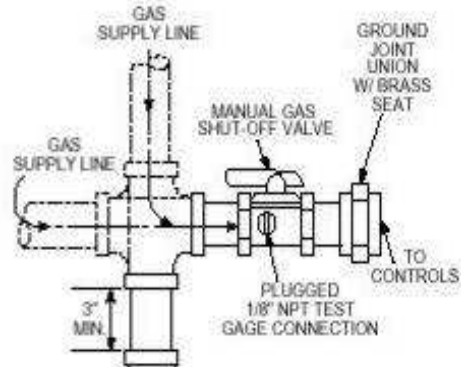
Gas Pressure Table

Gas Pressure Type	Gas Pressure
Inlet Pressure - Natural Gas	7 in. w.c. – 14 in. w.c.
Inlet Pressure - Propane	11 in. w.c. – 14 in. w.c.
Max. Manifold Pressure - Natural Gas	3.5 in. w.c. maximum
Max. Manifold Pressure - Propane	10 in. w.c. maximum
Min. Manifold Pressure - Natural Gas	0.15 in. w.c. minimum
Min. Manifold Pressure - Propane	0.75 in. w.c. minimum

pressures in excess of ½ psi. The heater must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than ½ psi.

- This unit requires a constant **7 in. w.c. minimum natural gas supply, (LP should be 11 in. w.c. minimum)** when the unit is operating at maximum gas flow. If the gas supply exceeds **14 in. w.c.** it will damage the internal valve components, and if it is below 7 in. w.c., the heater may not perform to specifications.

Gas Connection Diagram



NOTICE

Refer to the heater rating plate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which this heater is specified.

Electrical

Before connecting power to the heater, read and understand this entire section of this document. As-built wiring diagrams are furnished with each fan by the factory, and are attached to the door of the unit.

WARNING!!

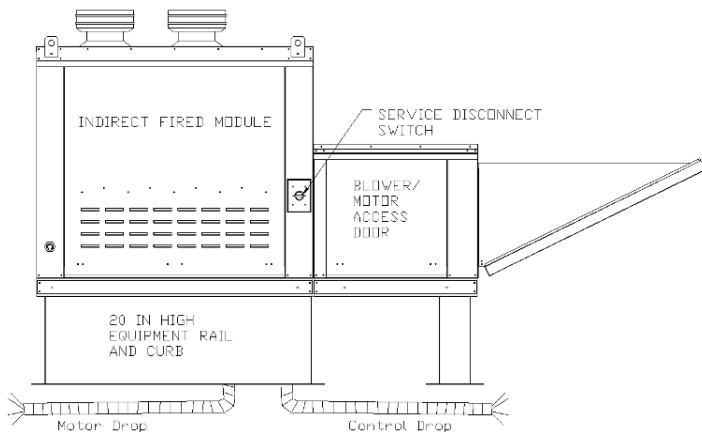
Disconnect power before installing or servicing fan. High voltage electrical input is needed for this equipment. This work should be performed by a qualified electrician.

Electrical wiring and connections should be done in accordance with local ordinances and the National Electric Code, ANSI/NFPA70. Be sure the voltage and phase of the power supply and the wire amperage capacity is in accordance with the motor nameplate. For additional safety information refer to AMCA publication 410-96, *Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans*.

- Always **disconnect power** before working on or near a heater. Lock and tag the disconnect switch or breaker to prevent accidental power up.
- An electrical drop containing the motor power wiring is shipped with every fan. The electrical drop should be brought through one of the conduit openings located in the base of the unit, run through the curb, and connected to a junction box inside the building.
- A dedicated branch circuit should supply the motor circuit with short circuit protection according to the National Electric Code. This dedicated branch should be run to the junction box mentioned above and connected as shown in a following illustration labeled "Fan to Building Wiring Connection".
- Make certain that the power source is compatible with the requirements of your equipment. The heater nameplate identifies

Copper Wire Ampacity

Wire Size AWG	Maximum Amps
14	20
12	25
10	30
8	40
6	55



the **proper phase and voltage** of the motor.

5. Units shipped with an optional remote panel have two electrical circuit drops. It is important to run the motor wires in a separate conduit from the remote control wiring. The DC wires from the unit temperature controller, located in the control drop, should either be shielded cable or be run in a separate conduit.
6. Before connecting heater to the building power source, verify power line wiring is de-energized.
7. Secure the power cables to prevent contact with sharp objects.
8. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces or chemicals.
9. Before powering up the heater, check fan wheel for free rotation and make sure that the interior of the heater is free of loose debris or shipping materials.
10. If any of the original wire supplied with the heater must be replaced, it must be replaced with type TW wire or equivalent.

PSC (Permanent Split Capacitor) Motor Speed Control

Some single phase direct drive fans contain speed controls that regulate the amount of voltage going to the motor. Specific PSC motors must be used in conjunction with speed controls. The speed control has a knob with an off position, and high to low range. At high speed, the speed control allows all of the line voltage to pass right to the motor.



A minimum speed adjustment is provided to allow independent control of the minimum speed setting. Minimum speed adjustment ensures motor runs with sufficient torque to prevent stalling. To adjust this:

- 1) Motor must be in actual operating conditions to achieve proper speed adjustment. Motor will not slow down unless proper load is applied.
- 2) Turn main control knob to lowest speed position.
- 3) Locate and adjust minimum speed setting and adjust with small screw driver. This can be found under the speed control faceplate. (rotate clockwise to decrease minimum speed; counter-clockwise to increase minimum speed).
- 4) Motor will now operate from this preset minimum speed to full speed.

The lowest minimum voltage that may be applied to these motors is 65VAC. Running lower voltages to the motor can cause premature failure and overheating problems.

ECM (Electronically Controlled Motor) Speed Control

ECM motors and control allows accurate manual adjustment of fan speed. The benefit of ECM motors is exceptional efficiency, performance, and motor life.

The control used with ECM motors features a 4 digit LED numerical display. The blue knob on the control allows the user to set the flow index with a screwdriver. Twenty seconds later, the display shows the motor RPM. Then, the display periodically alternates between the flow index and motor RPM. The flow index has a range of 0 to 100% and is typically linear with motor RPM.



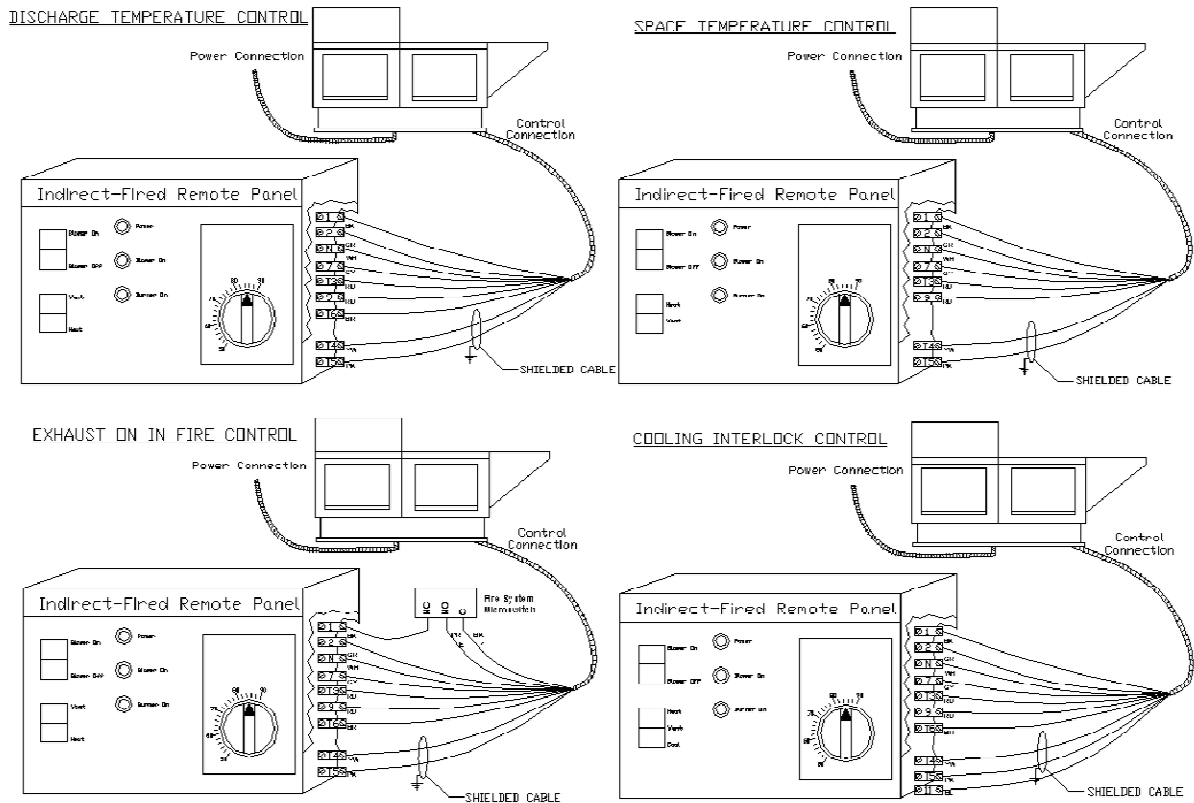
The ECM control requires a 24 VAC input and can locally turn the motor on and off. The motor can be adjusted between 300 RPM and maximum speed with this control.

NOTE: To adjust the speed of 3 phase direct drive motors, a variable frequency drive is required.

Motorized Intake Damper

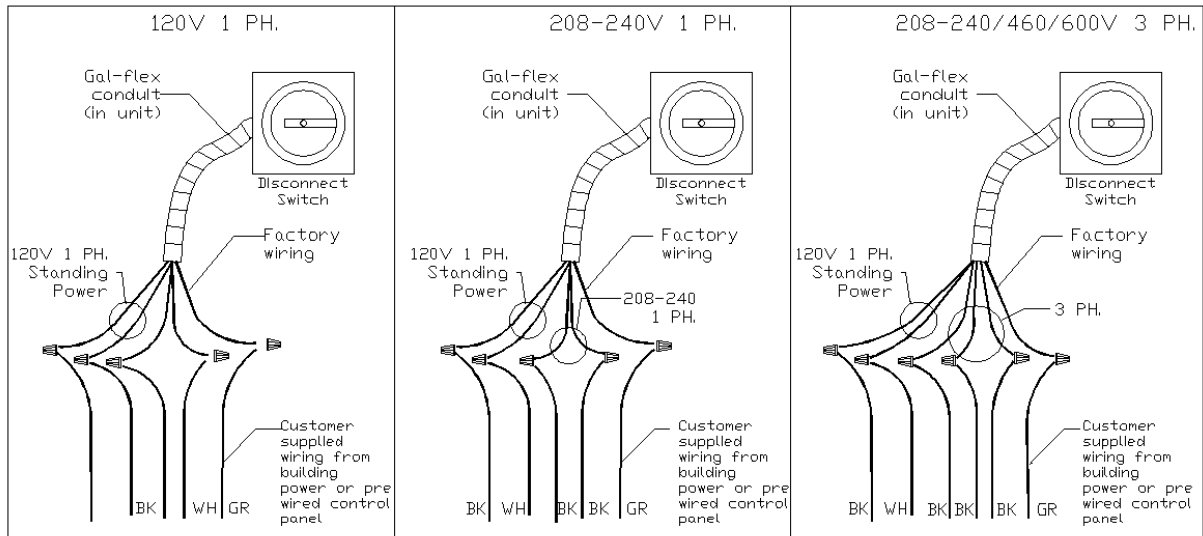
On units shipped with the optional motorized intake damper, a power transformer is supplied with the unit if the main incoming voltage is greater than 120V. The damper motor is automatically energized when the main disconnect switch is in the ON position. **No external wiring to the damper motor is required.**

Remote Control Panel



On units shipped with the optional remote control panel, an electrical drop containing the panel wiring is provided with the heater. There is a terminal strip inside the remote panel that matches the terminals in the heater unit. The remote panel should be wired as shown below.

Fan to Building Wiring Connection



OPERATION

Prior to starting up or operating the heater, check all fasteners for tightness. In particular, check the set screw in the wheel hub, bearings and the fan sheaves (pulleys). With power and gas to the heater OFF or prior to connecting ventilator to power, turn the fan wheel by hand to be sure it is not striking the inlet or any obstacles. Re-center if necessary.

Start Up

Special Tools Required

- AC Voltage Meter
- Tachometer
- Standard hand Tools
- Amperage Meter
- Manometer
- Thermometer

Start Up Procedure

1. Check all electrical connections for tightness and continuity.
2. Check pulley alignment and belt tension as described below.
3. Inspect the condition of the intake damper and damper linkage, if provided.
4. Inspect the air-stream for obstructions and install intake filters if missing.
5. Compare the supplied **motor voltage** with the fan's nameplate motor voltage. If this does not match, correct the problem.
6. Start the fan up, by turning the external disconnect to the **ON** position, and shut it **OFF** immediately to **check rotation of the wheel** with the directional arrow on the blower scroll. Reversed rotation will result in poor air performance, motor overloading and possible burnout. For units equipped with a single-phase motor check the motor wiring diagram to change rotation. For 3-phase motors, any two power leads can be interchanged to reverse motor direction.
7. When the fan is started up, observe the operation and check for any unusual noises.

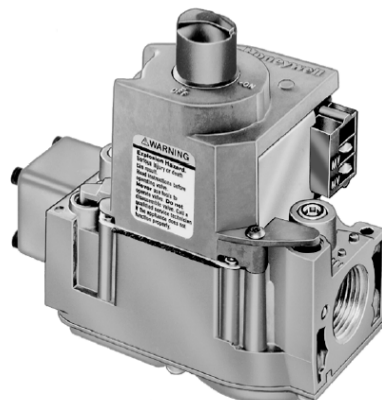
Forced High Fire Light-Off (Modulating Stage)

1. Restart the fan and check the gas supply pressure at the inlet gas tap upstream of all electronic valves. The inlet pressure should be **7 in. - 14 in. w.c. on natural gas and 11 in. – 14 in. w.c. on propane gas**. If the inlet pressure is too high, install an additional pressure regulator external to the unit.
2. Open the field installed manual gas shut-off valve and the manual main gas valve on the combination gas control valve.
3. Check the inlets to all of the firing tubes on the furnace and ensure that they are all clear of foreign debris and line up properly with each nozzle of the gas manifold.
4. Simulate a call for heat with the thermostat (turn set-point to temperature above outside air) and allow the furnace to light (Note: There is a 1 minute standard power-vent flue pre-purge time prior to the unit attempting to light). If the furnace does not light, purge the gas train and gas manifold.
5. Upon successfully sensing flame at the upper most firing tube, the unit will continue to fire at full high fire for a period of 17 seconds. At the end of this timing sequence, it will modulate down to the appropriate gas firing rate to satisfy the Temperature Selector Dial setting.
6. Check the characteristics of the flames in every firing tube of the furnace. Non-existence of or a lazy flame can be caused by low gas pressure, a dirty nozzle orifice, or clogged section of exhaust flue.

High-Fire and Low-Fire Burner Adjustment

1. After it has been verified that the furnace is lighting off properly, the manifold gas pressure should be adjusted to jobsite conditions. The gas pressure regulator (integral to the On/Off gas control) is adjusted at the factory for average gas conditions. It is important that the gas be supplied to the furnace in accordance with the input rating on the rating plate.
2. **(Skip this step and continue with step # 3 if unit contains a single furnace.)** If there are additional ON/OFF furnaces in the heater, it must be verified that they are all running at high-fire manifold pressure before setting high and low fire on the modulating stage. Reference “Gas Pressure Adjustment Reference Information” in this manual for an overview of proper pressure settings of all furnaces and a visual representation of the layout of the modulating and ON/OFF Furnaces. All ON/OFF furnaces must be running in full fire while setting high and low fire on the modulating gas valve. To do this, the entire unit must be locked into high fire mode. On units with discharge temperature control this is achieved by disconnecting one of the wire leads to the discharge air sensor. If the unit is set up for space temperature control, momentarily configure the unit to discharge temp control and lock the unit into high fire mode by changing the dipswitch settings inside of the remote-mounted, white Viconics temperature selector Dial/Thermostat in the tempered space. Refer to the “Modulating Furnace Thermostat Dipswitch Settings” section of this manual for proper dip-switch settings. If the Unit is set up for BAS(Building Automation Control), lock the unit into high fire by sending the unit a constant 10Vdc or 20mA signal. With all burners lit, set the manifold gas pressure on the non-modulating stages using the adjustment screw on the ON/OFF Gas Valve. Non-modulating furnaces can be easily identified as all of the furnaces except the one furthest downstream in the unit. They are also the ones with only a single ON/OFF gas valve on their gas train. Read the manifold gas pressure off of the 0-10” w.c. pressure indicator gauge on each of these non-modulating stages. The gas pressure should be set at **3.5 in w.c.** for natural gas and **10 in w.c.** for propane to obtain maximum

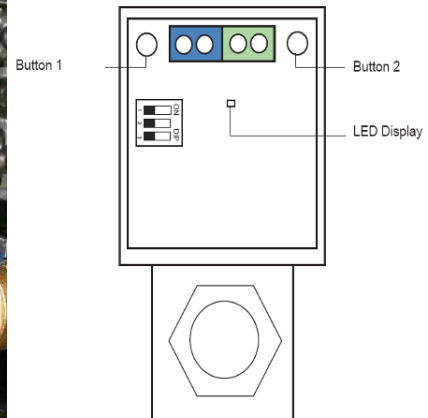
Honeywell ON/OFF Gas Valve



efficiency. If the gas pressure needs to be adjusted remove the pressure regulator adjustment cap and screw on the ON/OFF valve and using a screwdriver, turn the inner adjustment screw clockwise to increase the gas pressure. Once proper gas pressure has been set for these non-modulating stages leave them lit and move on to step # 3.

3. Create a high fire call for heat on the modulating gas valve. This should be done with the blower on and all gas controls on as described in step # 2. High fire can be achieved by first disconnecting the leads going from the discharge temperature sensor to the thermostat. Remove the cover on the Maxitrol Modulating Valve and press and hold button #1 until the LED lights solid red. Release. The valve is now in high fire setting mode. Buttons #1 and #2 are used to set desired high fire setting. Press or hold button #1 to increase gas flow. Each button press equates to the minimum available step size and will decrease slowly. Holding the button down auto steps and eliminates the need to continuously press the button. Use this feature to rapidly decrease the flow. Manifold pressure can be read off of the 0-10" w.c. gas pressure gauge located directly on the gas manifold. For natural gas systems, the high fire manifold pressure should be set at **3.5 in. w.c.** For propane gas, the high fire manifold pressure should be set to **10 in. w.c.** To save the high fire setting, simultaneously hold buttons #1 and #2 until the LED turns off. If 3.5" w.c. gas pressure cannot be achieved at high fire by adjusting the modulating gas valve and it has been verified that the inlet gas pressure is within the acceptable range of 7-14" w.c., adjust the regulator of the ON/OFF gas valve located upstream of the modulating gas valve. To do this remove the pressure regulator adjustment cap and screw on the ON/OFF valve and using a screwdriver, turn the inner adjustment screw clockwise to increase the gas pressure at the inlet of the modulating gas valve.

Maxitrol Modulating Valve

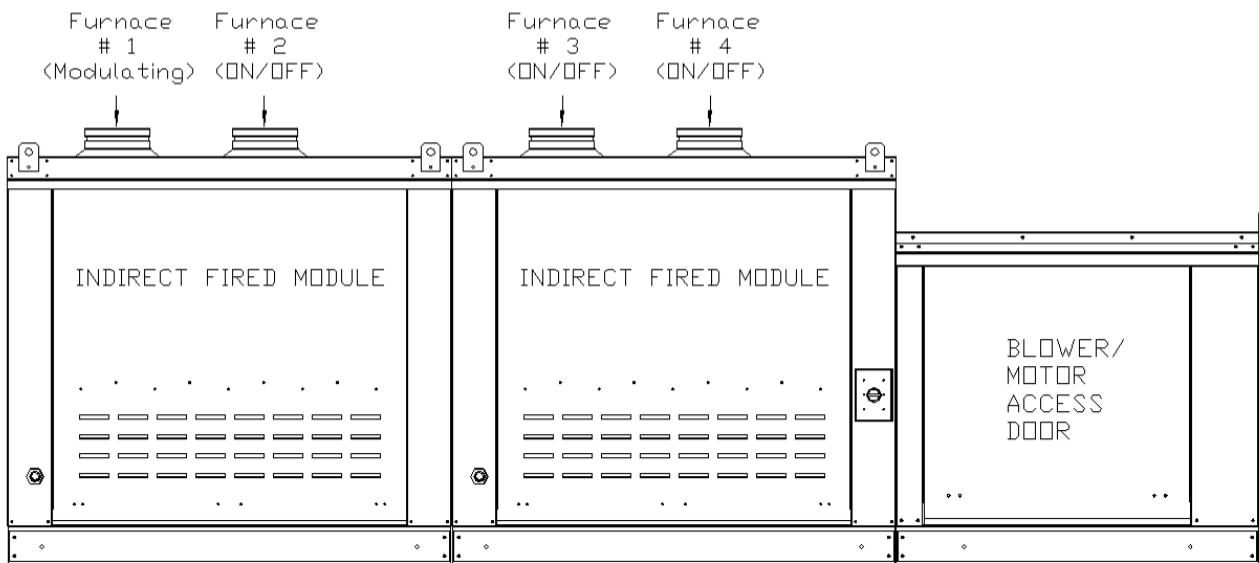


4. Using buttons #1 and #2, adjust the high fire manifold pressure to 3.5 in. w.c. for natural gas and 10 in. w.c. for propane gas. If button #1 is at the end of its adjustment and more pressure is needed, then adjust the main gas pressure regulator spring (on the On/Off valve) to achieve the proper manifold pressure. Turning the regulator screw clockwise will increase pressure and counter-clockwise will decrease pressure.
5. Save the high fire setting by simultaneously holding down buttons #1 and #2 until the LED turns off.
6. The low fire manifold pressure must now be set. The two leads coming from the discharge thermostat must be connected together instead of to the discharge air sensor to ensure the unit is in low fire mode. This ensures a reading of 0 Ohms to the thermostat. Press and hold button #2 until the LED light blinks red. Release. The valve is now in low fire setting mode. Buttons #1 and #2 are used to set desired low fire setting at this point. Press or hold button #2 to decrease gas flow. Each button press equates to the minimum available step size and will decrease flow slowly. Holding the button auto steps and eliminates the need to continuously press the button. Use this feature to rapidly decrease the flow. Press or hold button #1 to increase gas flow. Each button press equates to the minimum available step size and will increase slowly. Holding the button down auto steps and eliminates the need to continuously press the button. Use this feature to rapidly increase the flow.
7. Using buttons #1 and #2, adjust the low fire manifold pressure to **0.15 in. w.c.** for natural gas and **.75 in. w.c.** for propane gas.

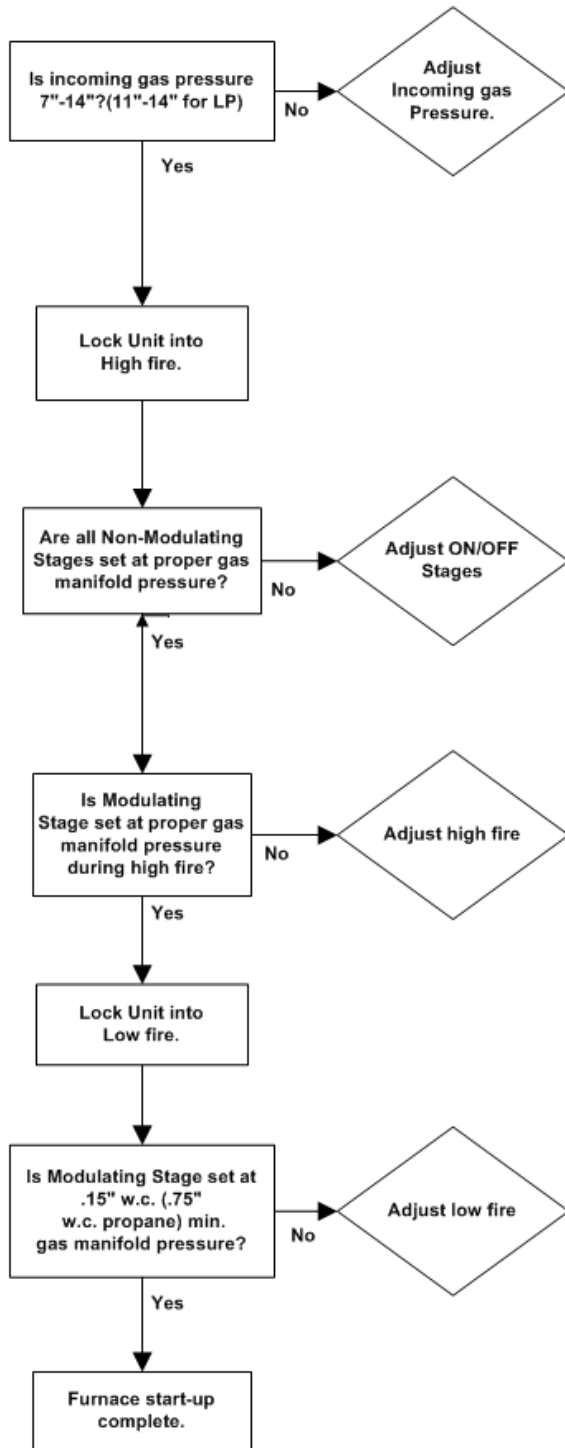
8. Save the low fire setting by simultaneously holding down buttons #1 and #2 until the blinking LED turns off. Reconnect the wires leading from the thermostat to the discharge air sensor.
9. There are 3 dip switches on the Maxitrol modulating valve. Switch 1 and 3 should be in the "OFF" position, and switch 2 should be in the "ON" position for most controls. Leave switch 2 off for BAS temp controls. In the image above, all three dip switches are shown in the "OFF" position.
10. Replace the cap to the Maxitrol modulating gas valve and all pressure regulator adjustment caps on the ON/OFF gas valves.
11. If necessary, reconnect the wire to the discharge air temperature sensor and set the dipswitch settings on the thermostat back to space control mode if these were changed during step # 2.
12. A final gas leak check shall be performed to verify the gas-tightness of the heater's components and piping under normal operating conditions.

Gas Pressure Adjustment Reference Information (Natural Gas)

		# of Furnaces in Unit			
		1 Furnace	2 Furnaces	3 Furnaces	4 Furnaces
Gas Valve Regulator Settings	1st Furnace (Modulating)	ON/OFF Valve Fully Open Maxitrol Modulating Valve @ 3.5" w.c.	ON/OFF Valve Fully Open Maxitrol Modulating Valve @ 3.5" w.c.	ON/OFF Valve Fully Open Maxitrol Modulating Valve @ 3.5" w.c.	ON/OFF Valve Fully Open Maxitrol Modulating Valve @ 3.5" w.c.
	2nd Furnace (ON/OFF)	N/A	3.5" w.c.	3.5" w.c.	3.5" w.c.
	3rd Furnace (ON/OFF)	N/A	N/A	3.5" w.c.	3.5" w.c.
	4th Furnace (ON/OFF)	N/A	N/A	N/A	3.5" w.c.



Furnace Start-Up Summary



Setting incoming pressure:

Pressure must be measured at the first "T" in The supply gas line before the first gas valve.

Adjusting ON/OFF Stages:

Remove the pressure regulator adjustment cap and screw on the ON/OFF valve and using a screwdriver. Refer to the table on pg. 15 of this manual for proper adjustment settings based on # of furnaces in the unit. Turn the inner adjustment screw clockwise to increase the gas flow and counter-clockwise to decrease the gas flow. Replace the pressure regular adjustment cap and screw.

Adjusting high fire(Modulating Stage):

Refer to the table on pg. 15 of this manual for proper adjustment settings based on # of furnaces in the unit. Press and hold button #1 down on the modulating gas valve until the LED lights solid red. This will drive the valve into its full open position. Adjust high fire. Press or hold button #1 to increase gas flow. Press or hold button #2 to decrease gas flow. Hold down both buttons to save the high fire setting. Replace cover.

Adjusting low fire (Modulating Stage):

Low fire manifold pressure should be .15" for natural gas and .75" for propane. Press and hold button #2 down on the modulating gas valve until the LED blinks red. This will drive the valve into its minimum flow position. Adjust low fire. Press or hold button #1 to increase gas flow. Press or hold button #2 to decrease gas flow. Hold down both buttons to save the low fire setting. Replace cover.

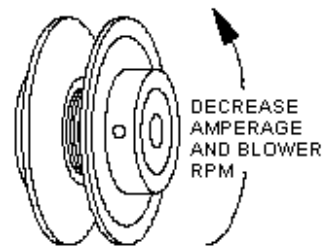
Final Start-Up Procedure

1. With the air and burner systems in full operation and all ducts attached, measure the system airflow. Motor sheave (pulley) is variable pitch, and allows for an increase or decrease of the fan RPM to adjust the airflow, as shown in the illustration below. For your convenience, a RPM chart is included in the following pages.
2. Once the proper airflow is achieved, measure and record the fan speed with a reliable tachometer. **Caution - Excessive speed will result in motor overloading or bearing failure. Do not set fan RPMs higher than specified in the maximum RPM chart.** See the troubleshooting guide for more information.
3. Measure and record the **voltage** and **amperage** to the motor and compare with the motor nameplate to determine if the motor is operating under safe load condition.
4. Once the rpm of the ventilator has been properly set, disconnect power and recheck belt tension and pulley alignment as described below.

Maximum RPM and HP Chart

Blower Size	Maximum RPM	Maximum HP
10"	1800	2
12"	1500	3
15"	1400	5
18"	1200	5
20"	1000	10
25"	900	20

Pulley Adjustment Illustration



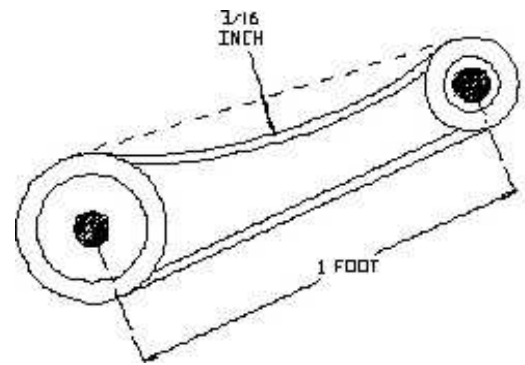
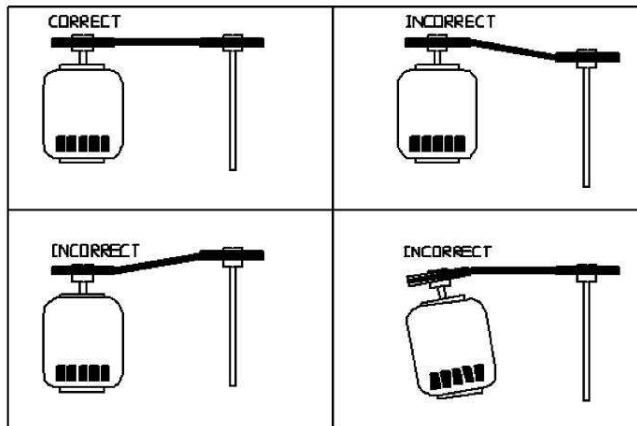
Pulley Adjustment

The adjustable motor pulley is factory set for the RPM specified. Speed can be increased by closing or decreased by opening the adjustable motor sheave. Two groove variable pitch pulleys must be adjusted an equal number of turns open or closed. Any increase in speed represents a substantial increase in horsepower required by the unit. Motor amperage should always be checked to avoid serious damage to the motor when the speed is varied. Always torque setscrews according to the setscrew torque chart.

Setscrew Torque

Thread Size	Torque (IN/Lb)
No. 10	32
1/4"	72
5/16"	130
3/8"	275
7/16"	384
1/2"	600

Pulley Alignment/Proper Belt Tension



Pulley Combination Chart

Motor RPM		1725																									
10 - 20 IN. BLOWER**	1/3 to 1-1/2 HP AX BELTS		MOTOR PULLEY 1V134		Dd1 1.9	Dd2 2.9	Pd1 2	Pd2 3	TURNS ON MOTOR PULLEY																		
				Open												Closed											
	BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0													
	AK114	11	11.2	308	323	339	354	370	385	400	416	431	447	462													
	1/3 to 2 HP AX BELTS		MOTOR PULLEY 1V140		Dd1 2.4	Dd2 3.4	Pd1 2.6	Pd2 3.6	TURNS ON MOTOR PULLEY																		
				Open												Closed											
	BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0													
	AK114	11	11.2	400	416	431	447	462	477	493	508	524	539	554													
	AK94	9	9.2	488	506	525	544	563	581	600	619	638	656	675													
	AK79	7.5	7.7	582	605	627	650	672	694	717	739	762	784	806													
	AK66	6.2	6.4	701	728	755	782	809	836	863	889	916	943	970													
	AK54	5	5.2	863	896	929	962	995	1028	1062	1095	1128	1161	1194													
	AK46	4.2	4.4	1019	1059	1098	1137	1176	1215	1255	1294	1333	1372	1411													
	AK39	3.5	3.7	1212	1259	1305	1352	1399	1445	1492	1539	1585	1632	1678													
	AK32	3	3.2	1402	1455	1509	1563	1617	1671	1725	1779	1833	1887	1941													
3 to 5 HP BX BELTS		MOTOR PULLEY 2VP42		Dd1 2.9	Dd2 3.9	Pd1 3	Pd2 4	TURNS ON MOTOR PULLEY																			
			Open												Closed												
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	6	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0												
2BK160H	15.4	15.7	330	339	348	357	366	375	385	394	403	412	421	430	439												
2BK140H	13.4	13.7	378	388	399	409	420	430	441	451	462	472	483	493	504												
2BK120H	11.4	11.7	442	455	467	479	491	504	516	528	541	553	565	577	590												
2BK110H	10.4	10.7	484	497	511	524	537	551	564	578	591	605	618	631	645												
2BK100H	9.4	9.7	534	548	563	578	593	608	622	637	652	667	682	697	711												
2BK90H	8.4	8.7	595	611	628	644	661	677	694	710	727	744	760	777	793												
2BK80H	7.4	7.7	672	691	709	728	747	765	784	803	821	840	859	877	896												
2BK70H	6.4	6.7	772	794	815	837	858	880	901	923	944	965	987	1008	1030												
2BK60H	5.4	5.7	908	933	958	984	1009	1034	1059	1084	1110	1135	1160	1185	1211												
2BK55H	4.9	5.2	995	1023	1050	1078	1106	1133	1161	1189	1216	1244	1272	1299	1327												
2BK50H	4.4	4.7	1101	1132	1162	1193	1223	1254	1285	1315	1346	1376	1407	1438	1468												
7-1/2 to 10 HP BX BELTS		MOTOR PULLEY 2VP60		Dd1 4.3	Dd2 5.5	Pd1 4.7	Pd2 5.9	TURNS ON MOTOR PULLEY																			
			Open												Closed												
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	6	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0												
2BK160H	15.4	15.7	516	527	538	549	560	571	582	593	604	615	626	637	648												
2BK140H	13.4	13.7	592	604	617	630	642	655	667	680	693	705	718	730	743												
2BK120H	11.4	11.7	693	708	722	737	752	767	781	796	811	826	840	855	870												
2BK110H	10.4	10.7	758	774	790	806	822	838	854	871	887	903	919	935	951												
2BK100H	9.4	9.7	836	854	871	889	907	925	943	960	978	996	1014	1031	1049												
2BK90H	8.4	8.7	932	952	972	991	1011	1031	1051	1071	1091	1110	1130	1150	1170												
2BK80H	7.4	7.7	1053	1075	1098	1120	1143	1165	1187	1210	1232	1255	1277	1299	1322												
25 IN. BLOWER	3 to 5 HP BX BELTS		MOTOR PULLEY 2VP42		Dd1 2.9	Dd2 3.9	Pd1 3	Pd2 4	TURNS ON MOTOR PULLEY																		
				Open												Closed											
	BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	6	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0											
	2BSV278	27.8	28.1	184	189	194	200	205	210	215	220	225	230	235	240	246											
	2BSV250	25	25.3	205	210	216	222	227	233	239	244	250	256	261	267	273											
	2BSV234	23.4	23.7	218	224	230	237	243	249	255	261	267	273	279	285	291											
	2BSV200	20	20.3	255	262	269	276	283	290	297	304	312	319	326	333	340											
	2BSV184	18.4	18.7	277	284	292	300	307	315	323	331	338	346	354	361	369											
	2BSV160	16	16.3	317	326	335	344	353	362	370	379	388	397	406	414	423											
	2BSV154	15.4	15.7	330	339	348	357	366	375	385	394	403	412	421	430	439											
	2BSV136	12.6	12.9	401	412	423	435	446	457	468	479	490	501	513	524	535											
	2BSV124	12.4	12.7	407	419	430	441	453	464	475	487	498	509	521	532	543											
	2BSV110	11	11.3	458	471	483	496	509	522	534	547	560	572	585	598	611											
	7-1/2 to 10 HP BX BELTS		MOTOR PULLEY 2VP60		Dd1 4.3	Dd2 5.5	Pd1 4.7	Pd2 5.9	TURNS ON MOTOR PULLEY																		
				Open												Closed											
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	6	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0												
2BSV278	27.8	28.1	289	295	301	307	313	319	325	331	338	344	350	356	362												
2BSV250	25	25.3	320	327	334	341	348	355	361	368	375	382	389	395	402												
2BSV234	23.4	23.7	342	349	357	364	371	378	386	393	400	408	415	422	429												
2BSV200	20	20.3	399	408	416	425	433	442	450	459	467	476	484	493	501												
2BSV184	18.4	18.7	434	443	452	461	470	480	489	498	507	517	526	535	544												
2BSV160	16	16.3	497	508	519	529	540	550	561	571	582	593	603	614	624												
2BSV154	15.4	15.7	516	527	538	549	560	571	582	593	604	615	626	637	648												
2BSV136	12.6	12.9	628	642	655	669	682	695	709	722	735	749	762	776	789												
2BSV124	12.4	12.7	638	652	666	679	693	706	720	733	747	761	774	788	801												
2BSV110	11	11.3	717	733	748	763	779	794	809	824	840	855	870	885	901												
15 to 20 HP BX BELTS		MOTOR PULLEY 2VP75		Dd1 5.8	Dd2 7	Pd1 6.2	Pd2 7.4	TURNS ON MOTOR PULLEY																			
			Open												Closed												
BLOWER PULLEY	DATUM DIAMETER	PITCH DIAMETER	6	5 1/2	5	4 1/2	4	3 1/2	3	2 1/2	2	1 1/2	1	1/2	0												
2BSV278	27.8	28.1	381	387	393	399	405	411	417	424	430	436	442	448	454												
2BSV250	25	25.3	423	430	436	443	450	457	464	470	477	484	491	498	505												
2BSV234	23.4	23.7	451	459	466	473	480	488	495	502	509	517	524	531	539												
2BSV200	20	20.3	527	535	544	552	561	569	578	586	595	603	612	620	629												
2BSV184	18.4	18.7	572	581	590	600	609	618	627	636	646	655	664	673	683												
2BSV160	16	16.3	656	667	677	688	698	709	720	730	741	751	762	773	783												
2BSV154	15.4	15.7	681	692	703	714	725	736	747	758	769	780	791	802	813												
2BSV136	12.6	12.9	829	842	856	869	883	896	909	923	936	949	963	976	990												

** 2HP Motors on 20 IN Blowers use 2VP42 Pulleys

Sequence of Operation

The Indirect-fired heater is most easily understood when broken down into smaller individual systems. There are two main systems; a make-up air fan and a heater. The make-up air fan consists of a heavy-duty blower and motor. The heater may be further broken down into two control systems, the Modulating Gas System (MGS) and the Flame Safety Control (FSC). The burner mixes air with the gas (Natural or Propane) which heats a heat exchanger which heats the air. There are between one and four furnaces in each heater depending on the total required heating output capacity for the application. Included in every unit is a modulating furnace, located furthest downstream, closest to the discharge of the heating module. The modulating furnace and additional On/Off furnaces (if used) are controlled using vernier-type modulation methods resulting in fully linear heating output over the entire gas-firing range.

Modulating Gas System

The first system, the **Modulating Gas System**, consists of an Intake Air Thermostat, a Temperature Selector Dial, an Electronic Modulation Step Controller, a Discharge Air Sensor(only on discharge temp control option), and a Modulating gas valve. The Intake Air Thermostat is only used to power the Electronic Modulation Step Controller and the On/Off redundancy Gas Valve on the gas train of the modulating furnace. It is important to understand that this intake air thermostat is only used for these two purposes and does not control the discharge/space temperature in which the module tries to maintain. For Kitchen MUA heating applications, the dial setting on the Intake Air Thermostat should be set at 45 °F, whereas the Temperature Selector Dial should be set at 55 °F. For all other applications, the dial settings should be set appropriately based on the end-users preferences and on-site conditions.

There are 3 different options for controlling the gas firing output of these units. These include Discharge Temperature Control, Space Temperature Control, and Building Automation Control. Refer to page 24 for how to configure for each type of control:

1. **Discharge Control:** When wired for discharge control, the Electronic Modulation Step Controller utilizes a discharge air sensor in the unit and heats the incoming air to the selected setting on the Temperature Selector Dial.
2. **Space Control:** When the space control option has been selected, the Temperature Selector Dial is mounted in the space, sensing the temperature in the room with use of an internal sensor. The discharge sensor in the unit is not used.
3. **Building Automation Control:** Use of the Temperature Selector Dial is completely eliminated and a 0-10vdc or 4-20mA signal is sent to the electronic modulation step controller from the building control system to regulate the heating output of the unit.

In all cases, the Electronic Modulation Step Controller controls the amount of gas to the burner based on the temperature rise needed. When the modulating gas valve is all the way open and achieving the maximum BTUs and temperature rise of the unit, it is called "high fire".

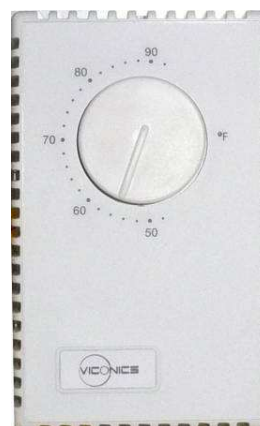
Intake Air Thermostat



Electronic Modulation Step Controller



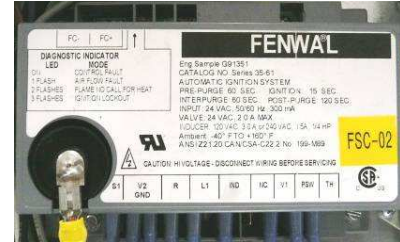
Temperature Selector Dial



Flame Safety Control

The second system to understand is the **Flame Safety Control**. The FSC is present **only** to monitor the flame, NOT to control temperature. The FSC uses a sensor mounted at the intake of the upper-most firing tube of the furnace to sense the existence of a flame. The FSC controls the opening of the redundant solenoid gas valves and the operation of the spark igniter to initiate a flame upon start up. When there is a call for heat, the LED on the FSC is energized indicating that the unit has power. Then, there is a one minute pre-purge in which the power-vent blower on the furnace is sent to high speed to exhaust any gas in the Heat-exchanger/Control Cabinet that may be present prior to trial for ignition. As soon as the pre-purge has initiated, the FSC checks that airflow is sensed by the power-vent airflow switch* and that the High Limit and Roll-out switches are not tripped. (**NOTE: If while trouble-shooting the unit it is necessary to jumper-out this airflow switch, the jumpers must be applied to the contacts immediately after the power-vent motor is turned on and the FSC begins to check for airflow, otherwise the unit will go into lock-out mode.*) Upon successful sensing of induced power-vent airflow and continuity of temperature limit and Roll-out switches, the FSC initiates a 15 second ignition sequence. During this ignition sequence, the FSC opens the On/Off gas valves and allows gas to pass through to the Gas Manifold. At the same moment, the spark igniter begins to spark, causing the electrode on the burner to ignite the gas. This results in a flame at the lowest firing tube of the furnace which immediately ignites the flow of gas in each succeeding firing tube moving vertically until the entire furnace is lit. When the sensor detects the flame at the intake of the upper-most firing tube the FSC continues to power the On/Off gas valve until there is a loss of flame presence. This is the normal operating mode.

Flame Safety



the power-vent airflow switch* and that the High Limit and Roll-out switches are not tripped. (**NOTE: If while trouble-shooting the unit it is necessary to jumper-out this airflow switch, the jumpers must be applied to the contacts immediately after the power-vent motor is turned on and the FSC begins to check for airflow, otherwise the unit will go into lock-out mode.*) Upon successful sensing of induced power-vent airflow and continuity of temperature limit and Roll-out switches, the FSC initiates a 15 second ignition sequence. During this ignition sequence, the FSC opens the On/Off gas valves and allows gas to pass through to the Gas Manifold. At the same moment, the spark igniter begins to spark, causing the electrode on the burner to ignite the gas. This results in a flame at the lowest firing tube of the furnace which immediately ignites the flow of gas in each succeeding firing tube moving vertically until the entire furnace is lit. When the sensor detects the flame at the intake of the upper-most firing tube the FSC continues to power the On/Off gas valve until there is a loss of flame presence. This is the normal operating mode.

Flame Safety Ignition Sequence

Interval Description:	Initial Call for Heat	1 Min. Pre-purge	15 Sec. Trial for Ignition	1 Min. Inter-purge	15 Sec. Trial for Ignition	1 Min. Inter-purge	15 Sec. Trial for Ignition	2 Min. Post-purge	1 hr Lockout	Repeat Cycle
Time(Min:Sec):	0:00	1:00	1:15	2:15	2:30	3:30	3:45	5:45	End of Cycle	
(Non-Linear Scale)										

Modulating Stage Sequence

As mentioned in the previous sections, every unit is equipped with a modulating furnace located furthest downstream at the discharge of the heater module. This modulating stage operates differently than the other On/Off staged furnaces in that instead of being "On" or "Off", the gas flow to this furnace is modulated up and down to account for varying calls for heat during the units operating period. In addition, the speed of its power-vent blower is varied as the gas flow changes in order to maintain constant 83% combustion efficiency over the entire firing range. The modulating furnaces Power-vent blower is controlled by a speed controller that varies the output voltage to the motor based on a 0-10Vdc signal from the Electronic Modulation Step Controller. The Output voltage (True RMS) to the motor varies non-linearly between 120Vac @ 10Vdc for high fire and 75.6Vac @ 0Vdc for low fire. ***NOTE: Red dip switches located on the modulating furnaces Power-vent Blower Speed Controller are de-activated and should not be adjusted.**

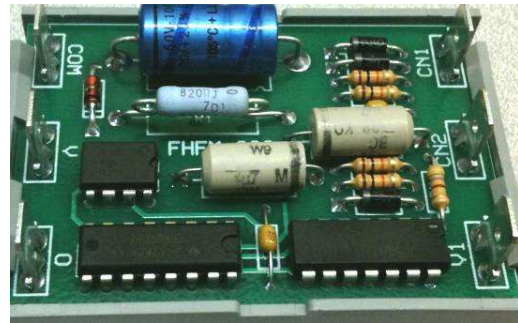
Power-vent Blower Speed Controller*



Forced High-Fire Start

In order to ensure proper light-off in all conditions, every unit is equipped with a FHF-809 component that forces the modulating furnace to light at high fire when there is an initial call for heat. This component has a built in timer that allows it to send a constant 10Vdc signal to the modulating gas valve and power-vent blower speed controller and force the furnace into high fire for a period of 17 seconds after initial light-off. After this forced high-fire light-off period has expired, the modulating furnace's power-vent blower and modulating Gas Valve are controlled solely by the 0-10Vdc signal from the Electronic Modulation Step Controller.

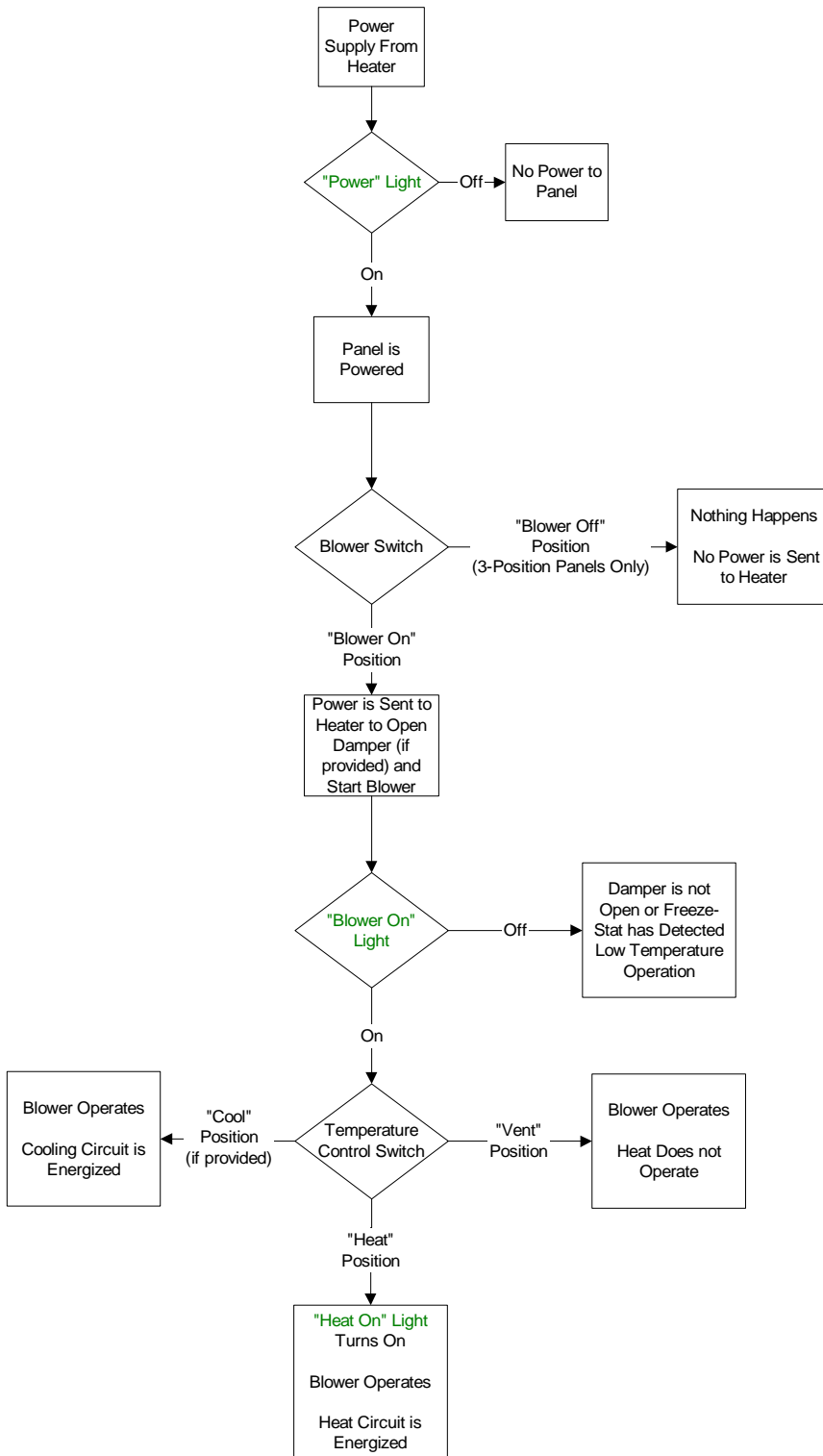
Forced High Fire Module



Operation Summary

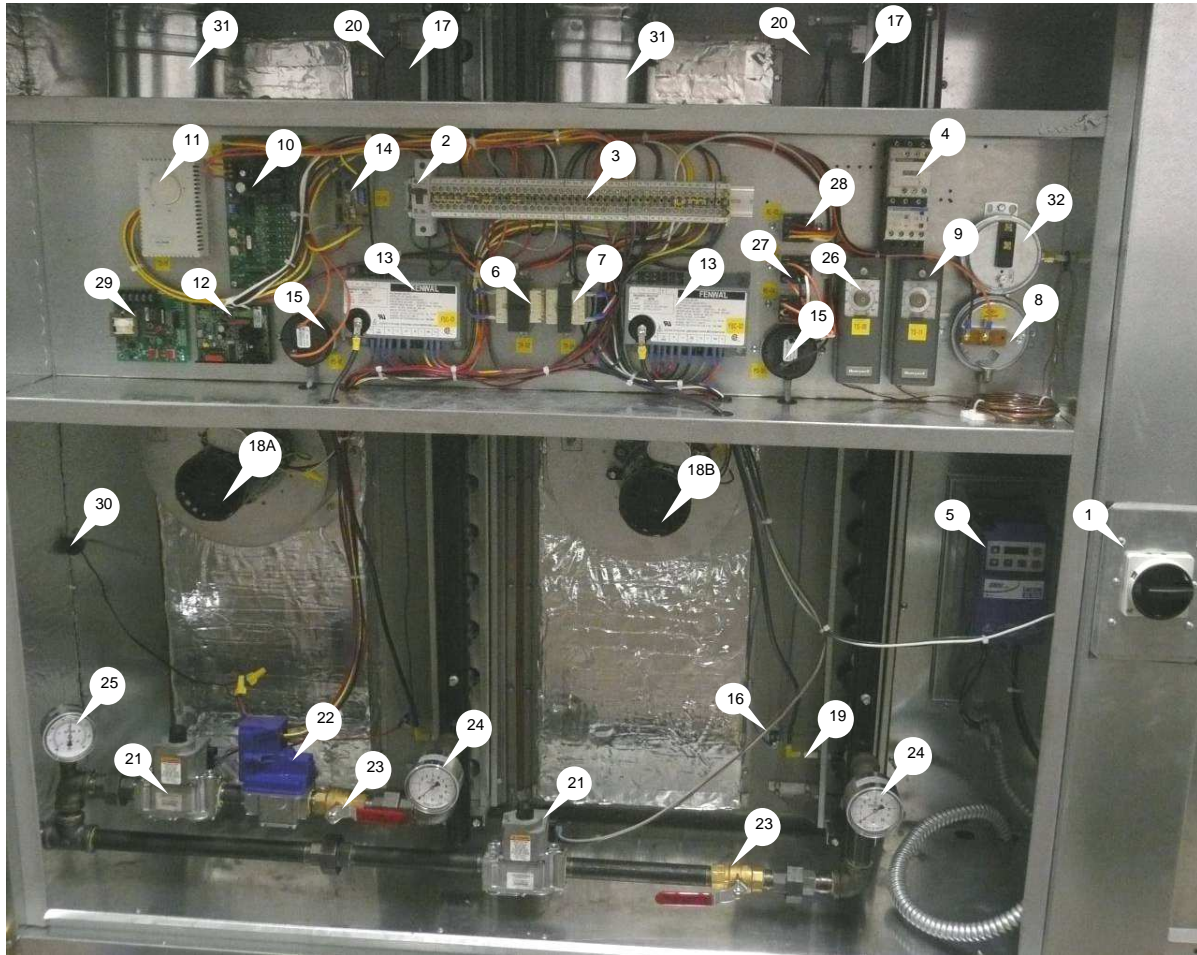
- Main Blower is turned "On" and the Main Airflow Switch is proven.
- Air temperature at the intake of the unit falls below the setting of the Intake Air Thermostat sending 24Vac power "Call for Heat" to FSC-1 and Electronic Modulation Step Controller.
- FSC-1 sends 120Vac power to the line in-put of the Power-vent Blower Speed Controller.
- Air temperature at discharge of the unit falls below the setting on the Temperature Selector Dial.
- Forced High Fire Module is in its un-triggered state and sends a 10Vdc signal to Electronic Modulation Step Controller and Power-vent Blower Speed Controller.
- Power-vent Blower Speed Controller is controlled by the 10Vdc input signal from Forced High Fire Module and sends a 120Vac signal to Power-vent Blower Motor to initiate 1 min pre-purge at high speed.
- 24Vac signal runs through the safety circuit (Power-vent Airflow Switch/High Temperature Limit/Flame Roll-out Switch) and into FSC-1.
- FSC-1 initiates Trial for Ignition by sending signal to Spark Igniter to light furnace and 24Vac power to On/Off Gas Valve and Forced High Fire Module. This opens On/Off Gas Valve and triggers the start of the 17 second long internal timer on the Forced High Fire Module.
- Flame is sensed by FSC-1's Remote Flame Sensor at the upper-most firing tube of furnace.
- Forced High Fire Module's 17 second high-fire off-delay time sequence runs out and 0-10Vdc modulating signal from Electronic Modulation Step Controller is output from Forced High Fire Module to Modulating Gas Valve and Power-vent Blower Speed Controller.
- Electronic Modulation Step Controller continues to modulate the heat output of MAU by adjusting the 0-10Vdc signal to Modulating Gas Valve and turns other On/Off Staged Furnaces on and off as required to satisfy the Temperature Selector Dial setting within one degree Fahrenheit.

Optional Remote Panel Circuit



Components

The following image and list outlines the typical in-direct fired heater components and their functions.



1. **Main Disconnect Switch** – Controls all electrical power to entire unit.
2. **Circuit Breaker** – Protects electrical components from high current spikes.
3. **Terminal Strip** – Central location to terminate control wiring. Should be used for troubleshooting.
4. **Motor Starter** – Contactor with overload protection to start and protect motor.
5. **Variable Frequency Drive (Optional)** – Used in place of motor starter to protect main blower motor and to control the speed of the main blower to vary main airflow across unit.
6. **Control Transformer** – 120V primary; 24V secondary control transformer.
7. **Modulating Gas Valve Control Transformer** – 120V primary; 24V secondary control transformer. Provides standing 24V power to Modulating Gas Valve.
8. **Main Airflow Switch** – Senses that there is main airflow across the Heat-exchanger of the furnace. Adjustable set-point. Heater circuit will not energize unless proven.
9. **Intake Air Thermostat** – Energizes Flame safety control for the modulating furnace and the electronic modulation step controller if ambient temperature at intake drops below set-point.
DOES NOT CONTROL THE TEMPERATURE AT WHICH THE UNIT HEATS THE DISCHARGE AIR TO (COMPONENT #11 USED FOR THIS PURPOSE).

10. **Electronic Modulation Step Controller** – Controls the 0-10 VDC signal to modulating furnace controls and 24 VAC signals to staged furnace controls. Works in conjunction with component # 11.
11. **Discharge/Space Dial Temperature Control** – Controls the Discharge or Space temperature to which the heating module heats to and constantly tries to maintain. Mounted in the unit for discharge temperature control and remotely for space control.
12. **Modulating Furnace Power-vent blower Speed controller** – Controls the speed of the power-vent blower on the modulating furnace to maintain constant combustion efficiency. Dip-switches de-activated. Non-adjustable, comes pre-programmed from factory.
13. **Flame Safety Control** – Initiates and monitors flame. Equipped with non-adjustable time settings for pre-purge, inter-purge, and post-post of the exhaust flue and control cabinet.
14. **Forced High Fire Module** – Forces heater to high fire for initial light-off sequence.
15. **Power-vent Airflow proving Switch** – Normally open, non-adjustable airflow switch. Senses whether the power-vent blower is running and allows furnace to spark when airflow is proven.
16. **High Limit Switch** – Normally closed high temperature switch. De-energizes heater circuit on individual furnace if temperature exceeds mechanical set-point. Automatic recycling. 325°F set-point.
17. **Flame Roll-Out Switch** – Normally closed temperature activated switch. Mounted on bracket at inlet of the upper-most firing tube. Senses for any flame roll-out in the event of a blocked tube, low airflow, or low gas pressure. If flame-rollout is present, de-energizes heater circuit on individual furnace. Must be manually reset. 200°F set-point.
18. **Power-vent Motor**– Induces airflow through heat exchanger and flue of furnaces A) Modulating furnace variable speed blower motor. B) Non-modulating furnace constant speed blower motor.

Power Vent Motor Orifice Size

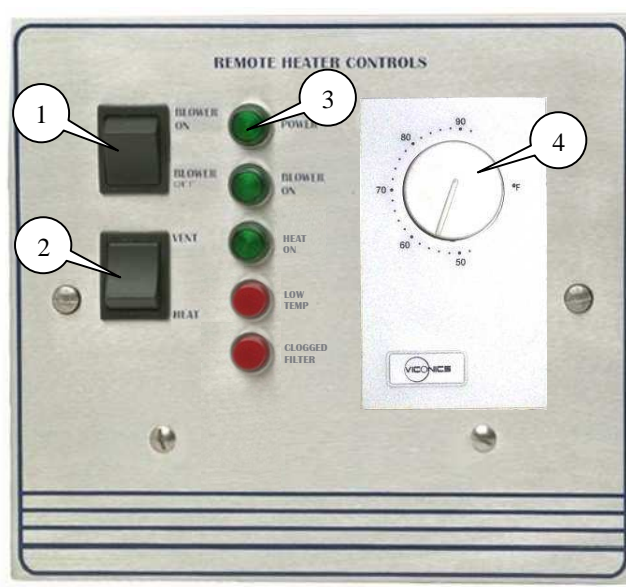
Furnace BTU (x1000/hr)	Dia. (in.)
400	2.625
300	2.25
200	2.375
150	1.875

19. **Spark Igniter** – Powered by Flame safety control to initiate light-off.
20. **Flame Sensor** – Continuously Senses for the presence of flame in heating mode after ignition has commenced. Wired to Flame Safety Control.
21. **On/Off Redundant Gas Valve** – On/off gas valve with built in regulator and manual shut off switch. One used on each furnace gas train.
22. **Modulating Gas Valve** – Controls the amount of gas to the modulating furnace to meet desired discharge/Space temperature.
23. **Manual Gas Shut-Off Valve** - Allows gas flow to burner to be shut off to leak test gas train.
24. **Manifold Gas Pressure Gauge** – Indicates manifold gas pressure on individual furnace.
25. **Main Inlet Gas Pressure Gauge** – Indicates inlet gas pressure to unit.
26. **Cooling thermostat (Optional)** – Senses intake air temperature and initiates call for cooling if temperature rises above set-point.
27. **Cooling Relays (Optional)** – Powered by cooling thermostat. Contacts used to send power to the compressors in the condensing unit during a call for cooling.
28. **Remote Panel indicating light Relay (Optional)** – Contacts energize appropriate circuits to indicate to the user that the main Blower is running, there is a call for heat, or clogged filters.
29. **Freeze-Stat (Optional)** – Senses discharge temperature and shuts down power to the main blower if the temperature drops below the set-point for a time longer than what is set on the adjustable dial.

30. **Discharge Air Sensor** – Used on units with discharge temperature control to sense the temperature at discharge
31. **Exhaust Flue Pipe** – Ventilates combustion exhaust between the power-vent discharge and top of the unit.
32. **Dirty Filter Airflow Switch (Optional)** – Senses whether the filters at the intake to the main blower are free of dirt and contaminant.

Remote Panel Option

The Remote Panel is a device used to control the operation of the heater from a remote location. This unit is available in both a “2 Position” or “3 Position” configuration and with or without a cooling output. It also will accommodate both the Discharge and Space Temperature Control options. It is important to understand the following Remote Panel controls and uses:



1. **Blower On/Blower Off Switch** - Used to control blower operation and tempering mode of unit. The **Blower On** position sends power to the blower motor and the heater begins to ventilate. The **Blower Off** position turns the blower and heating functionality off. This switch is disabled when the “2 Position” remote panel is ordered and fan power is then controlled by the pre-wire package.
2. **Heat/Vent Switch** – This switch is used to control the tempering mode of the unit. The **VENT** position will prevent the burner from operating and the heater will deliver un-tempered air. The **HEAT** position will force the burner on and the unit will heat the incoming air. This switch becomes a Heat/Vent/Cool switch when the cooling interlock is ordered. This option provides a 120V cooling output from the remote panel.
3. **Lights-** Displays the current status of unit features. The light definitions are as follows:
 - POWER** - Illuminated when there is power to Remote Panel.
 - BLOWER ON** - Illuminated when the blower motor is powered and airflow is present.
 - HEAT ON** - Illuminates after pilot flame has established and main valve is powered.
 - LOW TEMP** - (Optional) Illuminated when the Freeze-stat turns off blower.
 - CLOGGED FILTER** – (Optional) Illuminated when the Intake Filters are Dirty.

4. **Temperature Control** – Controls the discharge temperature of a standard unit. The Temperature Selector Dial is included on the remote panel in Space Heating applications and is used to control the space temperature.

Modulating Furnace Thermostat Dip Switch Settings

Thermostat*	
Discharge Control	
S1	On
S2	Off
Space Heating	
S1	Off
S2	On

To test and verify all coil circuits during startup, perform the following:

- Discharge Control: Disconnect one wire to the discharge air sensor to simulate a call for maximum heat output.
- Space Control: Set the Thermostat dipperswitches to discharge control.

Once high and low fire gas pressure adjustments have been made, configure wiring and dipperswitches to their original state.

Step Controller Coil Thermostat Dip Switch Settings

Step Controller and Thermostat Dip Switch Setting Chart*						
Thermostat		Step Controller Input		Step Controller Control		
Discharge Control		S1	Off	S1	Off	1 Modulating, 3 Staged
S1	On	S2	Off	S2	Off	S3 On
S2	Off	S3	Off			S4 On
Space Heating		S4	On	1 Modulating, 1 Staged		
S1	Off			S3	On	
S2	On			S4	Off	
				1 Modulating, 2 Staged		
				S3	Off	
				S4	On	

*NOTE: All dip switch settings specific for each unit are displayed on the electrical schematic. Red dip switches located on the modulating furnaces power-vent blower speed controller are de-activated and should not be adjusted.

Troubleshooting

The following tables list causes and corrective actions for possible problems with in-direct heater units. Review these lists prior to consulting manufacturer.

Airflow Troubleshooting Chart

Problem	Potential Cause	Corrective Action
Fan Inoperative	Blown fuse or open circuit breaker	Replace fuse or reset circuit breaker and check amps
	Disconnect switch in "Off" position	Turn to "On" position
	Motor wired incorrectly	Check motor wiring to wiring diagram located on fan motor
	Broken fan belt	Replace belt
	Motor starter overloaded	Reset starter and check amps
	Remote panel set to "Blower Off"	Set Remote Panel to "Blower On"
Motor Overload	Fan rotating in the wrong direction	Be sure fan is rotating in the direction shown on rotation label
	Fan speed is too high	Reduce fan RPM
	Motor wired incorrectly	Check motor wiring to wiring diagram located on fan motor
	Overload in starter set too low	Set overload to motor FLA value
	Motor HP too low	Determine if HP is sufficient for job
	Duct static pressure lower than design	Reduce fan RPM
Insufficient Airflow	Fan rotating in the wrong direction	Be sure fan is rotating in the direction shown on rotation label
	Poor outlet conditions	There should be a straight clear duct at the outlet
	Intake damper not fully open	Inspect damper linkage and replace damper motor if needed
	Duct static pressure higher than design	Improve ductwork to eliminate or reduce duct losses
	Blower speed too low	Increase fan RPM. Do not overload motor
	Supply grills or registers closed	Open and adjust
	Dirty or clogged filters	Clean and/or replace
	Belt slippage	Adjust belt tension
Excessive Airflow	Blower speed too high	Reduce fan RPM
	Filters not installed	Install filters
	Duct static pressure lower than design	Reduce fan RPM
Excessive Vibration and Noise	Misaligned pulleys	Align pulleys
	Damaged or unbalanced wheel	Replace wheel
	Fan is operating in the unstable region of the fan curve	Refer to performance curve for fan
	Bearings need lubrication or replacement	Lubricate or replace
	Fan speed is too high	Reduce fan RPM
	Belts too loose, worn or oily	Inspect and replace if needed

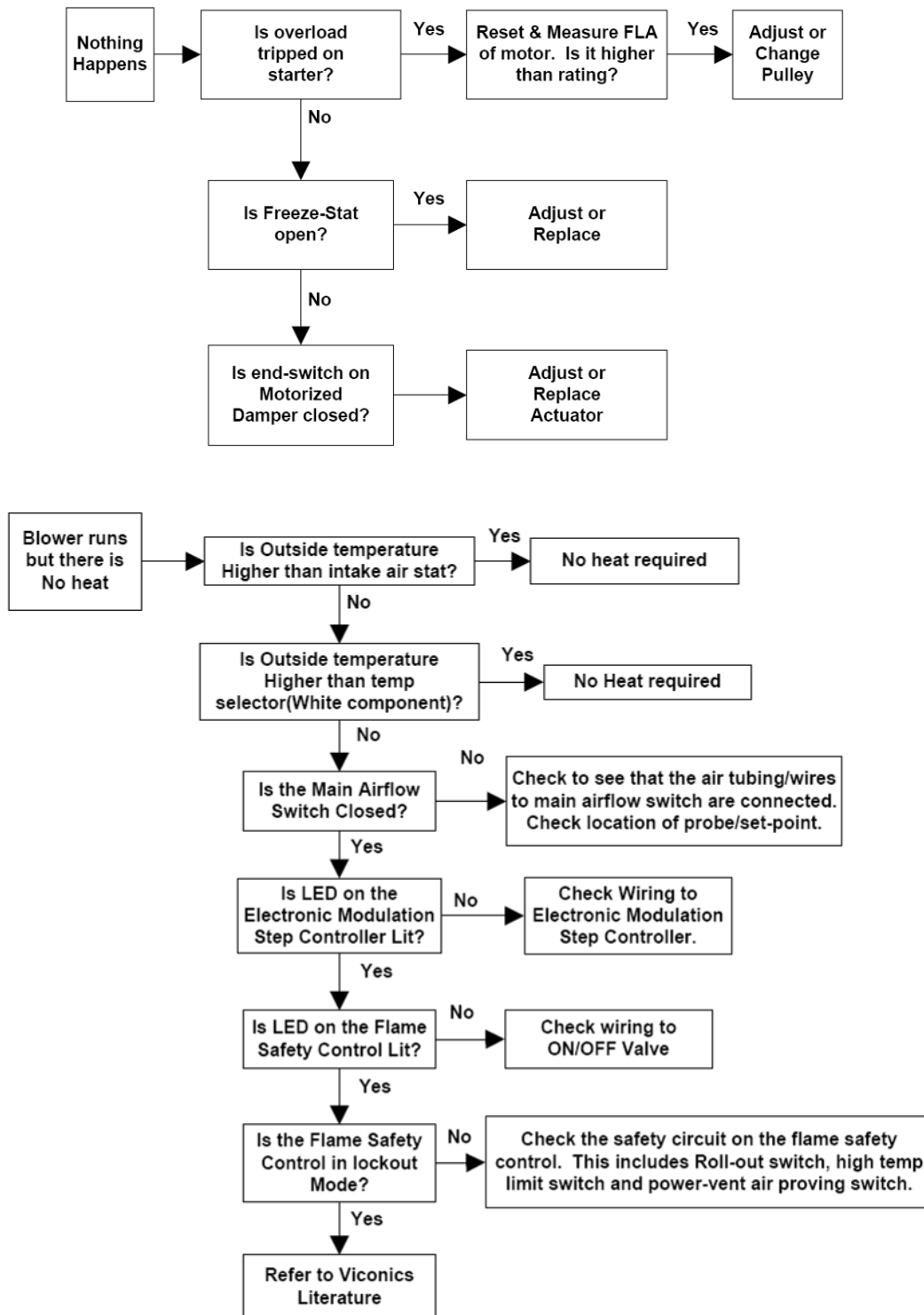
Furnace Troubleshooting Chart

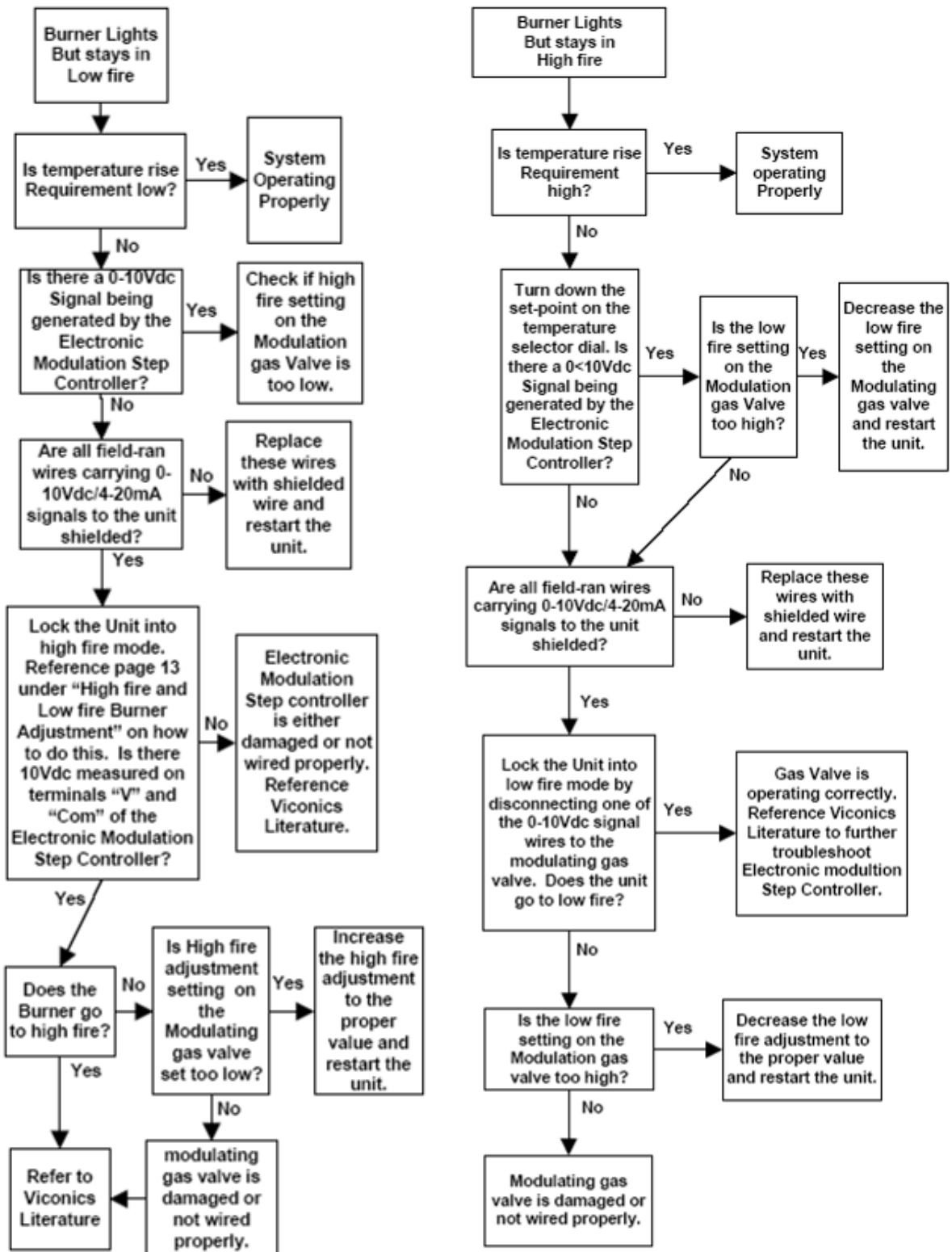
Problem	Potential Cause	Corrective Action
Furnace Does Not Light/Stay Lit	Main gas is off	Open main gas valve
	Air in gas line	Purge gas line
	Dirt in burner orifices	Clean orifices with compressed air
	Gas pressure out of range	Adjust to proper gas pressure
	ON/OFF Gas valve is off	Turn ON/OFF Gas valve on
	Spark Igniter Rod out of position	Relocate Spark Igniter Rod to proper area
	Excessive drafts	Re-direct draft away from unit
	Safety device has cut power	Check limits and airflow switch
	Dirty flame sensor	Clean flame sensor
	Remote panel in "Vent" mode	Change to "Heat" mode
	No spark at igniter	Check wiring, sensor, and ignition controller
	Defective valve	Replace ON/OFF or Modulation Gas Valve
	Loose valve wiring	Check wiring to valve
	Defective flame sensor	Replace flame sensor
	Shut off valve closed	Open shut off valve
	Defective Flame Safety Controller	Replace Flame Safety Controller
Unit cycling on high limit	Increase airflow through furnace and check gas pressure	
Not Enough Heat	Main gas pressure too low	Increase main gas pressure – do not exceed 14 in. w.c. inlet pressure
	Unit locked into low fire	Check wiring
	Too much airflow	Decrease airflow if possible
	Furnace undersized	Check design conditions
	Gas controls not wired properly	Check wiring
	Thermostat setting too low	Increase thermostat setting
Too Much Heat	Thermostat malfunction	Check/replace thermostat
	Defective modulating gas valve	Check/replace modulating valve
	Thermostat setting too high	Decrease thermostat setting
	Unit locked into high fire	Check Modulation Valve Settings/10Vdc source
	Thermostat wired incorrectly	Check thermostat wiring
	Too much primary air	Reduce primary air
Lifting Flames or Flashback	Manifold pressure set too high	Reduce manifold pressure
	Dirty orifice	Check and clean orifice
	Orifice too large	Check orifice size
Yellow Tipping	Insufficient primary air	Increase primary air
	Misaligned orifice	Check manifold alignment
	Orifice too large	Check orifice size
Floating Flames or Flame Rollout	Insufficient primary air	Increase primary air
	Manifold pressure too high	Decrease manifold pressure
	Blocked vent	Check venting system
	Misaligned orifice	Check manifold alignment

Remote Panel Troubleshooting Chart

Light Indication	Condition	Possible Cause
No Lights	Power not available to Remote Panel	Bad voltage to unit
		Main disconnect in "OFF" Position
		Circuit breaker tripped
		Bad main transformer
POWER Light Only	Proper unit Off Operation	No problem
	No power to motor starter	Blower On/Blower Off Switch in "Blower Off" Position
		Improper damper function
		Low Temperature Thermostat Timed Out (Option)
	Improper Airflow	Insufficient Airflow
		Bad airflow switch
		Problem with air probes
		Problem with airflow tubing
		Broken Belt
	POWER Light and BLOWER ON Light	Proper Ventilation Operation
No Power to Flame Safety Controller		Heat/Vent Switch in "Vent" Position
		Gas Pressure Switch Tripped (option)
		High Temperature Limit Thermostat Tripped
CLOGGED FILTER Light On (Optional)	Filters Clogged	Filters Dirty or Need Replacement
LOW TEMP Light On (Optional)	Freeze-stat has shut blower down	Discharge Temperature Too Cold Heating System is not Functioning
POWER Light and BLOWER ON Light and HEAT ON Light	Proper Heating Operation	No Problem

Troubleshooting Flow-charts





MAINTENANCE

To guarantee trouble free operation of this heater, the manufacturer suggests following these guidelines. Most problems associated with fan failures are directly related to poor service and maintenance.

Please record any maintenance or service performed on this fan in the documentation section located at the end of this manual.

WARNING: DO NOT ATTEMPT MAINTENANCE ON THE HEATER UNTIL THE ELECTRICAL SUPPLY HAS BEEN COMPLETELY DISCONNECTED AND THE MAIN GAS SUPPLY VALVE HAS BEEN TURNED OFF.

General Maintenance

1. Fan inlet and approaches to ventilator should be kept clean and free from any obstruction.
2. Motors are normally permanently lubricated. Check bearings periodically. If they have grease fittings lubricate each season. Use caution when lubricating bearings, wipe the fittings clean, the unit should be rotated by hand while lubricating. **Caution: Use care when touching the exterior of an operating motor. Motors normally run hot and may be hot enough to be painful or cause injury.**
3. All fasteners should be checked for tightness each time maintenance checks are performed prior to restarting unit.
4. Blowers require very little attention when moving clean air. Occasionally oil and dust may accumulate causing imbalance. If the fan is installed in a corrosive or dirty atmosphere, periodically inspect and clean the wheel, inlet and other moving parts to ensure smooth and safe operation.
5. Before each heating season, verify that the drain on the bottom of each common flue box of every furnace in the unit is clear.

Re-Setting of the Unit

If the flame safety control is locked out (Spark igniter fails or no gas supply), reset the unit by:

1. Turn OFF Power to the unit.
2. Turn Power to the unit back ON.

Emergency shutdown of unit

To shut down the unit in the event of an emergency do the following:

1. Turn power OFF to the unit from main building disconnect.
2. Turn the external disconnect switch to the OFF position.
3. CLOSE the inlet gas valve located on the heater.

Prolonged shutdown of the unit

For prolonged shutdown the following steps should be done:

1. Turn the external disconnect switch to the OFF position.
2. CLOSE the inlet gas valve located on the heater.

To re-start the unit the following steps should be done:

1. Turn the external disconnect switch to the ON position.
2. OPEN the inlet gas valve located on the heater.

2 weeks after startup

1. Belt tension should be checked after the first 2 weeks of fan operation. Belts tend to stretch and settle into pulleys after an initial start-up sequence. **Do not tension belts by changing the setting of the motor pulley**, this will change the fan speed and may damage the motor. To re-tension belts, turn the power to the fan motor OFF. Loosen the fasteners that hold the blower scroll plate to the blower. Rotate the motor to the left or right to adjust the belt tension. Belt tension should be adjusted to allow 1/64" of deflection per inch of belt span. Exercise extreme care when adjusting V-belts as not to misalign pulleys. Any misalignment will cause a sharp reduction in belt life and produce squeaky noises. Over-tightening will cause excessive belt and bearing wear as well as noise. Too little tension will cause slippage at startup and uneven wear. **Whenever belts are removed or installed, never force belts over pulleys without loosening motor first to relieve belt tension.** When replacing belts, use the same type as supplied by the manufacturer. On units shipped with double groove pulleys, matched belts should always be used.
2. All fasteners should be checked for tightness each time maintenance checks are performed prior to restarting unit.

Every 3 months

1. Belt tension should be checked quarterly. See instructions in the previous maintenance section. Over-tightening will cause excessive bearing wear and noise. Too little tension will cause slippage at startup and uneven wear.
2. Filters need to be cleaned and/or replaced quarterly, and more often in severe conditions. Washable filters can be washed in warm soapy water. When re-installing filters, be sure to install with the **airflow in the correct direction** as indicated on the filter.

Filter Quantity Chart

Intake	16" x 20"	20" x 25"
Size 1 Sloped	3	
Size 2 Sloped		3
Size 3 Sloped	6	
Size 4 Sloped	10	
Size 5 Sloped		8
Size 1 V-Bank		3
Size 2 V-Bank	8	
Size 3 V-Bank		8
Size 4 V-Bank	15	
Size 5 V-Bank		12

Yearly

1. Before each heating season, verify that the drain on the bottom of each common flue box of every furnace in the unit is clear.
2. Inspect bearings for wear and deterioration. Replace if necessary.
3. Inspect belt wear and replace torn or worn belts.
4. Inspect bolts and set screws for tightness. Tighten as necessary.

5. Inspect motor for cleanliness. Clean exterior surfaces only. Remove dust and grease from the motor housing to ensure proper motor cooling. Remove dirt and grease from the wheel and housing to prevent imbalance and damage.
6. The heat exchanger should be checked for cracks. The heat exchanger should be replaced immediately if cracks are detected.
7. Inspect the combustion blower motor for cleanliness. Clean exterior surfaces of the combustion blower motor only. Removing excess dust and grease guarantees proper motor cooling.
8. Before each heating season, examine the burner and gas orifices. Inspect burner ports for foreign debris, heat exchanger, and spark igniter for cleanliness.

