Compact Direct Fired Heater

Installation, Operation, and Maintenance Manual

FOR YOUR SAFETY

If you smell gas:

1. **Open windows.**
2. **Don't touch electrical switches.**
3. **Extinguish any open flames.**

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. 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, THE USE OF A SLING IS ADVISED.

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. All air to the heater must be ducted from the outdoors. Recirculation of room air is not permitted. If in doubt regarding the application, consult the manufacturer.

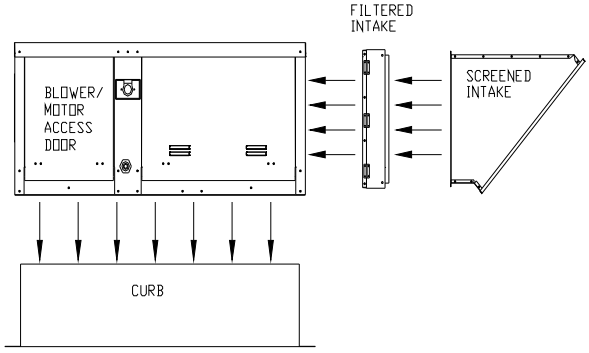
CLEARANCES

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.

Assembly

Intakes and curbs are shipped unassembled. Upon unit arrival, follow 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 filtered intake.
2. Screw the flanges of the intake hood or filtered intake to the unit with the supplied sheet metal screws. Cover screw heads with silicone to prevent water leaks.



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 minimum fan outlet duct size is 12 inches x 12 inches with a recommended minimum straight duct length of 36 inches. **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.

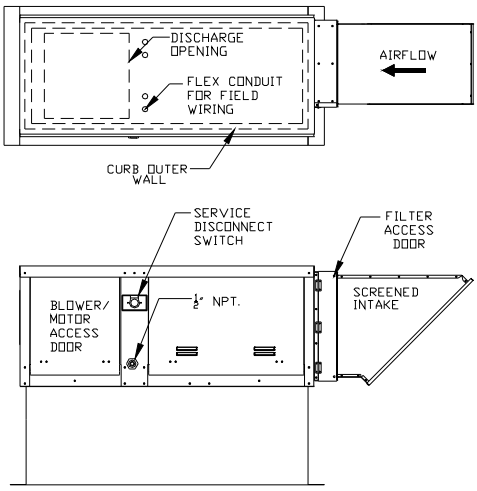
Adequate building relief shall be provided so as to not over pressurize the building when the heating system is operating at its rated capacity. This can be accomplished by taking into account, through standard engineering methods, the structure's designed infiltration rate; by providing properly sized relief openings; or by interlocking a powered exhaust system; or by a combination of these methods.

Heaters installed with intake ductwork must be purged to replace at least four air changes of the volume of the intake duct.

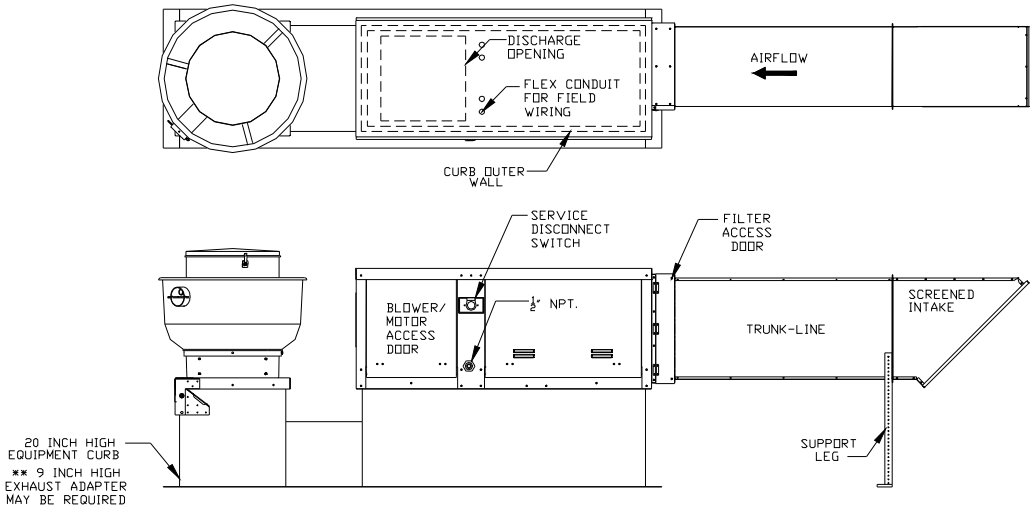
If the failure or malfunction of this heater creates a hazard to other fuel burning equipment in the building (e.g. when the heater is providing make up air to a boiler room), the unit is to be interlocked to open inlet air dampers or other such devices.

Units being installed in **airplane hangars** should be installed in accordance with the Standard for Aircraft Hangars, ANSI/NFPA 409. Units being installed in **public garages** should be installed in accordance with the Standard for Parking Structures, ANSI/NFPA 88A, or the Standard for Repair Garages, ANSI/NFPA 88B, and with CAN/CGA B149 Installation Codes.

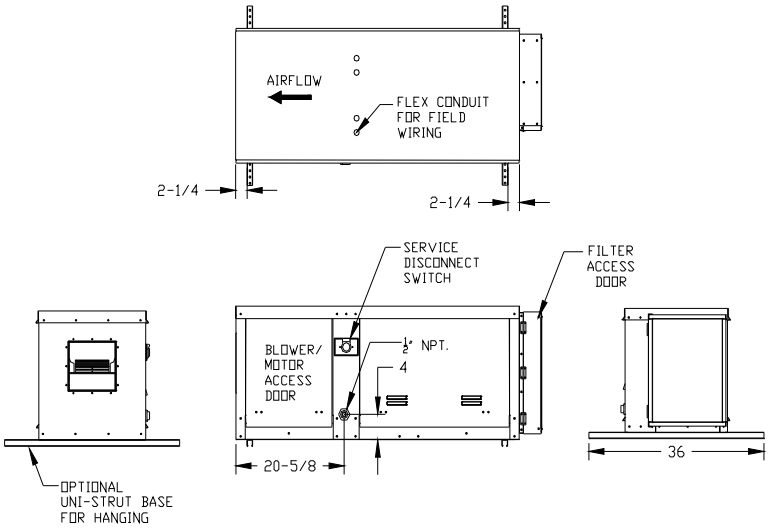
Roof Mount Installation



Installation with Exhaust Fan



Indoor (INLINE) Installation



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 PRESSURE INDICATED ON NAMEPLATE. SEE UNIT NAMEPLATE 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 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.

Gas Connection Sizes

Unit Size	Gas Pipe Size (NPT)
76	1/2"

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.

Gas Pressure Table

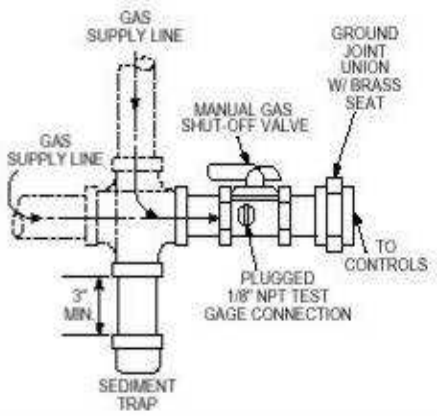
Gas Pressure Type	Gas Pressure
Natural	5 in. w.c. – 14 in. w.c.
LP	5 in. w.c. – 14 in. w.c.

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 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.
8. This unit requires a constant **5 in. w.c. minimum natural gas supply,** 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 5 in. w.c., the heater may not perform to specifications.

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.

Gas Connection Diagram



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.

Electrical wiring and connections should be done in accordance with local ordnances 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.*

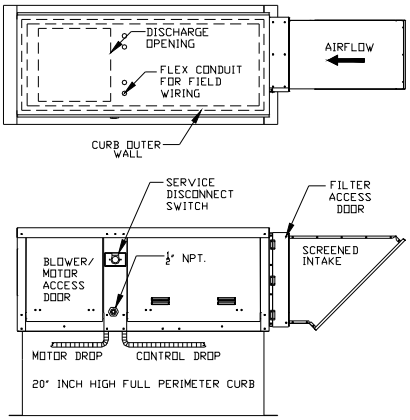
WARNING!!

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.

Copper Wire Ampacity

Wire Size AWG	Maximum Amps
14	20
12	25
10	30
8	40
6	55
4	70

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. 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.
3. 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”.
4. Make certain that the power source is compatible with the requirements of your equipment. The heater nameplate identifies 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

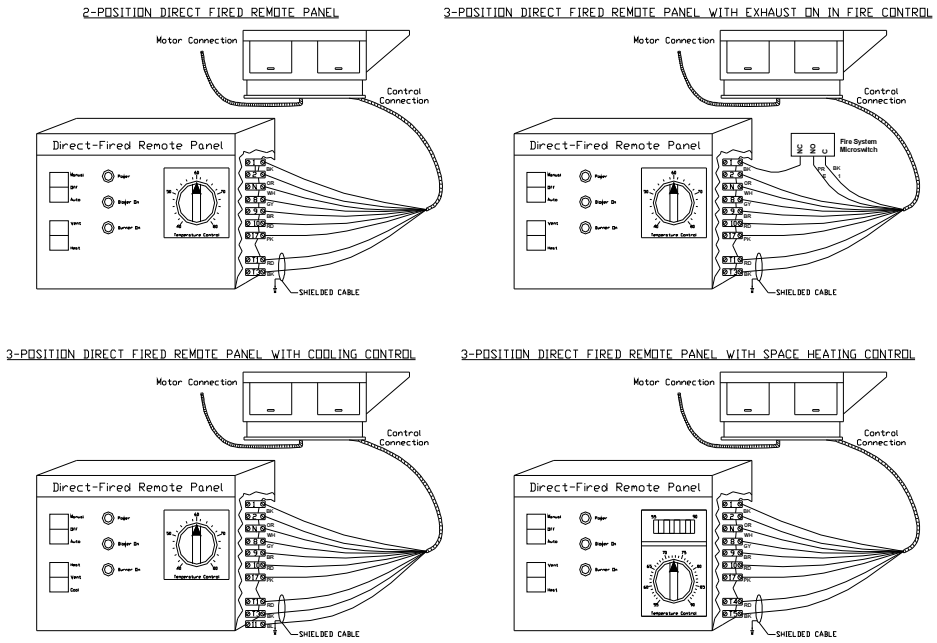
On units shipped with the optional motorized intake damper, a power transformer is supplied with the unit if the main incoming voltage is greater than 120V. The damper motor is automatically energized when the main disconnect switch is in the ON position. **No external wiring to the damper motor is required**.

Electric Cabinet Heater

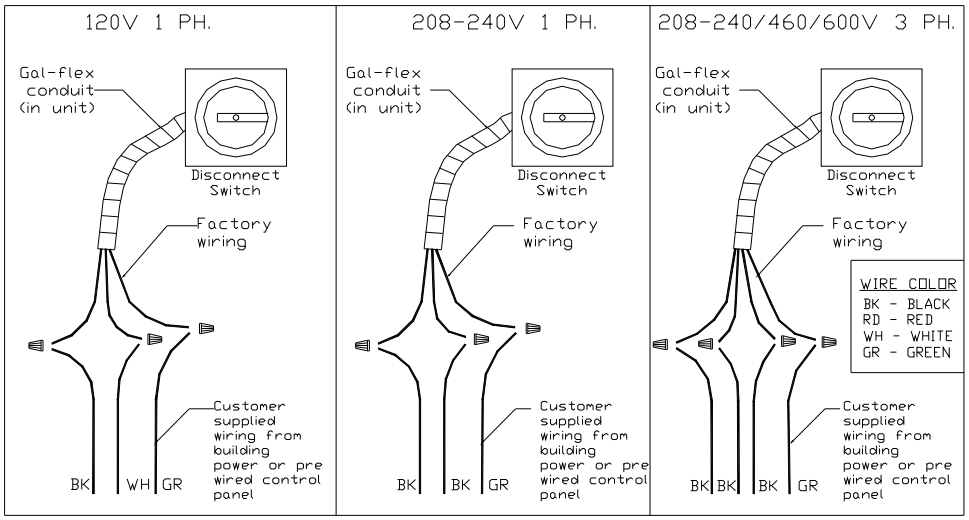
On units shipped with an optional electric cabinet heater, ensure that the heater is wired to a **separate** 120V, 15 amp input, the thermostat sensing bulb is mounted correctly in the control vestibule where the heater is located, and the **thermostat set to 0 Degrees Fahrenheit.**

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
- Differential Pressure Gauge

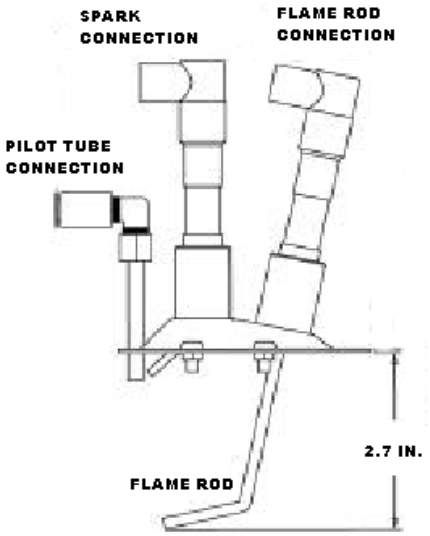
Start Up Procedure

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.

Pilot Adjustment

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 **5 in. - 14 in. w.c.** 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. Call for heat with the intake air thermostat (turn set-point to temperature above outside air) and allow the pilot to light. If the pilot does not light, purge the pilot line. If air purging is required, disconnect the pilot line at the outlet of the pilot valve.
4. A weak pilot flame can be caused by low gas pressure, or a dirty pilot orifice. To adjust the pilot flame, remove the cap from the pilot adjustment screw on the combination gas valve. Increase the pilot gas flow by turning the screw counter-clockwise. Decrease the pilot gas flow by turning the screw clockwise.
5. Once the pilot has been established, open the main manual gas shut-off valve downstream of the electronic valves. Check to make sure that the main gas valve opens, and gas flows to the burner.

Pilot Assembly

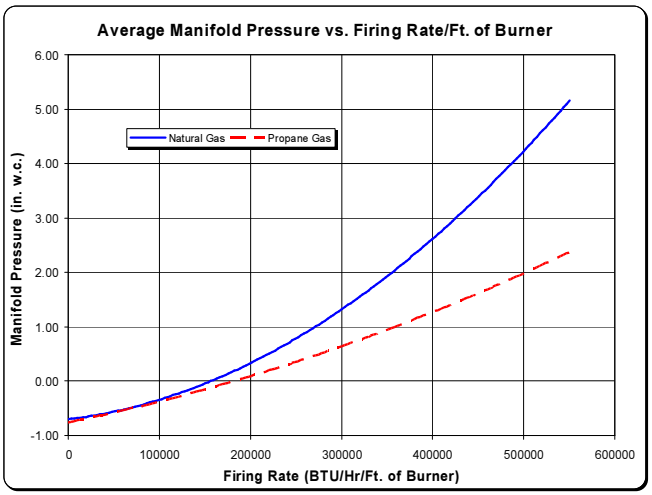


Main Burner Adjustment

Mod Valve Voltage Summary

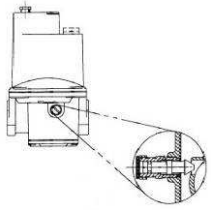
Volts DC	Firing Mode
0 to 5 VDC	Low Fire
5 to 15 VDC	Modulation
15 to 20 VDC	High Fire

1. Once the pilot has been properly established, the manifold gas pressure or temperature rise should be adjusted to jobsite conditions. The gas pressure regulator integral to the combination gas control is adjusted at the factory for average gas conditions. It is important that the gas be supplied to the burner in accordance with the input rating on the rating plate.
2. Create a high fire call for heat. This should be done with the blower on and all gas controls on. High fire can be achieved by removing the wire at terminal **#4** (remove wires #2 and #4 for Maxitrol 44 systems) from the Maxitrol 14 amplifier.
3. The manifold pressure should be checked at the pressure tap downstream of the modulating valve. The graph to the right indicates the proper manifold pressure for the desired amount of BTUs per foot of burner. For natural gas systems, the high fire manifold pressure should not exceed **5 in. w.c.** For propane gas, the high fire manifold pressure should not exceed **2.5 in. w.c.** Another method of checking high fire is to measure the temperature rise of the unit. The temperature rise should be set to design conditions and typically is minimum 70°F.

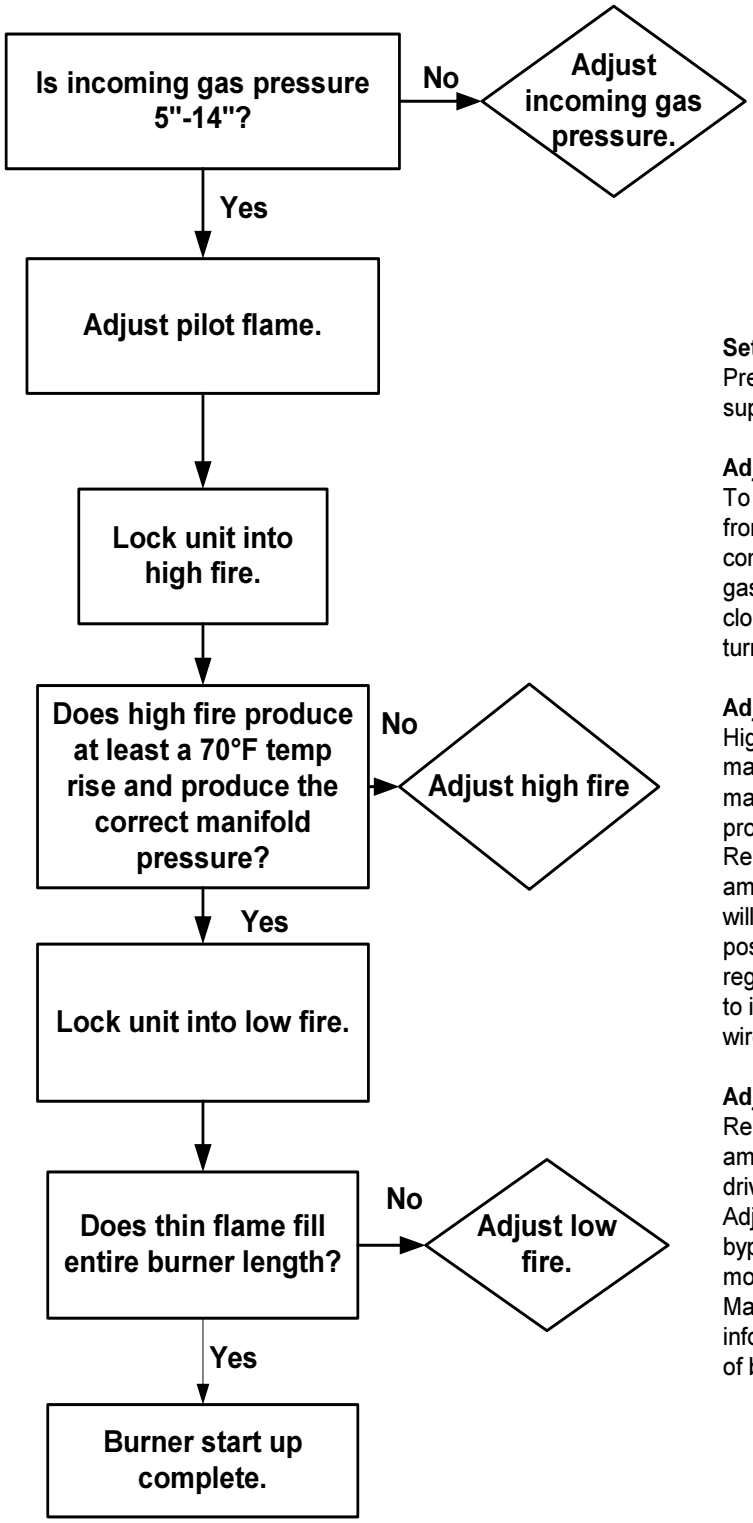


4. Remove the cap from the combination gas valve regulator adjustment. Using the regulator pressure adjusting screw, adjust the high fire manifold pressure to 5 in. w.c. maximum for natural gas and 2.5 in. w.c. maximum for propane gas. High fire should be set to generate the desired temperature rise. If the high fire screw is at the end of its adjustment and more pressure is needed, then adjust the main building gas pressure regulator spring (located external to the unit) to achieve the proper manifold pressure. Turning the regulator screw clockwise will increase pressure and counter-clockwise will decrease pressure.
5. Reconnect the wire on the Maxitrol 14 amplifier at terminal **#4** (wires #2 and #4 for Maxitrol 44).
6. The low fire manifold pressure must now be set. Low fire can be achieved by removing the wire at terminal **#5** from the Maxitrol 14 amplifier (remove #8 for Maxitrol 44).
7. Using the bypass screw located on the side of the M411, adjust the low fire manifold pressure until there is a very thin flame along the entire length of the burner. No dark spots should be seen in the burner. The burner may be observed through the view-port located on the external wall of the heater. Replace the cap to the Maxitrol valve and restore all of the original wiring on the Maxitrol amplifier and gas components.
8. A final gas leak check shall be performed to verify the gas-tightness of the heater's components and piping under normal operating conditions. This can be done by measuring the gas pressure at the ¼" gas plug just downstream of the modulating valve.

Maxitrol M411 Low Fire Bypass Screw



Heater Start Up Summary



Setting incoming pressure:
Presure must be measured at first "T" in supply gas line before the first gas valve.

Adjusting the pilot:
To adjust the pilot flame, remove the cap from the pilot adjustment screw on the combination gas valve. Increase the pilot gas flow by turning the screw counter-clockwise. Decrease the pilot gas flow by turning the screw clockwise.

Adjusting high fire:
High fire manifold pressure should be 5" maximum for natural gas and 2.5" maximum for propane. High fire should produce at least a 70°F temperature rise. Remove wire #4 from the Maxitrol 14 amplifier (#2 and #4 for Maxitrol 44). This will drive the valve into its full open position. Adjust high fire with the regulator inside the unit. Turn clockwise to increase temperature rise. Replace the wires on the Maxitrol Amplifier.

Adjusting low fire:
Remove wire #5 from the Maxitrol 14 amplifier (#8 for Maxitrol 44). This will drive the valve into its lowest position. Adjust the low fire by turning the low fire bypass screw on the side of the M411 modulating valve. Refer to the included Maxitrol literature for more detailed information. Ensure that the enite length of burner is filled with a thin flame.

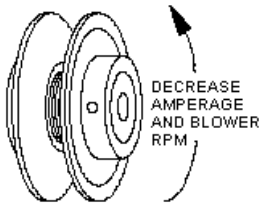
Final Start Up Procedure

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
7”	2400	2

Pulley Adjustment Illustration



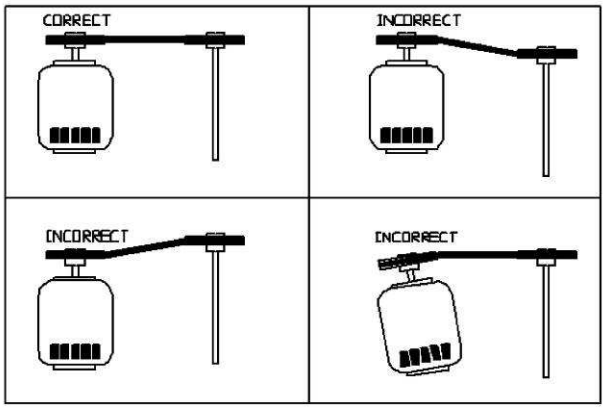
Pulley Adjustment

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.

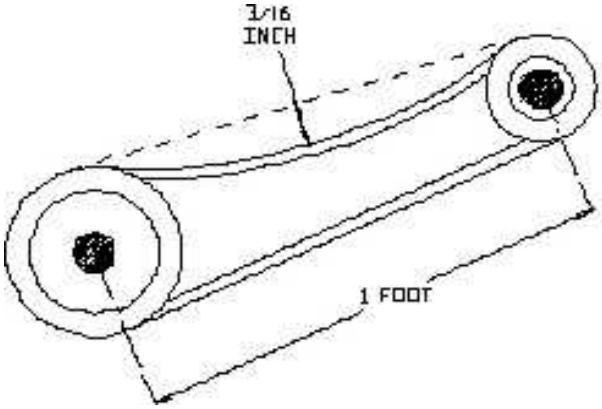
Pulley Setscrew Torque

Thread Size	Torque (IN/Lb)
No. 10 (bushing)	32
1/4” (bushing)	72
5/16”	130

Pulley Alignment



Proper Belt Tension



Pulley Combination Chart

Pulley Combination Chart

	Motor RPM		1725											
7 IN. BLOWER	**1/3 to 1-1/2 HP**		MOTOR PULLEY	Dd1	Dd2	Pd1	Pd2							
	AX BELTS		1VP50	3.4	4.4	3.6	4.6							
				Open	TURNS ON MOTOR PULLEY									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
	AK32H	3	3.2	1941	1995	2048	2102	2156	2210	2264	2318	2372	2426	2480
	1/3 to 1-1/2 HP		MOTOR PULLEY	Dd1	Dd2	Pd1	Pd2							
	AX BELTS		1VL44	2.8	3.8	3	4							
				Open	TURNS ON MOTOR PULLEY									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
	AK32H	3	3.2	1617	1671	1725	1779	1833	1887	1941	1995	2048	2102	2156
	1/3 to 2 HP		MOTOR PULLEY	Dd1	Dd2	Pd1	Pd2							
	AX BELTS		1VL40	2.4	3.4	2.6	3.6							
				Open	TURNS ON MOTOR PULLEY									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
	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

Sequence of Operation

The direct-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 blower and motor. The heater may be further broken down into two control systems, the Flame Safety Control (FSC) and the Modulating Gas System (MGS). The burner mixes air with the gas (Natural or LP) which heats the air.

Flame Safety Control

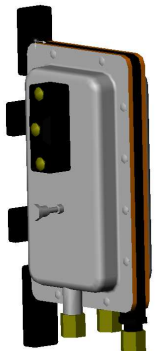
Flame Safety Controller

The first system to understand is the **Flame Safety Control**. The FSC is there ***only*** to monitor the flame, NOT to control temperature. The FSC uses a flame rectification sensor mounted on the pilot assembly to detect the presence of flame in the burner. The FSC is also wired into an airflow switch, which tells it whether there is proper airflow through the unit (not *just* any airflow, but *proper* airflow). Proper airflow occurs when there is a **.15 in. w.c. to .80 in. w.c. differential pressure drop across the burner**. The FSC controls the opening of the redundant solenoid gas valves and the operation of the spark igniter to initiate a pilot flame upon start-up.

Upon a call for heat, there is a 15 second Pilot Trial For Ignition (PTFI). During PTFI, the FSC opens the pilot gas valve and allows gas to flow to the pilot assembly. At the same moment, the spark igniter is started, causing the spark to ignite the pilot gas. When the flame rod sensor detects the flame it powers the modulating gas system. This is the normal operating mode. The FSC continues to monitor the flame and airflow. Once this occurs, the unit is in a main flame cycle and thus powers the main gas valve and the modulating gas system. This is the normal operating mode. The FSC continues to monitor the flame and airflow. If the flame fails to light after 15 seconds of sparking, the FSC goes in to lock-out mode. Anytime this occurs, the problem must be diagnosed and corrected to avoid future lockouts after resetting. To begin troubleshooting, or to reset the FSC, shut down power to the heater and restart the heater. This will clear the alarm from the flame safety.

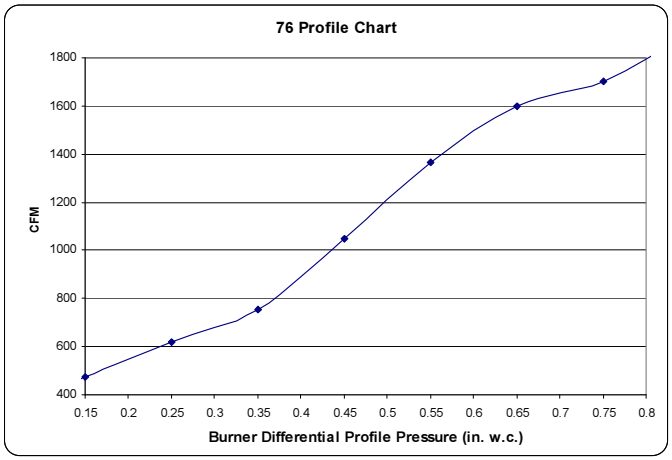
Air Flow Switch

Air Flow Switch



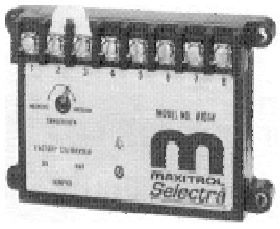
There are both high and low **airflow switches** contained within one housing measuring the pressure drop across the burner. This is to insure that there is proper airflow **(.15 in. w.c. to .80 in. w.c.**) across the burner and proper combustion at all times. Both switches are wired in series and have single pole double throw (one common contact, one normally open contact, and one normally closed contact) switches that are 'switched' by air pressure. There are two airflow tubes in the heater, located near the burner and profile plate assembly (profile plates surround the burner and control air into the burner section). In the case of clogged filters, blocked intake, excessive duct static pressure, or a broken belt, the correct burner differential pressure may not be achieved, not allowing the low airflow switch to close. The high airflow switch protects against profile plate failures that cause excessive airflow through the burner. In the event that the pressure drop across the burner is not in the range of the airflow switch, gas flow to the burner is stopped by the Flame Safety Control.

The graphs below illustrate the approximate cfm going through the unit vs. the differential pressure measured by the airflow switch. Simply measure the differential profile pressure drop at the airflow tubes in the unit and match that value up to the matching unit curve below. This will show the cfms traveling through the burner and will indicate proper airflow or airflow problems (too much or not enough). **If the pressure drop is outside of the .15" to .80" range, the blower rpm should be adjusted to fix airflow**.



Modulating Gas System

Maxitrol 14 Amplifier



The second system, the **Maxitrol modulating gas system,** consists of a temperature selector dial, a discharge air sensor, an amplifier, and a modulating gas valve. The two types of Maxitrol systems used are the Maxitrol 14 series or the Maxitrol 44 series. The Maxitrol 14 utilizes a discharge air sensor and modulates the Maxitrol gas valve to provide discharge air to match the selected temperature on the temperature selector. The Maxitrol 44 utilizes a room temperature sensor to control room temperature as well as a discharge air sensor in order to control the discharge air temperature. The modulating gas valve controls the amount of gas flow 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".

High Temperature Limit

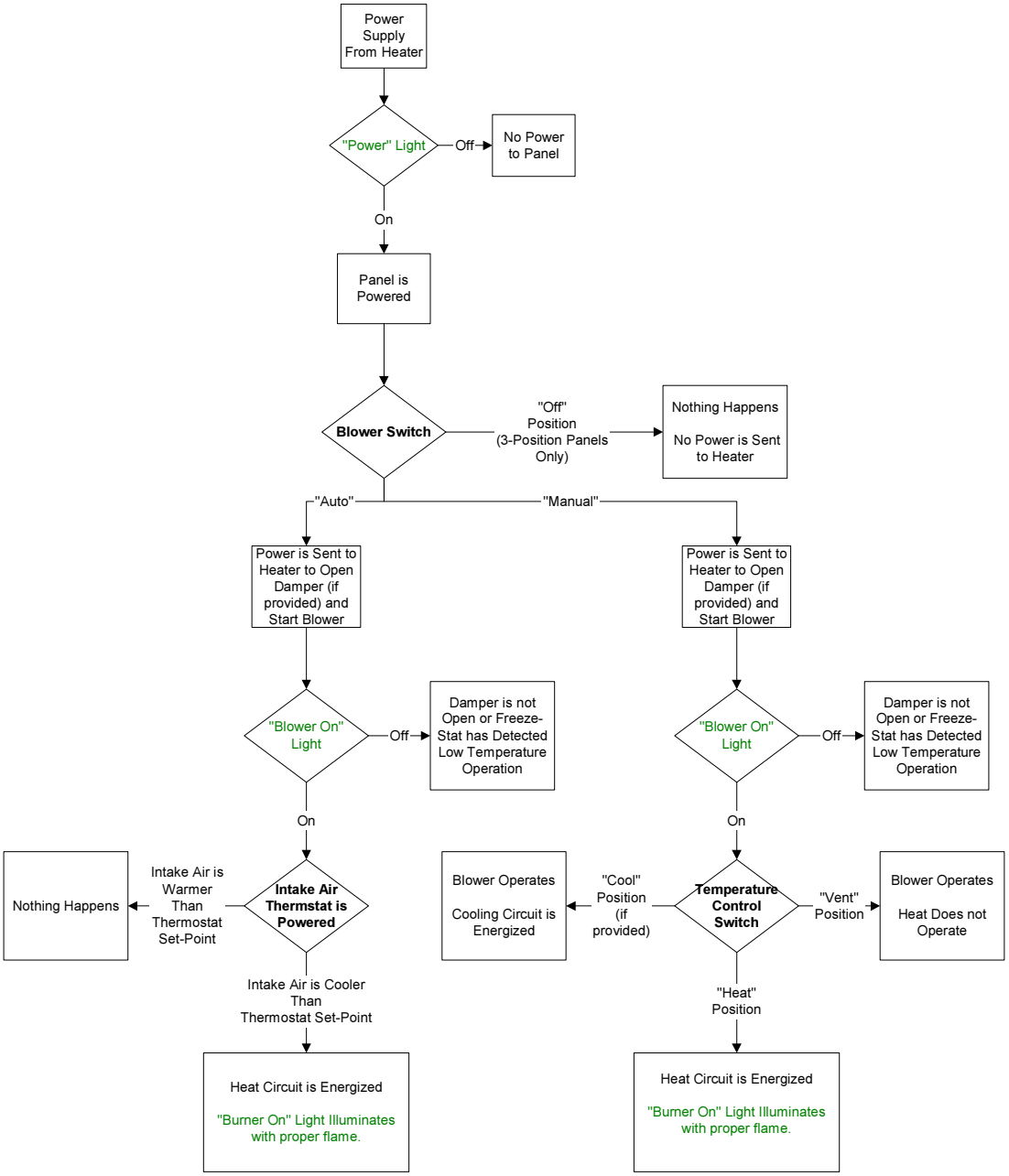
One of the back up safety device is the **high temperature limit** switch. This switch is a mechanical thermostat that measures the temperature inside the unit downstream of the burner. If the factory-set temperature of **180°F** is exceeded, it will signal the FSC to turn off the burner. This requires a manual reset of the high temperature limit. This insures that the discharge does not exceed 185°F.

High Temperature Limit

Operation Summary

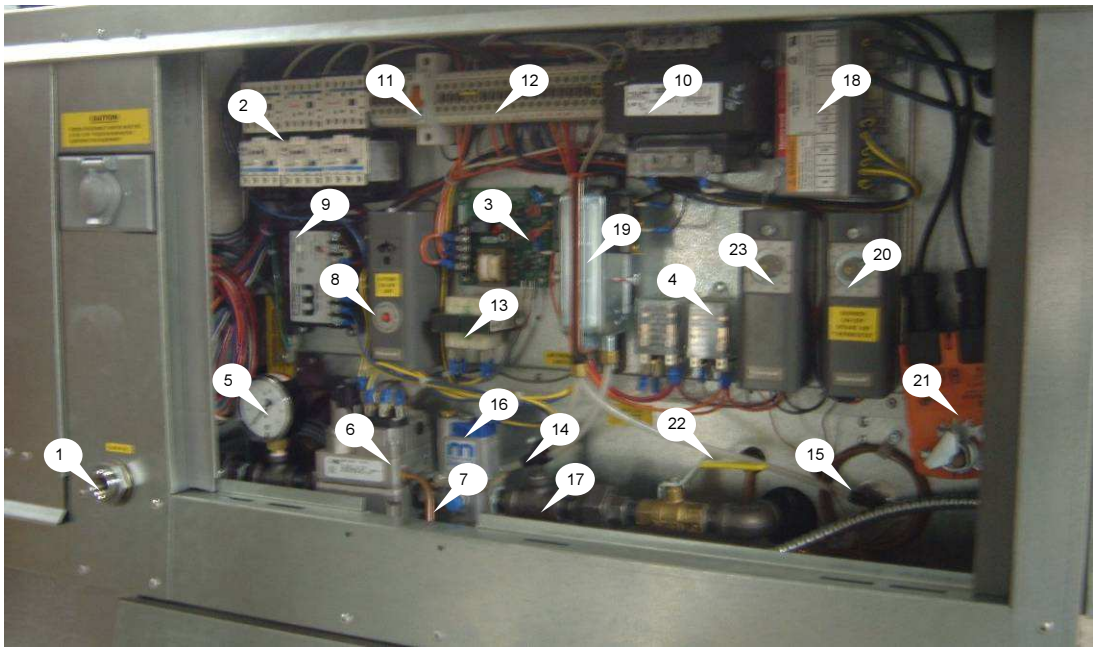
- With the blower already running and the airflow switch proven;
  - ✓ The outside air temperature falls below the setting of intake air thermostat
    or
  - ✓ The optional remote panel is set to “Manual” and “Heat” mode
- The FSC in energized and the following occurs;
  - ✓ FSC indicates that it has power
  - ✓ FSC verifies proper Airflow
  - ✓ Begins a 15 second Pilot Trial For Ignition
  - ✓ The pilot gas solenoid valve is opened, the spark igniter begins sparking, and the flamerod sensor watches for flame initiation
  - ✓ When flame is established, the main valve opens and the FSC powers the Maxitrol system and gas flow begins modulating
  - ✓ The FSC monitors the flame while the Maxitrol system adjusts to the selected temperature
- The Maxitrol system checks the discharge air temperature (and the room temperature for the Maxitrol 44) and regulates the gas going to the burner to satisfy the temperature setting. The Maxitrol system will modulate the main burner gas from 100% down to 5% as needed.

Optional Remote Panel Circuit



Components

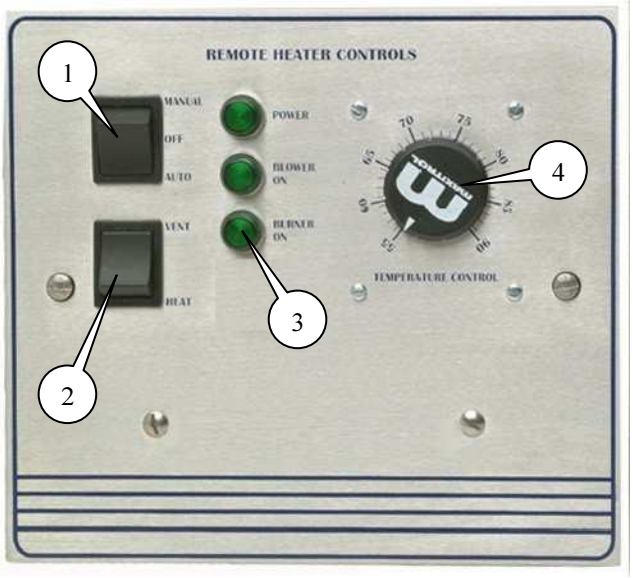
The following image and list outlines the typical direct fired heater components and their functions.



1. **Gas Inlet** – Main gas supply connection
2. **Motor Starter** – Contactor with overload protection to start and protect motor.
3. **Freeze-Stat Thermostat (Optional)** – De-energizes blower motor if the discharge air temperature falls below the set point.
4. **Cooling Interlock Relay (Optional)** – Energizes power to cooling circuit on call for cooling.
5. **Inlet Gas Pressure Gauge (Optional)** – Inlet gas pressure should be measured here.
6. **Combination Gas Valve** - A combination of redundant solenoid valves, pilot valve and gas regulator built into one unit.
7. **Pilot Tubing** – Pilot tube connection to combination gas valve.
8. **Manual Reset High Temperature Limit** – Safety device that prevents the heater from overheating.
9. **Maxitrol Modulating Amplifier** - Regulates temperature by modulating gas valve
10. **Power Transformer** – Installed when motor voltage > 120V. Used to provide 120V service to controls.
11. **Circuit Breaker** – Protects electrical components from high current spikes.
12. **Terminal Strip** – Central location to terminate control wiring. Should be used for troubleshooting.
13. **Control Transformer** – 120V primary; 24V secondary control transformer.
14. **Low Pressure Airflow Probe** – Measures profile pressure downstream of burner.
15. **High Pressure Airflow Probe** – Measures profile pressure upstream of burner.
16. **Modulating Gas Valve** – Modulates gas flow to burner to provide proper air temperature.
17. **Manifold Gas Pressure Tap** – Manifold gas pressure should be measured here.
18. **Flame Safety Control** – Initiates and monitors flame.
19. **Airflow Switch** – A safety device insuring proper air flow during burner operation.
20. **Intake Air Thermostat** – De-energize heating circuit when intake air exceeds set-point.
21. **Damper Actuator (Optional)** – Motor containing end switch that opens intake damper.
22. **Manual Gas Shut-Off Valve** - Allows gas flow to burner to be shut off to leak test gas train
23. **Auxiliary Cooling Thermostat (Optional)**– Dry contacts for cooling connection

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 Maxitrol discharge temperature dial and the Maxitrol space sensing Selectrastat. It is important to understand the following Remote Panel controls and uses:



1. **Manual/Off/Auto Switch** - Used to control blower operation and tempering mode of unit. The **AUTO** position allows the unit to “decide”, through the use of the intake air thermostat, whether or not heating is needed. The **MANUAL** position allows the user to control whether or not heat is needed. The **OFF** position will turn the blower off when a “3 Position” remote panel is ordered. The **OFF** position will disable all temperature controls when a “2 Position” remote panel is ordered and fan power is then controlled by the pre-wire package only.

2. **Heat/Vent Switch –** This switch is powered when the Manual/Off/Auto switch is in the **MANUAL** position. It is used to control the tempering mode of the unit. The **VENT** position will prevent the burner from operating and the heater will deliver untempered 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.
   BURNER ON - Illuminates after pilot flame has established and main valve is powered.

4. **Temperature Control –** Controls the discharge temperature of a standard unit. The temperature dial is replaced with Maxitrol Selectrastat in Space Heating applications and is used to control the space temperature.

Troubleshooting

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

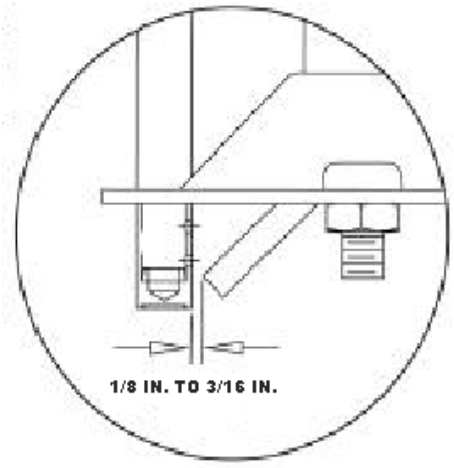
Airflow Troubleshooting Chart

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 “Off” Position	Set Remote Panel to “Manual” or “Auto” Position
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 to 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

Burner Troubleshooting Chart

Problem	Potential Cause	Corrective Action
Pilot Does Not Light/Stay Lit	Main gas if off	Open main gas valve
	Air in gas line	Purge gas line
	Dirt in pilot orifice	Clean orifice with compressed air
	Gas pressure out of range	Adjust to proper gas pressure
	Pilot valve is off	Turn pilot valve on
	Pilot orifice fitting leak	Tighten pilot orifice
	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. Check spark gap as shown below.
Main Burner Does Not Light (Pilot is Lit)	Defective valve	Replace combination valve
	Loose valve wiring	Check wiring to valve
	Defective pilot sensor	Replace pilot sensor
	Shut off valve closed	Open shut off valve
	Defective flame safety controller	Replace flame safety controller
	Pilot fails as main gas valves open and main gas begins to flow	Plug the first burner port next to the pilot gas tube with burner cement
Not Enough Heat	Main gas pressure too low	Increase main gas pressure – do not exceed 14 in. w.c. inlet pressure
	Too much airflow	Decrease airflow if possible
	Burner undersized	Check design conditions
	Gas controls not wired properly	Check wiring
	Thermostat setting too low	Increase thermostat setting
	Thermostat malfunction	Check/replace thermostat
	Unit locked into low fire	Check wiring
Too Much Heat	Defective modulating gas valve	Check/replace modulating valve
	Thermostat setting too high	Decrease thermostat setting
	Unit locked into high fire	Check wiring
	Thermostat wired incorrectly	Check thermostat wiring

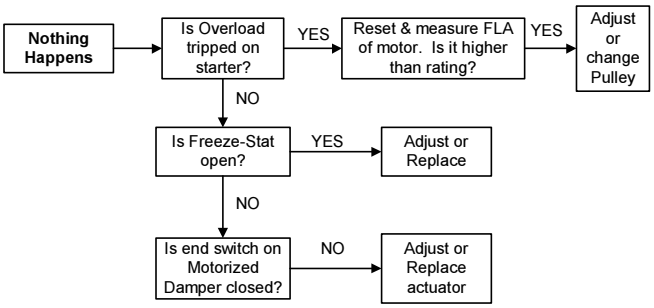
Proper Spark Gap

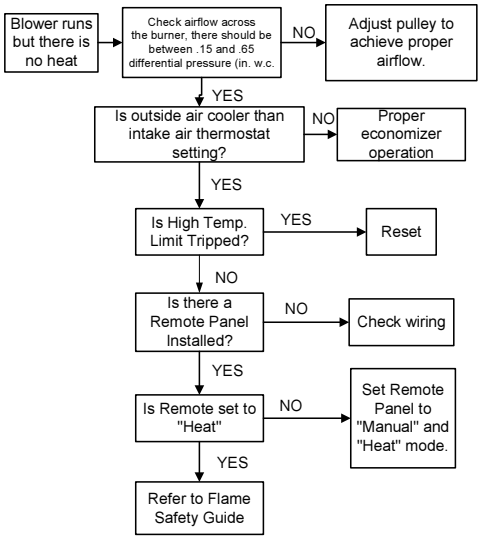


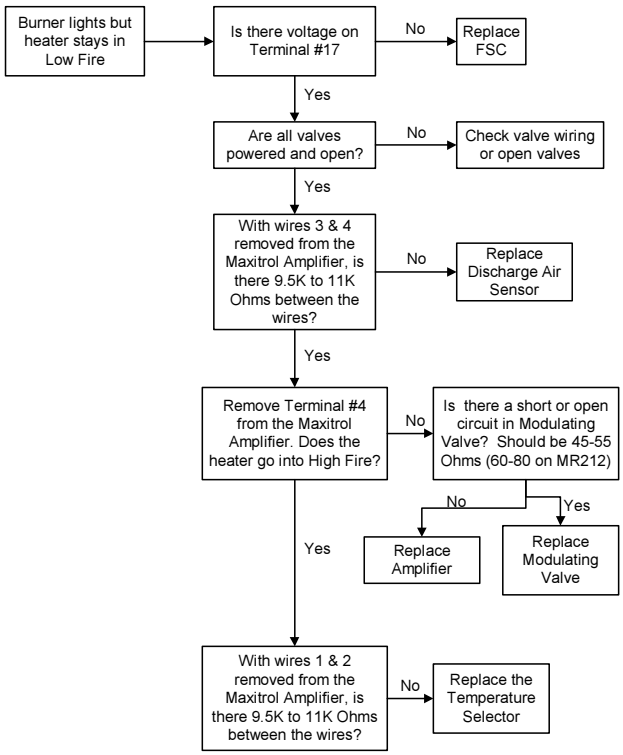
Remote Panel Troubleshooting Chart

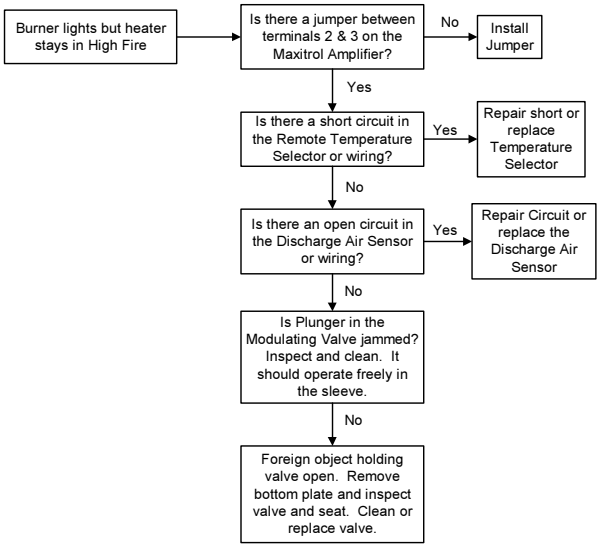
Light Indication	Condition	Possible Cause
No Lights	Power not available to Remote Panel	Bad voltage to unit
		Main disconnect in “OFF” Position
		Circuit breaker tripped
		Bad main transformer
POWER Light Only	Proper unit Off Operation	No problem
	No power to motor starter	Manual/Off/Auto Switch in “Off” Position (3 Position Remote Panels Only)
		Improper damper function
		Low Temperature Thermostat Timed Out (Option)
POWER Light and BLOWER ON Light	Proper Ventilation Operation	No Problem
	No Power to Flame Safety Controller	Manual/Off/Auto Switch in “Off” Position (2 Position Remote Panels Only)
		Heat/Vent Switch in “Vent” Position
		High Temperature Limit Thermostat Tripped
		Manual/Off/Auto Switch in “Auto” Position and Intake Air Thermostat not Satisfied
		Insufficient Airflow
	Improper Airflow	Excessive Airflow
		Bad airflow switch
		Problem with air probes
		Problem with airflow tubing
		Broken Belt
		Filters Dirty or Need Replacement
POWER Light and BLOWER ON Light and BURNER ON Light	Proper Heating Operation	No Problem

Troubleshooting Flowcharts









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 preformed 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.

Re-Setting Of The Unit

If the flame safety control is locked out, 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 preformed 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"
76	1

Yearly

1. Inspect bearings for wear and deterioration. Replace if necessary.
2. Inspect belt wear and replace torn or worn belts.
3. Inspect bolts and set screws for tightness. Tighten as necessary.
4. 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.
5. Check for gas leaks and repair if present.
6. Clean flame sensor by rubbing with steel wool to remove any rust build-up,
7. Clean burner with a wire brush and insure burner ports are free of debris. Then wipe the burner with a clean rag.

Burner Orifice Drill Size

Orifice	Drill Size
Gas Port	31
Air Port	43

Start-Up and Maintenance Documentation

START-UP AND MEASUREMENTS SHOULD BE PERFORMED AFTER THE SYSTEM HAS BEEN AIR BALANCED AND WITH THE HEAT ON (Warranty will be void without completion of this form)

Job Information

Job Name	
Address	
City	
State	
Zip	
Phone Number	
Fax Number	
Contact	
Purchase Date	

Service Company	
Address	
City	
State	
Zip	
Phone Number	
Fax Number	
Contact	
Start-Up Date	

Heater Information

Refer to the start-up procedure in this manual to complete this section.

Name Plate and Unit Information	
Model Number	
Serial Number	
Motor Volts	
Motor Hertz	
Motor Phase	
Motor FLA	
Motor HP	
Blower Pulley	
Motor Pulley	
Belt Number	
Gas Type	
Min. Btu/Hr	
Max. Btu/Hr	

Field Measured Information		
Motor Voltage		
Motor Amperage**		
RPM		
Burner Differential Pressure		in. w.c.
Gas Type		
High Fire Inlet Gas Pressure		in. w.c.
Low Fire Manifold Gas Pressure		in. w.c.
High Fire Manifold Gas Pressure		in. w.c.
Thermostat Set-Point		
Temperature Control	Discharge	
	Space	
Airflow Direction	Correct	
	Incorrect	

**If measured amps exceed the FLA rating on the nameplate, fan RPM must be reduced to decrease the measured amps below the nameplate FLA rating.

Maintenance Record

Date	Service Performed

Factory Service Department

Phone: 1-866-784-6900
Fax: 1-919-554-2415