A

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

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FORM #HE GUIDE March 1999

ENGINEERED AIR
HE GUIDE FOR SEMINARS

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ENGINEERED AIR

CALGARY, ALBERTA
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INSTRUCTION MANUAL FOR DIRECT FIRED MAKE UP AIR UNITS

This guide has been put together as a guide for the service technician that has attended one of the ENGINEERED AIR service training seminars. It is a comprehensive review of the contents of the course, particularly electrical troubleshooting or starting a unit that is about to be commissioned on site. The material contained herein is not official company policy, but is derived from years of field experience and hands on service.

Wade Pascoe

Engineered Air is a manufacturer of custom-built heating, ventilation and air conditioning equipment. If you wish to obtain technical or service information on any product Engineered Air has manufactured, please record the model and serial number located on the rating plate, and contact the nearest factory or sales office with your request.

1. Purpose of Unit

Make up air units are designed to deliver outside air into buildings to replace air which has been exhausted, *(e.g. Garages, paint booths, kitchens, warehouses, etc.).* By replacing the air that has been exhausted, we avert having the building under a negative pressure, which could allow chimneys to back draft, air to infiltrate around doors, windows, etc. Most make up air has a heat section build into it to bring the outside air up to a more comfortable temperature before putting it into the space. There are different methods of heating the air.

Two common methods are indirect gas fired units or direct gas fired units. Indirect gas fired units contain a heat exchanger so the products of combustion are exhausted to the outside through a venting system. Direct fired make up air units have a very special burner that has designed characteristics which take the burning process to a level that reduces harmful products of combustion to far below levels that are dangerous to human health. After the air passes over the burner and is heated by the flame, that same air is passed into the building space where it is eventually exhausted through the buildings exhaust system.

Different applications of exhaust and make up air require different rates of changing the air going into the space. Paint booths require more air changes per hour then most other uses due to the paint over spray in the air. Other applications such as garages, restaurants, parking structures, etc. require a lower number of air changes per hour to help remove harmful chemicals and unpleasant odors.

It is important to note that the maximum discharge temperature for direct fired make up air is 75°F. Direct fired make up air is not used to heat the space but is only for ventilation purposes. If additional heat is required in the space to correct for heat loss it should be from another source. In some special applications direct fired make up air units are allowed to operate at discharge temperatures above 75° such as when applied as a door heater or to allow paint to cure quickly in auto body shops.

2. Installing the Unit

Follow the instructions in the Installation and Operation Guide, Engineered Air form HE-1-97.

3. Preparation for Starting the Unit

a. Check the unit rating plate to ensure that voltage, phase and gas specifications of the unit match those at the installation site.

b. Before starting any piece of mechanical equipment always check the following:
   i. Ensure all gas and power to the unit is turned off.
   ii. All wire connections are tight on terminal strips, controls, and main power devices.
   iii. All fuses are of the correct size and type.
   iv. All gas connections are tight, have been leak tested and the gas is shut off to the unit.
   v. All blower set screws are tight.
   vi. All bearing set screws are tight.
   vii. All pulleys and gears are tight and drive belts snug, and properly aligned.
   viii. Remove all shipping bolts, support material and tie down assemblies for isolated blowers and other components.

BELT TENSION

Using a belt tension tool can properly set belt tension. If one is not available, a general "rule of thumb" is to set tension by pushing on the longest part of the span of the belt with a force of about 10-15 pounds. A deflection of $^1/_{16}$ to $^1/_8$ of an inch per foot of belt on longest span would be considered normal. Different styles of bearing each have a maximum design force. If a belt is too tight, it may cause a bearing and/or it's mount to fail. If belts are too loose, the edges of the belt will polish, the belt will overheat and crack, and the pulley may even have the edges worn off of it.

BELT ALIGNMENT

Belt and pulley alignment should be within $^1/_{16}$ of an inch for each foot of span between the pulleys. This can be measured with a straight edge or by tying a string to the inside of the fan or motor shaft and wrapping the string to the outside of the pulley. Stretch it past the outside of the other pulley and slowly moving the string in towards the pulley edges. Perfect alignment will have all pulley edges touching the string at the same time. All Engineered Air HE series Units are test fired at the factory but some job site adjustments are necessary for safe operation.

> ***NOTE:*** *To see if your unit contains items noted as "options" refer to your wiring diagrams.*

GENERAL OPERATION OVERVIEW

When most direct-fired make up air units are powered up, they follow these general steps. Due to local codes for exhaust fan interlocks, some of these steps may be altered to meet local requirements.

a. Make up air unit "remote panel" fan switch on.
b. Exhaust fan switch on *(installed by others, usually from a separate power source.)*
c. Exhaust fan starts and exhaust interlock closes.
d. Make up air dampers power open.
e. Damper end switch is tripped to a closed position.
f. Make up air unit supply fan starts.
g. If the heat switch located on the remote panel for the make up air unit is on, the heat will come on.
h. The discharge temperature of air from the make up air unit will be modulated to maintain the desired discharge air temperature *(usually 55° to 75° F.)*

DETAILED OPERATING AND TROUBLESHOOTING STEPS

4. *Electrically Energizing the Unit*

a. Turn off the unit. Disconnect switches located in or near the unit, *(main disconnect and the units control circuit switch.)* Turn on the main power supply for the unit at the buildings breaker panel or motor control centre. Return to the unit and measure the power at the unit's main power disconnect switch which is "off". Ensure that the voltage is within 10% of the units rating plate value. If the system is a three phase system, measure and record the voltage across all three phases and ensure the three readings are all within 2% for maintaining the systems voltage balance. If all the above is correct, turn "on" the unit disconnect switch to establish main power to the unit.

b. If the unit is equipped with a control transformer, *(most are)*, the transformer should now be powered. The main terminal strip terminals "H and N" *(newer units will have 1 + 2)* will be energized when the unit ***motor*** "disconnect switch" is turned on provided the control circuit fuse is good. The voltage on terminals "H and N" should be 118V (± 10%). Measure and record the control voltage from the output side of the transformer.

   (On rare occasions, units are ordered without control circuit transformers. They will require separate power supply for the control circuit from a breaker installed at the main control panel, and it must be turned on. A protective relay to ensure 3 phase power is turned 'on' before control circuit is activated.)

CONTROL CIRCUIT TROUBLESHOOTING METHOD

Control circuit troubleshooting can usually be simplified using the following method. Attach one lead of a voltameter or a 120-volt light to terminal "N" of the main control circuit-terminal-strip. This lead may be left there for most of the test procedure. Use the other lead of the test device to check for power on the following terminals:

First touch the free lead of your test device to terminal "H" or terminal 1. It should show that power is present. If power is present, proceed to step 5b.

If power is not present, then your test device is faulty, or power is not present. If power is not present, check for power on the output of the control transformer. If power is still not present, and power is being supplied into the control transformer, then the control transformer is faulty.

If you cannot prove power, then it may also be possible that your test device is faulty. The test device can be checked at any other location in the building where you have 120-volt power.

If you are using a digital meter for the following test, be aware that many digital meters are auto ranging devices. If your meter is auto ranging, ensure that each reading is in a scale that is applicable. Many a technician has had a reading in millivolts that are close to the reading he is expecting to see in volts. As he did not realize that the meter automatically shifted to a millivolt scale, he lost valuable time thinking he had power present that was not there and often changed parts that were not faulty.

5. *Cabinet Heaters (-60 Approval or Older Outdoor Units Only)*

If the unit you are working on does not have a control cabinet heater, proceed to section 6.

If the unit you are working on has been equipped with a control cabinet heater, note the following:

Older units and units located in -60°F areas require the installation of a heater in the control cabinet. This heater is to keep the controls above the lowest ambient temperature that the controls are approved to operate at. As the quality of controls increase, the ambient operating range for the controls is extended to allow operation down to -40°. *(There are some areas that have temperatures that fall below -40° and heaters are still required in these units).* If you are servicing an older unit that was manufactured with a control cabinet heater, the use of the heater should be maintained to meet the standards of the code for the components in that unit. Also note that the cabinet heater should be mounted near the bottom of the control cabinet and the air from the heater should be directed toward the cabinet low limit to prevent nuisance failures. The cabinet low limit should not be bypassed.

If the unit has a cabinet heater, power is taken from terminals "H and N" through a thermostat *(set point 7°C or 45°F)* to the cabinet heater. In order to prove the control cabinet is at a safe temperature there is a safety control *(refer to item 9d)* which will turn off the gas if control cabinet temperature is not maintained above its operating point.

a. If the heater is inoperative check to see if the thermostat is calling for it to operate *(setting 7°C - 45°F)* This can be done by accessing the wiring terminals of the thermostat and touching the free lead to each of the thermostat terminals. If both terminals have power on them, the thermostat is calling for the heater to come on and the heater should begin to warm up. If only one of the wiring terminals has power on it, turning the thermostat to a set point above the surrounding ambient temperature should cause the thermostat to put power onto this terminal. If it doesn't, replace the thermostat.

b. If the heater is found inoperative when the thermostat is calling *(above point 5a.)* any 750-watt in-car warmer may be used as a replacement.

6. *Starting the Fan*

Touch the free lead of your testing device *(referred to as "indicator" in following references)* to terminal "H" and your indicator should show power is there. If power is not present, review the steps in guide item 4 above. *(Most Engineered Air direct fired make up air units use the following sequence although local codes for exhaust interlocks, or if a system for night heat was specified, it is possible to have a different function. Refer to the wiring diagram for the unit you are working on to ensure it is wired to operate as per the following guide sequence.)*

a. Touch terminal 3 with the free lead from the indicator. If the indicator shows power move to step 6b.

   If the indicator doesn't show power check:

   i. The units control circuit switch is on. *(Referred to as "service switch" or "disconnect switch" on the wiring diagram)*.

   ii. The motor overload control circuit is closed. Push the reset button to reset it.

Furnas Overloads	*The long thin button resets it. The smaller round button opens the circuit.*
Cutler Hammer Overloads	*The blue reset button resets. Pulling this button opens the circuit.*

   OPTION ITEM

   iii. Some older units have a relay installed to prove that the main power for the supply fan motor is on. The relay contacts are closed when power is on.

NOTE: *Units supplied with a factory installed control transformer will not have this option.*

NOTE: *Steps 6b and 6c that follow are dependent on the remote wiring following our suggested wiring. Some installations have modified this wiring.*

b. Touch terminal 4 with the free lead of the indicator. If the indicator shows power is present, proceed with step 6c. If power is not present, check:

   i. The remote panel fan switch is not made *(on)*.

   ii. The remote wiring is not installed as per the factory's suggested method.

c. Touch terminal 5 with the free lead of the indicator. If the indicator shows power, proceed with step 6d. If the indicator doesn't show power check:

   i. The exhaust interlock.

   ii. Faulty wiring or a faulty interlock.

   There are 3 ways to properly interlock the unit with the exhaust fan as suggested in the **Installation and Operation Guide** Form HE-1-97 page 4. Note that some underground parking structures have CO *(carbon monoxide)* detectors that start the exhaust fan when CO levels get too high. The exhaust interlock in turn starts the make up air unit. This is one of the few instances where make up air units cycle on and off and as energy saving feature.

> ***NOTE:*** *On startup of new units or while troubleshooting, it is often easier to temporarily bypass the above remote wiring described in steps 6b and 6c and place a jumper across terminals 3 and 5 to start the fan. Also note that the heat switch terminals 9 and 10 described in this guides steps 8a and 8b can be jumpered to ensure proper operation of the heat once proper fan operation has been proven. After you are assured the unit operates correctly, you must remove these jumpers and then check if the remote wiring and remote controls turn the unit on and off properly.*

d. Touch terminal 6 with the free lead of the indicator. If the indicator shows power proceed with step 6e. If not, check:

   i. Terminals 5 to 6 normally have a jumper across them. If the optional low limit is installed, the jumper is removed and the low limit and associated low limit bypass device is wired to these terminals.

   ii. If a low limit is installed *(set point 5°C or 40°F)* and the discharge temperature is below that set on the low limit, the unit will not operate. In order to start the unit on cold days, a bypass for the low limit must be provided. There are two ways of doing this:

   - Manual pushbutton located on the remote panel. This must be depressed for 3 minutes to allow startup.
   - Automatic bypass relay located in the unit control cabinet and set for 3 minutes. This relay contains a set of normally closed contacts that fall open after 3 minutes. If the low limit is not satisfied, the unit will shut down after three minutes.

   If the unit shuts off on the low limit, the dampers will be closed, the supply fan will be off and the heat will be off. In order to have a direct fired make up air unit equipped with a low limit start up on cold mornings, it is necessary to use a limit that will reset automatically once it is warmed up. You cannot use a manual reset device for this application.

e. Units without dampers will have a jumper placed across terminals 6 and 7.

   i. Most units have dampers and a damper end switch. Once the dampers are open, the damper end switch trips and powers terminal 7. At this time the supply fan contactor should pull in and the supply fan should be running. If you hear the supply fan running, there is no need to test terminal 7 with the indicators free lead. Proceed to guide item 6-e-vii.

IF THE SUPPLY FAN IS <u>*NOT*</u> RUNNING

- If the indicator shows power on terminal 7, the fan motor contactor should have pulled in. If it did not, it is possible that the contactor coil is faulty or that the supply fan motor is faulty. Locate and correct the problem.
- If the indicator shows no power on terminal 7, proceed to item 6-e-ii.

ii. If terminal 7 doesn't have power to it, and the unit has dampers, the dampers must open and trip the damper end switch before terminal 7 gets power. Following is a description of the types and location of dampers. If there is a problem with the dampers, first understand the operation of the type of damper you have, then proceed to 6-e-iii. When the damper problem is corrected and the fan starts, proceed to 6-e-vii.

DAMPER LOCATION

Most dampers are located on the inlet of the make up air unit but be aware there are units with dampers located in the discharge. There are two types of dampers offered as a means of shutting out the cold air when the unit is shut off.

- **Standard Dampers** ***(Parallel Blade Style)***

  If the unit is equipped with the standard dampers, when terminal 6 is energized the damper motor powers to open the dampers. When the dampers are fully open, they trip a damper end switch which has a wand mounted through the side of the unit that physically senses when the dampers are open. When tripped, the damper end switch allows power to pass through the switch from terminal 6 to terminal 7.

- **Dual Capacity Dampers** ***(Opposed Blade Style)***

  If the unit is equipped with dual capacity dampers, when terminal 6 is energized the damper motor powers open. An eccentric cam is mounted on the fresh air damper shaft and the wand of the damper end switch rides on this. When the dampers are open far enough, the cam pushes the wand up enough to make the switch, thus allowing power to get from terminal 6 to 7. The fresh air dampers have three positions: closed, low capacity and high capacity.

  The first *(low)* position opens the damper between 1" and 1½" only. This is to choke the inlet air opening to reduce the amount of fresh air entering into the space. This type of unit also has a second damper motor, which on first *(low)* capacity closes a set of dampers above and below the burner to keep the air velocity up over the burner during the low capacity operation of the unit. These are called profile plate dampers.

  If the unit is to operate on second *(high)* capacity, a second exhaust fan interlock *(similar to the one described in 6c above)* closes to prove the second exhaust fan is in operation. This interlock is wired between terminals 11 and 12 on most units with this option. The interlock closes, the fresh air dampers open fully, the profile plate dampers open fully. This allows more air to flow through the unit. It is possible on some units to have a factory supplied transformer to power the damper motors as many of the motors used for this purpose are only available for a 24 V power supply. There is usually a relay installed on the system with damper motors of two different voltages.

iii. If the dampers don't open, before assuming the damper motor is burnt out it should be checked to make sure the dampers are not frozen or binding. Ensure there is power onto the damper motor and disconnect the damper linkage. If the motor moves, check if the dampers move freely. Set the damper linkage as described in 6-e-iv.

iv. The damper motor must stroke fully. When the dampers move freely and are fully open, make sure the damper motor has opened fully and stopped on its internal protection switch. If this doesn't happen then its possible to burn out the motor. At this time, tighten the damper linkage. The dampers will spring return to a closed position when power is removed from the damper motor.

v. Damper end switch bent. If the dampers open fully but do not trip the damper end switch, before assuming the damper end switch is faulty, check to see if the wand may have straightened out or is binding. If this has happened re-bend the wand.

vi. If the damper end switch failed, replace it and ensure that the wire on the switch is not located so that it may short on the cover of the box. If the switch has failed due to moisture, and the hole for the damper end switch passes through the wall of the unit on the “inside” of the dampers, relocate the hole to the outside and remount the switch. Plug up the original hole. The moisture comes from warm humid building air migrating back up the duct, and condensing on the damper end switch.

vii. Fan rotation and amperage. Once the fan is running and you’ve checked the fan rotation, you must check and record the motor amperage. If the motor is a three-phase motor, measure and record amperages on all three phases. Ensure the motor amperage is “balanced” within 10% on the three readings.

If the motor amperage draw is below that noted on the rating plate proceed with step 6-e-vi. If the motor amperage is above that on the rating plate either:

- The fan is operating at too high a speed and it must be slowed down or more static pressure placed in the ductwork to meet the original design conditions. If the motor amperage is above the rating plate value, the fan is moving more air then it was designed to do in this application.
- The voltage is incorrect.
- The belt is too tight.
- The motor is faulty.

7. *Terminal 8 is a Neutral Terminal*

It is the same as terminal 2.

8. *Lighting the Pilot*

Shut off the manual gas valves in the unit *(Main and Pilot)*. To troubleshoot lighting the pilot, the same tracing method used on starting the fan can be used here.

POWER TO HEAT SWITCH

a. Touch terminal 9 with the free lead of the indicator. If the indicator shows power proceed with step 8b. If the indicator doesn’t show power, check:

i. Terminals 7 and 9 are usually jumpered. If the optional outdoor control is installed, the jumper is removed.

OUTDOOR AMBIENT CONTROL OPTION

ii. If the unit is equipped with an outdoor ambient control to shut the heat off at a predetermined outside temperature *(usually 17°C - 60°F)* it is wired into this location. *(It is possible if the outdoor ambient controls sensing bulb is mounted in a warm area (e.g. Sun shining on it, warm area from a vent blowing on it, etc.) it may have to be relocated to obtain a more accurate reading).* To make this circuit for test purposes, this control may have to be jumpered or turned above the outside ambient temperature to turn the heat on.

PROVING HEAT SWITCH CLOSED

b. Touch terminal 10 with the free lead of the indicator. If the indicator shows power proceed with step 8c. If the indicator doesn’t show power, check:

i. The remote panel heat switch is turned on.

ii. Faulty wiring or a faulty switch.

POWER TO FLAME RELAY

c. Power to ignite the pilot should be available once terminal 10 is energized and the flame safety relay is powered. The control power and airflow lights should be 'on' now.

Most direct fired make up air units are equipped with flame safety relays which operate with flame rods and spark ignition. The flame relays commonly used are:

- **Fireye M Series II** which has a red cover and a number of lights on the cover to show what the relay is doing. This relay is available with a number of plug-in cards to perform various functions. Most Engineered units use the MARTIT card and the MP101 card. When it is tripped and if there is power to it, you will see an alarm light that is on. Note that this flame relay has to have power on it to reset it *(using the black pushbutton in the top left corner of the cover)* if there has been a flame failure.
- **Fireye TFM-ID** which has a gray cover with a red reset pushbutton in the top, left corner of it. This device can be reset without power on it.
- **Honeywell RA890F** which has a gray cover on it with a red pushbutton, located just below the middle of the cover. This device can be reset without power on it.

If the flame safety relay is tripped, push the reset button and check at the burner for a good bright blue spark about χ" long. The flame relay has a short delay before making a spark attempt. If a pilot is not proven the spark will quit after 15 seconds and the relay will lock out. If a good spark occurs, proceed with step 8d. If a good spark doesn't occur, check the following:

SPARK

i. Did the flame relay pull in to make an ignition attempt? An audible click can usually be heard from the flame relay as it pulls in and as well you will hear the pilot solenoid open. If not check terminal 10 and all the screws in the relay sub-base for tightness before assuming the relay is faulty.

ii. Did a 118V signal appear at terminal 4 of the relay sub-base? This is the terminal the ignition transformer is connected to. If so-

iii. Check the spark rod porcelain for signs of rust or cracking. If any exist replace the spark rod. To remove the spark rod undo the setscrew on the burner pilot assembly. This should enable the rod to slide out of the holder through the inside of the burner.

iv. The spark gap should be set about χ of an inch and the rod should face to the first pilot orifice hole toward the base. No part of porcelain should be in the flame area.

v. Is the ignition transformer putting out a spark? Disconnect the spark (*large*) wire from the ignition transformer. Run another wire from the transformer spark terminal to about χ" from the cabinet and fix it in place. Power the primary of the transformer. A good spark should appear. There are a number of different styles of spark transformers available. Many of them are outputting about 6000 volts that can usually throw a spark about ½ and inch in length. Be careful and avoid coming in contact with this high voltage.

vi. Try the same thing in step iii with the regular spark wire to prove the wire isn't broken down.

vii. If needed, you can remove the flame relay from the sub-base and connect a jumper wire from the ignition transformer terminal *(4 in the sub-base)* to terminal "H or 1" on the main terminal strip. This allows power to the spark and you can have the fan off by turning off the control switch.

D. PILOT GAS

After a good spark has been established make sure the main gas firing valve in the control cabinet is turned off. Turn on the external gas cock *(installed by plumber)* and check for leaks with soapy water up to the shut off valves.

When it has been established no leaks exist remove the χ" plug from the pressure tap on the inlet of the manifold and bleed the air out of the gas line. Attach a pressure gauge to the tap and check the inlet gas pressure and adjust as necessary on the external regulator. The inlet pressure should be the same as that recorded on the specification label attached to the unit.

> ***NOTE***: *The pressure rating is required at high fire.*

Turn on the two pilot gas firing valves and reset the flame relay. This should energize the spark and the pilot solenoid thus allowing a visible flame to burn in the pilot area of the burner. It may be necessary to partly remove the blower door to see the pilot flame. If the flame safety relay's pilot circuit proves that the pilot is sufficient to light the main burner, then the flame safety relay allows the main manifold valve to open. If this happens your safety controls in step 9 are ready to adjust.

If the pilot is not proven as being sufficient to light the main flame the flame relay locks out after about 12 to 15 seconds. Before most flame safety relays can be reset, a delay is built into the flame relay while the warp switch cools off. This can take from 1 to 3 minutes. The older flame relay models such as the Fireye TFM-ID do not need power on to them to be reset. The later models such as the Fireye M Series II do not have a warp switch heater in them and therefore can be reset immediately after tripping, however these relays need to have power on to them to reset.

> ***NOTE:*** *On some very small units serving into small areas such as kitchens with low ceilings, the amount of heat from the pilot flame can raise the discharge temperature 7 or 8°. If this is a concern, reduce the size of the pilot to a size that will allow the flame to just impinge on the flame rod and yet light well. When the size of the pilot is reduced, the temperature rise from the pilot flame will be reduced to as little as 2½°F. It will be necessary to turn the main gas regulator down two additional turns to increase the main gas flow at high fire to correct for the lower amount of heat from the pilot.*

E. NOT ESTABLISHING A PILOT

The possible reasons for not establishing a pilot flame are:

i. Flame relay not energized *(refer to step 8b).*

ii. Proper spark not established *(refer to step 8c)*.

iii. Gas shut off or air in line *(refer to step 8d)*.

iv. Faulty pilot solenoid.

v. Maladjusted, faulty or locked up pilot regulator.

vi. Air and gas mixture at the spark is not in quantities to allow combustion. Combustion air holes for pilot flame plugged.

If a pilot flame is not established try undoing the pilot tube connection and see if gas is passing through the pilot manifold during a pilot ignition attempt *(by installing a gas pressure gauge on the tubing connection)*. If it does reasons i, iii, iv, and v above are not at fault. If gas is flowing then either the spark is poor or badly located or else too much gas or too much air is present in the area of the spark to allow ignition. It may be necessary to adjust the pilot regulator to correct this situation although it has been factory preset and should not have to be adjusted in the field.

F. PILOT LIGHTS BUT DOESN'T PROVE

If a pilot flame has been established but the main valve doesn't open then it is probably being held off by one of the safety controls that have their adjustments noted in step 9.

9. Flame Proving Circuit

When the flame relay is energized it sends out three simultaneous signals *(line voltages)*. The first two signals, ignition transformer and pilot gas solenoid would have proven if the above steps were complete.

The third signal goes from the flame relay on terminal S2 through a series of safety devices to the flame rod. If any of these safety device switches are open, the voltage signal will not reach the flame rod. When voltage is on the flame rod and air, gas or an air gas mixture is present; the flame rod in effect has insulation around it. The moment that gases start to burn though, billions of new chemical changes occur within the flame. Many of the chemical changes are leaving particles of different elements and compounds that have become ionized. This means that they have an electric charge to them. This electrical charge on these particles allow electrons to flow through them more easily then a stable chemical, thus electrons flow from the flame rod to the burner surface and the burner rod which both act as a grounding surface for the electron flow.

The flame relay in turn interprets the rate of electron flow in the flame and if it is indicative of a proper flame, the flame safety relay allows the main burner to ignite.

It is important for a good grounding signal to be available between the burner ground rod and the flame relay. It is possible that the ground rod could be broken off of the burner or that the ground rod is not adequately grounded to the burner due to corrosion. *(It is also possible that the ground between the burners ground rod and the flame relay may have poor continuity at some other location. If this is something you wish to check for measure the resistance from the ground rod to the flame relay base. If necessary you may want to run a wire directly from the burner to the flame relay (terminal S1) if there is a poor ground path).*

The method of tracing out the flame rod signal is as follows:

- Attach one side of your light or voltameter to terminal "N" if it is grounded or to the unit cabinet making sure of a metal to metal contact such as a screw. Do not connect to the painted cabinet, as the paint does not make a good connection. Note that some test devices used for this purpose that will interrupt a flame signal if one has been established. For this reason, do not leave your indicator attached for too long a time. You just need it attached to the point long enough to establish that there is a signal. The actual voltage that you measure will vary between 50 and 400 volts if you are using a meter. The value of the voltage is not of as much importance as the continuity of the voltage through the switches. Reset the flame relay and while the pilot ignition is being attempted, use the other lead from your indicator to check for a signal on the special terminal strip that is provided to assist in troubleshooting the flame rod system. This terminal strip is labeled "A, B, C" and may also contain additional letters depending on the options that have been ordered on the unit. Use the terminal strip as follows:
    - ♦ Touch the free lead of the indicator to the terminals on the terminal strip in alphabetical order. You should have the same voltage signal on all of the terminals *(between 50-400 volts.)*

A. TERMINAL A-HIGH LIMIT

Used to provide protection against overheating. If a signal is present proceed with step 9b. If a signal is not present, check *(as per the wiring diagram)* that:

i. The signal is not being stopped by the high limit *(set point 65°C, 150°F)*.

ii. The signal is being transmitted by the relay from the respective terminal *(Honeywell F, Fireye S2)*.

iii. Loose or dirty contact on the relay sub-base, remove relay from sub-base and check if all contacts are clean and tight.

B. TERMINAL B – LOW VELOCITY AIR SWITCH

Used to provide protection against lack of proper airflow for proper combustion.

The low velocity air switch has two tubes that protrude through the wall of the control cabinet to sense pressures on either side of the profile plate.

If a signal is present proceed with step 9c.

If a signal is not present, check:

i. The possibilities that would restrict proper airflow:

- Dirty filters *(filters are to be removed in winter to avoid clogging with frost)*.
- Plugged intake screen.
- Loose or slipping fan belt.
- Fan wheel plugged.
- Fan wheel installed or rotating backwards.
- Plugged or shut duct and/or discharge grills.
- Closed fire dampers.

ii. Faulty or maladjusted low velocity air switch.

In order to set the low velocity air switch in the field it is best to establish main flame first. If the low velocity air switch is not made and no signal appears on terminal B during an ignition attempt, try to back *(counter clockwise)* the slotted screw head, all the way out. There are a number of styles of air switches in use. The Penn air switch has its adjustment screw located under the bent tab on the cover. The BEC air switch adjustment is under the red cap. *(On the BEC air switch only, when the screw head is backed out completely and further adjustment is necessary, the lock nut may be undone and the complete barrel adjusted (counter clockwise 2-5 turns))*. By this time a signal on terminal B should have been established. If the main gas valve is not energized then come back and complete these settings when the main gas valve has been energized.

Setting the Low Velocity Air Switch

When the main gas automatic valve is open, the manual firing valve can be turned partially on. This should establish a main flame. Make sure the manual gas valve throttles the gas back enough so as not to burn the insulation. Remove the blower door and slowly turn the slotted adjustment screw of the low velocity air switch clockwise, until the main flame goes out. If the blower door is replaced before the flame relay locks out *(10-15 sec.)* then the main flame should be re-established. If the blower door is not removed half of the way the main gas should remain on. When the blower door is totally removed, the main gas should shut off. Further fine adjustments may have to be made to obtain this setting.

C. TERMINAL C HIGH VELOCITY AIR SWITCH

To provide protection against the possibility of too much air-flow for proper combustion. If a signal is present, proceed with 9d.

If a signal is not present, check:

i. Maladjusted or faulty high velocity air switch *(turn clockwise until a signal is present on terminal C.)*

- Lack of specified external static as per Eng. Air rating plate attached to unit.
- This is preset at the factory but if field adjustment is needed proceed to next point.

ii. Set point of the high velocity air switch.

Setting the High Velocity Air Switch

To adjust high velocity air switch setting it is best to have the main flame established. If the gas is on and the high velocity air switch slotted screw head is adjusted counter clockwise, the main gas flame shuts off. You now adjust clockwise until the main flame is re-established. At this point, for Penn air switches, add an additional inch to the point where the switch remade. This would result in a set point between 1.2” and 1.5” on the scale.

If the unit is an older model using BEC air switches, you turn the screw a further 2 to 3 turns clockwise.

> ***NOTE:*** *When setting the high velocity air switch adjustment and you’ve backed the switch out to the point where you lose the flame signal, if the flame signal is not re-established in 1-10 seconds, the flame relay will lock out.*
>
> ***NOTE:*** *If the following options described in guide items 9d, 9e, or 9h are not on the unit the flame rod wire may be taken off an earlier terminal (C, D, or E) to go to the flame rod.*

D. CABINET LOW LIMIT *(-60 or Older Units with Heaters Only)*

Refer to guide item 5 for information about the use of the cabinet heater and low limit. Terminal D Cabinet low limit is to provide protection against the controls operating at temperatures below their approved ratings. The cabinet low limit disk opens if the temperatures in the control cabinet fall below 5°C or 40°F. On units made after 1990 and being used in a –60 location, the cabinet low limit can operate at as low as 30°F.

If a signal is present, proceed with step 9e.

If a signal is not present, check:

i. The control cabinet doors *(except when servicing)* should be on.

ii. The control cabinet thermostat brings on the cabinet heater *(setting 7°C - 45°F)*.

iii. The cabinet heater is not burned out.

iv. If it is necessary to work in the control cabinet on a cold day it is recommended that terminal C and D be jumpered. The owner of the equipment should be instructed to remove the jumper after four (4) hours.

E. TERMINAL E HIGH GAS PRESSURE SWITCH

To provide protection against high gas pressure, *(e.g. Regulator Diaphragm Rupture)* set at 5”. If a signal is present, proceed with step 9f. The high gas pressure switch is physically located near the end of the gas manifold and will react if the gas regulator diaphragm fail.

If a signal is not present, check:

i. Gas Pressure.

ii. Improperly adjusted or mis-calibrated switch.

iii. Faulty switch.

iv. If the manual firing valve is shut for test purposes this switch may have to be jumpered due to increased pressures without gas flow.

F. TERMINAL F LOW GAS PRESSURE SWITCH

To provide protection against low inlet gas pressures *(setting 3.5")*. If a signal is present, proceed with step 9g. The low gas pressure switch is located near the inlet of the manifold just downstream of the inlet regulator in most installations. If inlet pressures fall too low it will open the flame safety circuit and force the flame safety relay into a flame safety lockout.

If a signal is not present, check:

i. Inlet gas pressure is correct, refer 8d.

ii. Improperly adjust or mis-calibrated switch.

iii. Faulty switch.

iv. Gas pressure is adequate in peak demand conditions. Note guide item 11 for further detail.

G. FLAME ROD

The flame rod receives its voltage from the flame safety relay where it has followed the path described in section 9. If the main gas valve is activated refer to section 10. If the signal seems to be going to the flame rod and the flame relay still won't activate the main gas valve check the following points:

i. Flame rod or flame rod ground is not corroded.

ii. Flame rod or lead to the flame rod is not shorted to the ground. It has occurred where moisture has entered into the splice on the high limit wire where it lays near the top of the motor control box to create a "short" that will affect the way in which affect the flame rod signal. Likewise, older units have had moisture collect in a crack in the flame rod wire insulation where it passes through the control cabinet wall.

iii. Flame rod is mounted in its holder properly and the lead is connected.

iv. Flame rod porcelain is not cracked or rusted.

v. The flame signal is strong enough to activate the flame relay. The flame signal may be varied by the position of the flame rod or by the adjustment of the pilot regulator. Following are some pages with troubleshooting information for other possible causes.

H. IF THE MAIN FLAME ISN'T ESTABLISHED

Check the control circuit in section 9 and if a good signal is present but the main gas doesn't activate change the flame relay.

10. Safety Controls

a. Setting Safety controls. If the main flame has been established but the safety controls were not set properly then:

   i. Set high limit at 150°.

   ii. Set low velocity air switch as per 9-b-ii.

   iii. Set high velocity switch as per 9c.

   iv. If the unit is outdoor and the control cabinet is cold, follow the instructions in 9-d-iv.

b. If the main flame relay cycles the main flame repeatedly, re-check connections and controls in sections 8 and 9.

c. If the main flame has been established and the safety controls are set properly as per section 9 refer to section 10a.

i. Discharge Temperature Control

A direct-fired make up air unit is limited to a maximum discharge temperature of *(24°C - 75°F)*. It is not a heating unit but a piece of equipment designed to replace air being exhausted from a building *(ventilation)*. In doing this it will add some heat to a building but not enough to cover temperature loss.

A separate source of heat is desired for handling the heating loads. The heating load is not part of most MUA designs.

As this unit operates as ventilation equipment only, our discharge temperature is controlled at the discharge of the unit. **There should not be a room thermostat turning the unit on and off as a heater.** All Engineered Air HE, RE and DE series MUA equipment is supplied with a factory mounted discharge sensor.

In some situations optional two levels of discharge temperature are desirable. In yet other situations, a remote temperature selector is required. There are many methods of discharge control and by checking your wiring diagram and valve description you can determine which system you have. After you have determined the system you have to refer to the appropriate section below. Refer to the Manifold Diagrams at the end of this booklet also.

ii. Modusnap

Description: *A valve that has an adjustable knob on the top numbered 1 – 9. This valve has a liquid filled capillary attached to it with a sensing bulb that is mounted in the discharge of the fan. The unit is calibrated so number 9 is 21° (72) and each number lower is a 2.8°C (5°F) drop in discharge temperature. In order to obtain high fire for an extended period of time to do a temperature rise test it may be necessary to remove the sensing bulb from the discharge and place it in cool water outside the unit. The modusnap if faulty cannot be repaired but should be replaced with the same type of control.*

Calibration is accomplished by undoing the knob on the valve head and placing the required number at the indicator, which matched the discharge temperature *(e.g. 9 is 23°C or 75°F, 7 is 18°C or 65°F)*. This system is also available in two level discharge control. Refer to 14.

Modusnap valves will “snap” the main gas off so there is just a pilot in operation. This is ideal for small units. There is good control from a modusnap valve but over time the bellows loses some of its response and the valve may have wide temperature swings. In extreme cold weather, the amount of temperature droop in the valve can cause a need to set the discharge temperature up. A valve will not open further unless the temperature has fallen to a point that a call for more heat is made. As this valve is always being asked to open further as the discharge temperature falls, and as it cannot open further until the discharge temperature has fallen slightly, the valve is always lagging behind. This is the “droop” referred to above.

If a very small unit has too much heat from the low fire setting in some warmer condition where the modusnap is “snapping” on and off, the low fire can be turned down. You would want to set it so the low fire puts about 1” of flame across the burner. The low fire adjustment screw is located under the small cover one step below the dial set point. A pair of good pliers will open this seal.

iii. Combination Shut Off Valve and Modulating Head

(Setting 55° - 75°, 13° - 24° - Usually consists of a Honeywell V5055 valve body and a V9055 operator.)

Description: *This is a valve mounted in the gas manifold, which has a large removable operating head. The operating head will have 5 wires running into it. Two of the wires are for power, 3 of the wires are attached to a discharge temperature control which has a liquid filled capillary.*

There have been two styles of this type of valve used in our production. One was the ITT General Controls AH8 and AH2 series valve, used in the early 1970's.

The most common model is Honeywell's V9055 series. We will describe the Honeywell valve here; *(the ITT valve operates in a similar manner)*. The Honeywell valve is composed of two pieces, a V5055 valve body, and the V9055 operating head. Undoing the set-screws that attach it to the base can change the operating head. This avoids opening up the gas manifold for this service.

Operation

The V9055 opens to a low fire setting when it is energized by the flame relay. The V9055 valve can then modulate further open as it is called for by the discharge temperature control. Some modulation *(temperature swing)* may be present in this system. The valve modulation is controlled by a Honeywell T991E temperature control. When the discharge controller is not satisfied, its rheostat moves to a position that calls for more or less heat.

Assume we have called for more heat and the valve has opened sufficiently to allow enough heat to satisfy the T991E temperature controller, the liquid bellows of the rheostat controller moves a rheostat wire to a position which balances with the position of the rheostat wires in the modulation head. This operation of a balanced bridge system depends on when the balance point being reached and the valve holds this position within a few degrees. This system requires at least 5 minutes to balance itself from startup or if you have reset the discharge set point. If the modulation system does not work check the following:

- Power is supplied to the valve head as per the valve rating plate.
- All wire connections are correct and tight.
- For following test ensure manual firing valve is turned 'OFF'.
- Remove the wires in the valve head labeled R B W and connect a jumper across the V9055 terminals "R-B". After turning the power back on to the V9055, then you should see the valve power open. If not either the valve head has no power or it is faulty.
- If the above step operates the valve head but it doesn't operate when connected to the temperature control then:
    - ♦ The temperature-sensing bulb is in a poor location *(sensing incorrect temperature)*. Try moving sensor to another location.
    - ♦ Wiring between the valve head and temperature sensor is incorrect.
    - ♦ The temperature sensor is faulty.
    - ♦ The valve head is faulty.

iv. Electronic Modulation *(Maxitrol)*

(Setting 13° - 24°C, 55° - 75°F)

Description: *This system uses an amplifier, discharge temperature sensor and temperature dial to maintain control of the discharge temperature. The more common A1014 amplifier requires a 24-vac power input on terminals 7 and 8. This system uses a thermistor to sense discharge temperature. The temperature sensor changes resistance according to temperature and the resulting change in current flow through the sensor and set point adjustment is processed through an amplifier which in turn controls a modulating gas valve.*

The gas valve is at low fire below 2 volts DC, in its modulating range between 3 and 15 volts DC and is at high fire above 15 volts DC. The advantages to this system are as follows:

- Very accurate discharge temperature control with a minimum of modulation.
- Simple to give remote set point adjustment.
- Possible to have two-discharge temperature levels. This option is done by adding a normal room thermostat to the Maxitrol system that closes the circuit between the dial terminals 2 and 1 on a call for heat. The second *(high)* discharge temperature level is that of the dial plus the value added on from the override adjustment pot with the pointer marked 0 - 40°F on the back of the dial.

If any part of the Maxitrol modulation system is changed it may be necessary to recalibrate the system *(located on the back of the temperature selector)*. The usual causes for trouble with the Maxitrol system are as follows:

- Constant High Fire

  Causes: *Open Sensor*

  Faulty Amplifier
  Stuck "MR" Valve

- Constant Low Fire

  Causes: *Open circuit in temperature selector*
  No 24 Vac Power to 7 and 8
  Faulty amplifier

- Incorrect Discharge Temperature

  Causes: *Out of Calibration*
  Incorrect Sensor Location (Stratification)
  Electrical induction on the Maxitrol sensor from another source close to the sensor wires. (Recommend remote wiring in a shielded cable with the shield grounded at the unit end only.)

The Maxitrol sensor and set point should both read about 10,000 ohms resistance at 77°F. There is about a 40-ohm per degree change on the controls. The TS114 temperature sensor resistance falls as you heat the sensor. To simulate a call for full heat, open the sensor circuit by removing the wire from the A1014 amplifier terminal 4. To simulate a call for low fire, open circuit the TD114 set point circuit by removing the wire from the A1014 amplifier terminal 1 or 2 or remove power 24 VAC from 7 + 8.

If you suspect a faulty sensor as a problem and wish to test the amplifier, you can substitute a 10,000-ohm resistor in place of the sensor. You should then be able to dial the valve to a modulated output in the middle of its range and it should remain there in a stable condition. This can also assist in checking for problems where you suspect a sensor is located in an area with stratified airflow. If it settles down with the resistor-taking place of the sensor, suspect stratification. If it is still hunting, suspect power supply problems or voltage induction problems.

If you suspect problems from induced voltage in remote wires, it is best to place the remote set point at the unit to see if that corrects the problem. *(Ensure that the remote wires are not connected to the system at this time. Also note that you can usually measure how much induced AC voltage is on the remote wiring by measuring between the disconnected field wiring and ground with a digital AC voltmeter.)*

For more detailed information about troubleshooting the Maxitrol system consult the literature supplied with the unit.

11. Air Flow and Temperature Rise

When the main burner has been established the units airflow should be checked.

First ensure that there is adequate inlet gas pressure when the unit is at high fire. If the inlet gas pressure falls more then 1" below that of the rating plate when the unit is at high fire, there is too much pressure drop in the gas piping to the unit. This problem should be corrected. If the unit is being started in warm weather it may be possible to have adequate inlet gas pressures on that day - but on a colder day when the building is calling for additional gas fired equipment to operate, the inlet pressures may fall. This problem is also related to pressure drop in the gas piping to the unit and should be corrected.

All units are test run at the Engineered Air Factory. The fans are set as per the requested C.F.M. *(noted on the rating plate)* and the gas flow is clocked *(to be that on the rating plate)*. Therefore, if the external system static is as per the estimate everything should be correct. Do not adjust the gas regulator *(unless authorized by the factory)* as the units are set for the correct gas flow and to clock the unit at most installations is very difficult.

In order to check for correct airflow:

a. Obtain and record the inlet air temperature.

b. Place thermometer in the discharge air *(read step 7)*.

c. Turn the unit's manual firing valve off.

d. Open the modulating valve to full fire.

- **Modusnap** – remove bulb to cool air or a pail of cool water
- **Modulating Valve Head** – Jumper terminal R and B, remove *(if necessary)* wire from W.
- **Maxitrol Electronic** – Remove wire from the A1014 amplifier terminal 4. If there is another model of amplifier being used, refer to the instructions for that model.

e. Turn the manual-firing valve on.

f. Observe visually the flame. If flame is:

- Long, luminescent yellow – airflow is too low.
- Warmer weather – 18" long blue with some yellow flame – airflow is correct.
- Cold weather *(-30°F)* – 14" long with reddish orange tips is correct.
- Short bright blue – airflow is too high.

g. Note and record the discharge air temperature.

h. Shut manual firing valve off.

- If it is cold outside and if the flame looks good and the temperature rise *(difference between inlet and discharge)* is as noted on the rating plate then the operation is OK. Note additional information on the burner near the back of this guide.
- If it is warmer out, the flame as noted above will be slightly longer. The temperature rise will be about 12° - 15° higher then that noted on the rating plate if this test is done with 70°F air entering onto the burner.

PROCEED WITH STEP 12

If the temperature rise is higher than the rating plate, above instructions note, and the flame is long and lazy, the unit is not moving enough air and must be stepped up in some way. For example, opening up discharge grills, balancing dampers, fire dampers, or changing the drives on the fan and/or motor.

If the temperature rise is less than the rating plate says and the flame is short, sharp and bright blue, the unit is moving too much air and must be slowed down in some way. For example closing discharge grills, balancing dampers or changing the drives on the motor and/or fan.

If the temperature rise is correct but the flame is a touch too blue or too yellow an adjustment of 1" further open or 1" further closed may be made to the profile plates above and below the burner. This will change the velocity of the air across the burner but will have little or not effect on the temperature rise.

Remember to adjust the airflow first to obtain the correct temperature rise. If it is then found necessary adjust the profile plates for a better-looking flame. After any airflow adjustments re-check the air switch settings 9b and 9c.

12. Reinstall or Reset the Modulation Control

To obtain the correct modulation, reinstall or reset the modulation control. Set and check the discharge temperature to make sure it is in calibration.

Rough ideas of usual discharge set points are:

- Garages, Warehouses 60°F or 16°C
- Restaurants 65°F or 18°C
- Taverns, Lounges and Kitchens 58° - 65°F
- Paint Booths 72°F or 22°C

13. If Jumpers Were Used

If jumpers were used for test or startup make sure they are removed and then make sure the unit operates from the remote controls.

> ***NOTE:*** *The exhaust interlock on a direct-fired unit must prove an exhaust fan is operating before the make up unit can fire.*

14. Other Options *(available with the HE Series Units)*

A. FILTERS

To be kept clean and REMOVED IN WINTER *(if located before burner to avoid clogging with frost.)*

B. TWO LEVEL DISCHARGE CONTROL

(Refer to unit wiring diagram for the override terminal connections.)

The "two level discharge control" or room override option is designed to allow an overriding temperature discharge on units installed where large heat loads may affect the ventilated area on some occasions but not on other occasions. *(E.g. A community hall quarter full requires a discharge temperature of 70° while the same hall, full needs cool air at 60° to keep the hall comfortable because of the heat load from the people. Another common application is for a kitchen which at lunch hour rush requires a 55°F - 13°C discharge to cool the space. However, at 2:30 p.m., 55°F is too low and a warmer discharge of 70°F - 21°C is required to make up for the lack of heat from the stoves.)*

A thermostat is mounted in the space being served *(not near any item giving a false reading to it)* and it senses room temperature. For example, the room-mounted thermostat is set for 70°F, the units low discharge control set point is 60°F and the override set point is 75°F. The unit will try to maintain 70°F in the space by discharging 60°F when the thermostat is not calling and the area is warm. When the space cools the unit will discharge at 75°F to warm the space.

C. SWAMP COOLER

(Refer to wiring diagram for pump terminals.)

This consists of a metal pan mounted on the inlet of the makeup air unit with straw mat filters mounted vertically on its outside edges, and it is covered on top with a roof.

A pump is mounted in the pan which pumps water up and over the filters and drips back to the pan. The air passing over the moisture absorbs some and through the process of evaporation cools down the air. A squeeze clamp on the hose controls the pump flow. The flow should be enough to keep the filter media moist but not enough to create water carryover. The filters should be kept clean and removed in winter. The depth of water to be maintained in the pan is 2" – 2½ ". There is a float that maintains this level. To adjust the float level, bend the rod. To reduce the buildup of mineral in the water, there should always be some water overflow or else the pan should be drained at least weekly.

It is important to drain the pan every fall by removing the overflow plug and also drain the water supply line leading to the pan so it won't freeze and break.

NOTE: *Optional 3 way dump valves are available also.*

If the swamp cooler has excessive moisture landing on the spark and flame rods it can lead to ignition failure of the HE unit.

D. MECHANICAL COOLING

(Refer to the mechanical cooling manual).

E. CLOGGED FILTER INDICATION

(Refer to wiring diagram for wiring terminals).

This option consists of an air switch and an indicator light. The air switch has sensors on both sides of the filters. When the pressure differential across the filters is too great the air switch makes its electrical contacts and activates the light.

It is imperative that this control is set at the job site. Once set it may be discovered further minor adjustments are required by the operators of the equipment. The control is a clogged, not a dirty filter indicator. Filters should be checked regularly for cleanliness and changed well before the clogged filter indicator would trip. In order to make adjustment to the switch to meet your particular needs, adjust the screw on the air switch to the desired setting.

F. PRE-PURGE TIMER

Refer to wiring diagram for wiring terminals. *(Usually located between terminal 10 and the flame relay.)*

This is a time delay relay to enable the air to change in the ductwork if any hazardous gasses might exist *(having migrated from the area being served to the ductwork)*. This is normally a 3 – 10 second delay. It can be wired to:

- Allow the exhaust and supply fan to operate for a short time before starting the flame; or
- Open the make up air dampers, start the exhaust fan to draw any explosive vapors out of the make up air units duct work and blower cabinet before allowing the make up air units supply fan and then heat to start.

G. FLAME FAILURE INDICATION

(Refer to wiring diagram for appropriate terminals.)

This is an indicator tied back to the flame relay, which is activated when the flame relay locks out and must be manually reset.

H. DUAL CAPACITY

Some applications require two exhaust fans to be running (e.g. welding shops where only one exhaust fan is to be running at evening shift and both exhaust fans to be running during day shifts. This would require two make up air units. As this is not practical due to costs and maintenance, a dual capacity make up air can be used for above application.

A dual capacity make up air unit is commonly referred to as a two in one unit as it serves a purpose of 2 units.

The dual capacity unit consists of inlet dampers which in most cases are an opposed blade type and it also has profile plate dampers (a set of blades on top and bottom of burner).

During low capacity operation (one exhaust fan running) the inlet dampers open to approximately 50% CFM of the total CFM which is about the same as ½” to ¾” spacing between dampers and the profile plate dampers are fully closed. This way the burner air velocity is maintained.

During high capacity operation (both exhaust fans running). The inlet dampers open to 100% CFM and the profile plate dampers open to 100% to maintain the burner air velocity.

CAUTION NOTES

When some of this units switch from high to low capacity the air pressure drop across the profile plate reaches a point where the air pressure switch contacts open and cause flame failure problems. In order to resolve this problem an extra damper end switch on the profile plate interrupts the flame circuit and reactivates the low limit bypass relay until the profile plate dampers are almost fully closed.

During low capacity ensure the opening spaces between the inlet dampers isn’t too large so as to allow more than 50% air otherwise the burner velocity will be too high and pilot lighting problem may be experienced.

I. VARIABLE VOLUME MAKE UP AIR

Some applications include supply blower inlet vanes which modulate to control pressure in space. (E.g. A job where there is multiple cabinet fans coming on randomly. On these types of systems there would be a bypass set of dampers on the bottom of the burner to allow for a constant air velocity over the burner. This is done by having two floating type damper operators in parallel, controlling the inlet vanes and the other the bypass damper. When the inlet vanes close off the bypass dampers close simultaneously to maintain burner velocity.) The same operation can be obtained by VFD (Variable Frequency Drive) controls. Note that the vanes should never close below 30% or 30% speed on VFD.

On some indoor units the vent orifice fitting on the RV appliance regulator is to be vented to atmosphere. The field installed vent line should be sized adequately especially on longer runs. If there is more than one regulator connected to a common run that includes the main regulator, and the line is not adequately sized an erratic inlet pressure will result and cause improper combustion and also burner pulsating problems.

Some DJ unit manifolds have RV appliance regulators with a vent-limiting orifice usually a brass orifice marked ‘12A0G’. Ensure that this tiny orifice is free of dirt or debris. A plugged orifice will impede a regulators opening flow and cause improper air/fuel mixtures.

LACK OF MANIFOLD PRESSURE

Assuming the inlet pressure is correct, manifold pressure at high fire should match that set at the Factory Labels are marked at 3.5 inch manifold pressure but if a burner is not designed at full capacity, the actual factory setting will be below 3.5 inch. Contact factory for actual pressure.

Assuming the modulation system is fully open but manifold pressure is low or very slow to rise, the appliance regulator vent may be plugged.

MAINTENANCE ITEMS

FAN	*Should be kept reasonably clean. When the blades are fouled with dirt, airflow is reduced. Dirt may also cause problems with mechanical imbalance. The set-screws should be checked for tightness 3 times per year*
BEARINGS	*Should be kept clean and the set-screws checked for tightness at least 3 times per year. As most of the bearings are deep groove style ball bearings and they are operating well below their rated maximum speed, they operate cool. In most applications the bearing has adequate grease in it to last for the rated life of the bearing and so greasing is not needed. If you are going to grease the bearings, follow the bearing manufacturer's instructions or those in the* ***Installation and Maintenance Guide****.*
FAN BELTS	*Follow the tension and alignment recommendations of the belt and pulley manufacturers or as a general guide follow the instructions in section 3 of this guide.*
LOW LIMIT BYPASS TIMER	*Check its operation at the beginning of each heating season.*
CONTROLS	*All safety and operating controls should be checked at the beginning of each heating season.*
SPARK AND FLAME RODS	*If there are any cracks or rust on these parts, change them at the beginning of the heating season to avoid having to service them in the cold weather.*
FILTERS	***Filters should be removed in winter if they are located before the heat as they will plug with snow or frost.*** *In seasons where the filters are in the unit, they should be maintained in a reasonably clean condition. Do not use an unsupported cardboard frame filter in the inlet of a make up air unit as they could get wet and be drawn into the fan. If the cardboard frame filter has an adequate support and screen on the air leaving side, it should be satisfactory.*

TOP TROUBLE POINTS

FAN BUT NO HEAT

Heat Switch Shut Off	*Turn on heat switch*
Air switch locks out flame relay due to:	
Dirty or frosted filters	*Remove and clean –reset flame relay*
	NOTE: Filters installed before burner must be removed in winter.
Frosted intake screen	*Clean frost from intake screen. Reset flame relay.*
Closed discharge grills	*Open discharge ducts or duct dampers.*
Incorrectly adjusted or loose fan belt	*Adjust to correct deflection fan belt. Refer to Section 3 Belt Tension*
Wet or frozen flame and spark rods	*If unit is used in moist environments keep inlet dampers from closing fully and/or install car warmer inside burner cabinet to keep rods from freezing.*
Incorrectly adjusted air switch	*Adjust as per section 9.b.ii*
Controls too cold due to:	*Replenish power as per section 4.*
Power interruption	*Jumper terminals of cabinet low limit (C-D). Reset flame relay. Remove jumper after 4 hours.*
Door left off control cabinet	*Replace control cabinet door.*
Burnt out cabinet heater	*Replace cabinet heater.*
Low or no gas pressure	*Replenish gas supply.*
No fan no heat	
Motor power supply disconnected	*Replenish power supply as per 4, reset flame relay.*
Low discharge temperature limit	*Refer to wiring diagram to see if this option exists. If it's an automatic type, shut off and turn on unit disconnect switch. This should reset bypass relay (set for 3 minutes). If manual bypass depress manual bypass for 3 minutes. Refer 6d.*
Dampers frozen shut	*Remove ice, free damper, energize unit*

FLAME TROUBLESHOOTING GUIDE

Honeywell RA890

Meter on MA scale READING should be greater than 2 MA and steady.

METER SIGNAL DURING IGNITION ATTEMPT	**Cause**	**Correction**
Dead – No Needle Movement	Open flame rod circuit resulting from broken lead or limits	*Repair break in limits (Section 9).*
	Dead short of flame rod to ground.	*Correct short and check flame relay for damage.*
	Low voltage	*Line voltage should read at least 100V.*
	Defective relay	*Replace relay*
Reading, Slightly Fluctuating Needle	Incorrectly installed rod	*Adjust flame rod so that porcelain insulator protrudes χ” through pilot castings*
	Low voltage	*Line voltage should read at least 100V*
Reading, Rapidly Fluctuating Needle	Voltage leaking	*Replace flame rod clean and dry pilot burner section* *Replace flame rod lead (use only thermoplastic insulated wire).*
Quick Full Scale Reading – Then Zero	Dead short of flame rod to ground	*Correct short and check flame for damage.*
Erratic Reading Fluctuating Rapidly	Induction interference	*Remove flame rod wire from interference; i.e.* • *Flame rod wire run in same area as motor power supply* • *Flame rod wire wound in coil*
	Spark interference	*Spark electrodes set with too wide a gap.*

FLAME TROUBLESHOOTING GUIDE

Fireye M Series II or TFM-1D MARTIT

Meter on DV volts (red and black probes on TFM-ID, probes on card on MC120) reading should be greater than 10VDC and steady.

METER SIGNAL DURING IGNITION ATTEMPT	**Cause**	**Correction**
Dead – No Needle Movement	Open flame rod circuit resulting from broken lead or limits Dead short of flame rod to ground. Low voltage Defective relay	*Repair break in limits (#9).* *Correct short.* *Line voltage should read at least 100V.* *Replace relay.*
Low Needle Reading	Voltage leak Induction interference	*Replace flame rod clean and dry pilot burner selection replace flame rod lead* ***(use only thermoplastic insulated wire)****.* *Remove flame rod wire from interference* ***(i.e. Flame rod wire run in same circuit as motor power, manifold piping.)***
	Spark interference Incorrectly installed	*Spark electrodes set too wide* ***(refer checking the ignition)****.* *Adjust flame rod so that porcelain insulator protrude χ" through pilot casing*
	Low Voltage	*Line voltage should read at least 100 volts*

Refer to flame relay pamphlet supplied with the unit for further information.

> ***NOTE****:* *If an MA reading is desired you can series the MA meter in the flame rod circuit and adjust the pilot for the highest reading.*

Burner Information

Engineered Air has used two versions of the MIDCO burner – the MAXON burner and in 1992 introduced Engineered Air's own burner in its product line. There are no parts that can be interchanged among the burners except for the spark and flame rods being interchangeable on the later model MIDCO and Eng. A burners. All of the above burners are designed to operate best as a draw through burner. *(You need a template for this).*

The maximum velocity of air over any of the burners is 3200 FPM. The usual minimum design is 2500 FPM but note that the Eng. A burner can operate cleanly down to 1600 FPM. When designing a unit, the designer will size the profile opening to deliver air across the burner at 2850 FPM except for the Eng. A burner which is calculated to operate at 2750 FPM.

Assuming that all airflow is lineal through the unit, it is possible to obtain a fairly accurate estimate of the air velocity over the burner by measuring the negative pressure in the manifold while the firing valve is turned off. To do this you will need a "U tube" manometer or a Magnahelic Gauge scaled to read in inches water column. Measure the negative pressure in the manifold *(at the pipe plug downstream of the firing valve)*. The high side of the meter should be connected to the air inlet side of the profile plate *(such as being inserted into the air switch tubing hole "high side" behind the profile plate*). If the outside temperature is not close to 70°F then use the following multiplier on the reading you have taken:

90°F multiply your reading by .92
70°F multiply your reading by 1.0
50°F multiply your reading by 1.08
30°F multiply your reading by 1.16
10°F multiply your reading by 1.26
-10°F multiply your reading by 1.38

Example: *You read .64" on a 30°F day. Multiply .64 by 1.16 to get 0.7424. As per the following table velocity will be about 2650 FPM.*

Compare the multiplied reading to the following values.

Velocity of 3200 FPM – corrected reading should be – 1.0 " w.c.
Velocity of 2850 FPM – corrected reading should be - .8 " w.c.
Velocity of 2500 FPM – corrected reading should be - .7 " w.c.

At the time of design the Midco burner is sized at 2850-FPM velocity. The Engineered Air burner, which became available in 1992, is sized at 2750-FPM velocity. You can tell whose burner by obtaining the name from the back of the burner casting.

At the burners maximum rated high fire condition, the manifold pressure for these burners is designed to be 3.5" w.c. If the burner is being used to its full capacity of 550,000 BTUH per lineal foot then the manifold pressure at high fire should be 3.5". However, in most instances the burner is operating below its maximum rated capacity. To accomplish this the actual operating manifold pressure is less then the 3.5" noted on the rating plate. If you wish to obtain the actual manifold pressure that the burner was clocked at in the factory, obtain the unit model and serial number and phone the factory.

The burner is designed to burn at the rate of 550,000 BTUH per foot of burner. If the burner is operating at that rate, as noted above, the manifold pressure on the burner will be about 3.5" w.c.

If the burner is operating at 500,000 BTU/ft., the manifold pressure will be about 3.1" w.c.

At 400,000 BTU/ft., manifold pressures will be about 1.7" w.c.

At 300,000 BTU/ft will be about .6" w.c.

These burners are all operated with some type of modulation system on them. Please ensure you have taken the burner to high fire for the above mentioned temperature rise tests. Also, while at high fire some of the following characteristics may be noted.

> ***NOTE:*** *That as this burner is applied in a draw through application, the burner is at a negative pressure when the gas is off and in order to raise the manifold pressure to 0" w.c. when the burner is on, the flame will be about 6' long.*

Flame length will also be shortened if the burner is not operating at full capacity. Assuming the burner is at full capacity *(high fire)* and firing at 550,000 BTU/hr, the flame length should be about 15" long. That is if the inlet air is about -30°F on a unit designed with a temperature rise of 100°F. If the burner is artificially forced to high fire in warmer temperatures, then the flame length and temperature rise will increase slightly as the warmer inlet air is less dense *(less molecules of air per cubic foot then the cold air)*. If a unit is designed with a temperature rise of 100°F from -30° - + 70°F and you are trying to do a temperature rise test on a warm day, you will get a temperature rise of about 120°F because of the change in air density.

If that same burner is designed and is operating at 500,000 BTU/hr the flame length will only be about 12" at high fire. At design of 450,000 BTU/hr the flame length will only be about 10" in length past the end of the burner.

If a burner rated for 100°F rise is operating at full fire and delivering 70° air into the space with a design profile velocity of 2850 FPM and a design profile pressure drop of .55" w.c. the supply blower will be delivering the rated CFM of air. However, note that the actual velocity of air across the profile plate will have fallen to about 2300 FPM and the pressure drop over the burner will have fallen to .36" w.c. This is because of the expansion of air as the flame heats it. As the blower is a constant volume device, it will move the same CFM. The air density will be reduced as the air is heated. However, due to the expansion of the air as it is being heated, the amount of air entering into the unit will decrease due to the back pressure from the air expanding as it is warmed. At 70° inlet temperature onto the burner and with the flame turned off, the blower will be delivering the same CFM as above. The pressure drop will be at the design .55" w.c. and the velocity of air over the burner will be at the rated 2850 FPM.

Further note that air density may be best understood by picturing it as cold air having more molecules per cubic foot then warm air. If you are working on a direct fired make up air unit on a cold day and have an amprobe measuring the motor amps, you will note that if you have the burner firing and then turn the heat off with the manual firing valve, the motor amperage draw will increase. When you turn the flame back on the amperage draw reduces. You are moving fewer molecules per cubic foot with the warm, less dense air and motor uses less horsepower.

Measuring Products of Combustion

Products of combustion are possible to measure by using instruments such as a Drager. In order to determine if a burner is operating cleanly, it is usually necessary to only measure CO *(carbon monoxide)*. The 1994 Canadian Gas Code for this style of burner has a maximum limit of 10 ppm CO and the Midco burner will usually operate in the area of 7 to 8 ppm at high fire. The USA gas code has a limit of 5 ppm CO. The Eng. A burner can operate at or below these levels through its modulating range and raise the temperature of outside air of -40° to temperatures well in excess of 80° discharge.

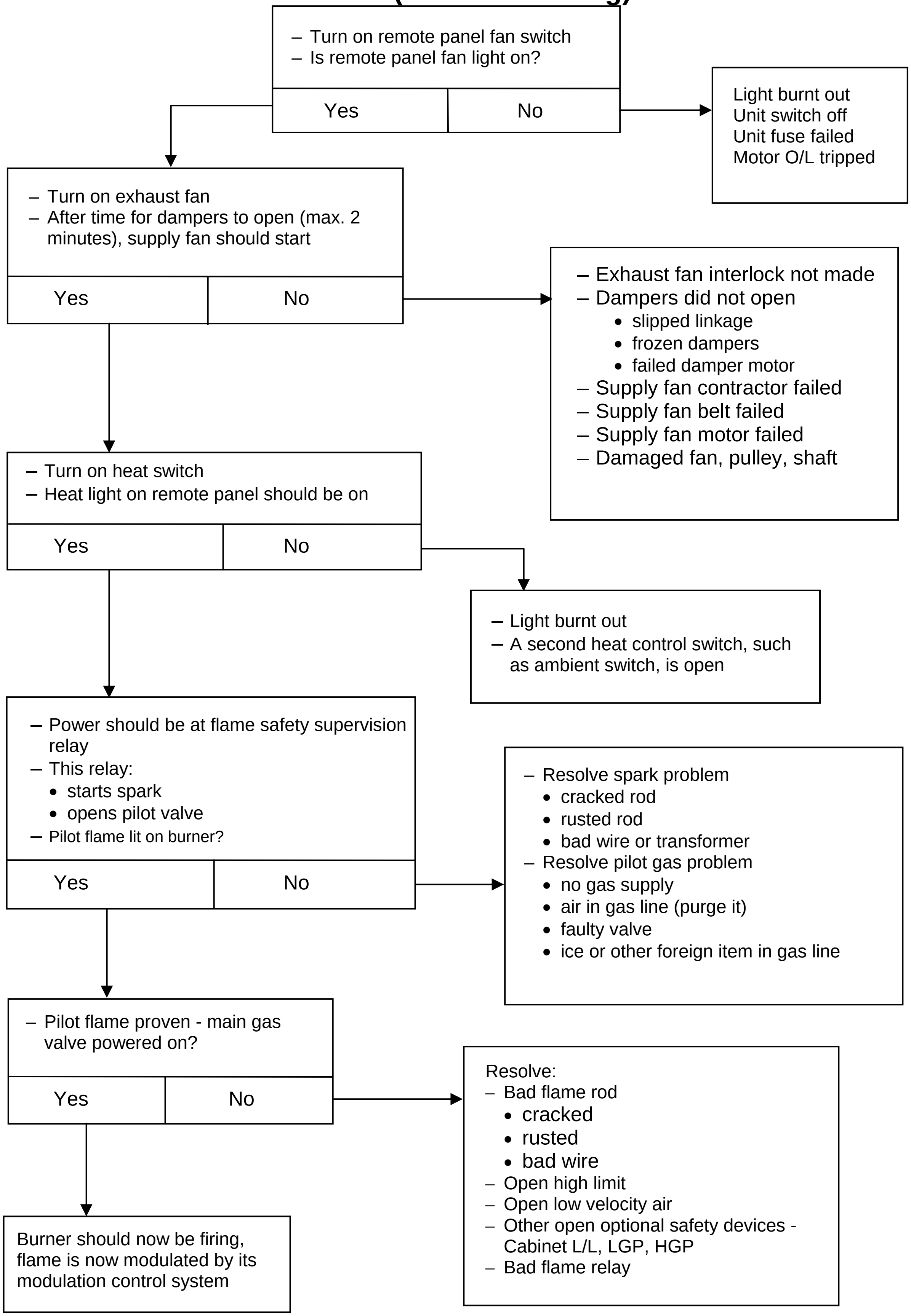
Second Flame Rod Location

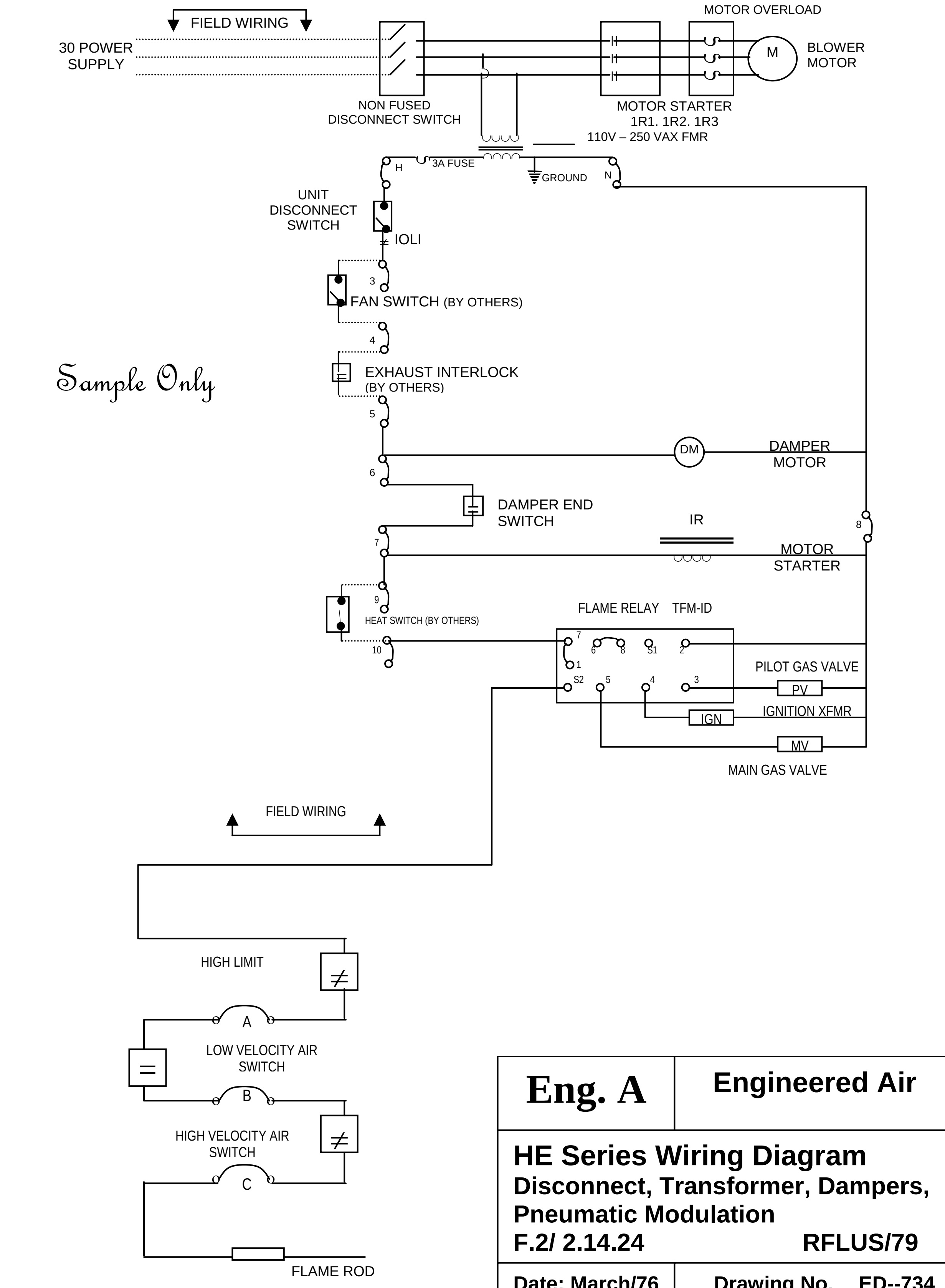
If the burner being used is a very long burner, there will be a second flame rod. The first flame rod is used to prove the pilot. After the pilot is proven, the main flame starts and the flame rod is switched to the other flame rod to prove that the rest of the burner has lit. This is a special flame rod with a bend in it and it is mounted into a special holder. Do not attempt to substitute a normal flame rod or a normal holder for this location.

Orifice Sizes

Midco burner main gas orifices are 31, primary air holes 40.
Eng. A burner main gas orifices are 42, there is no primary air.
Pilot orifice size 55 for both.

HE UNIT (Standard Wiring)

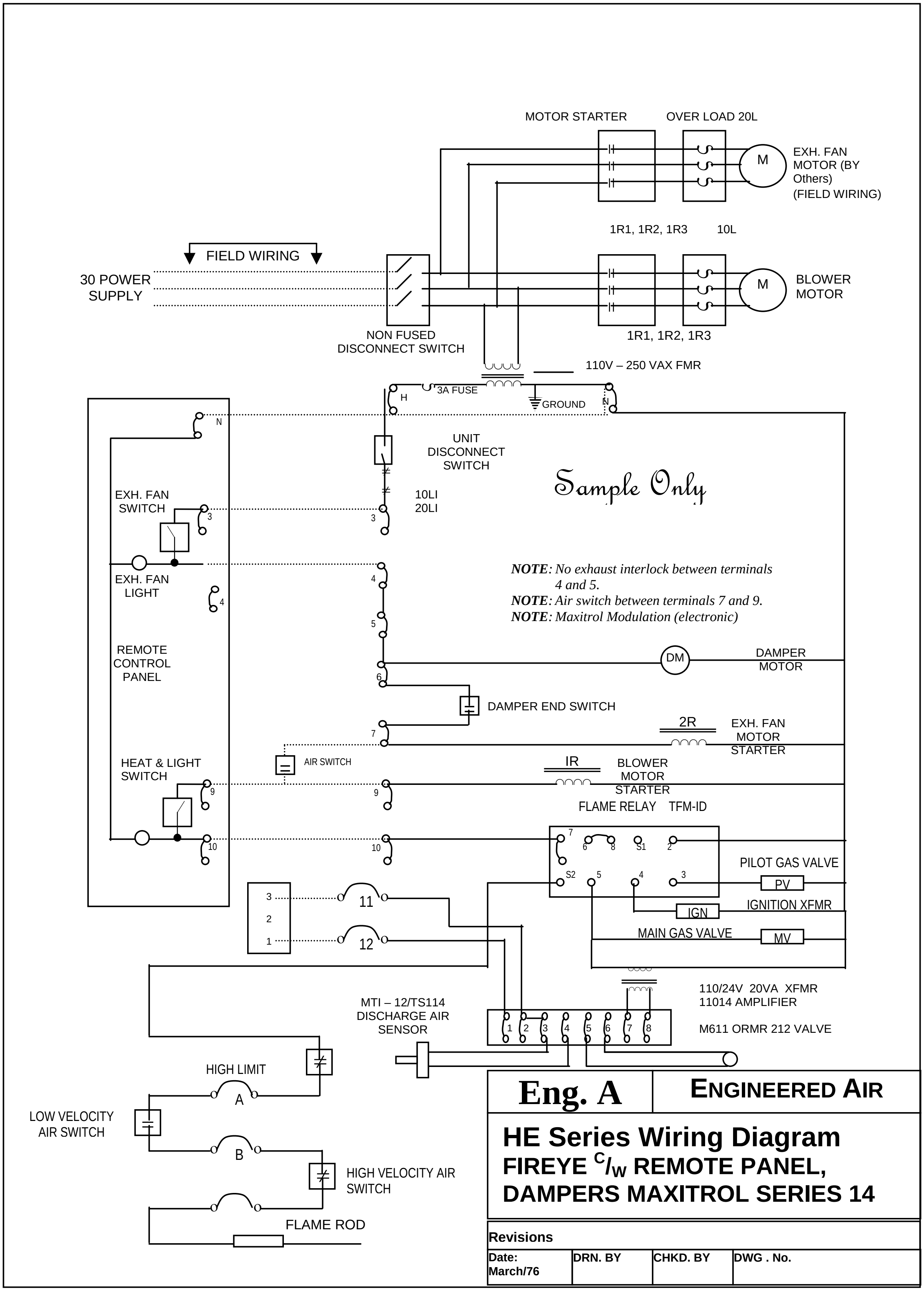




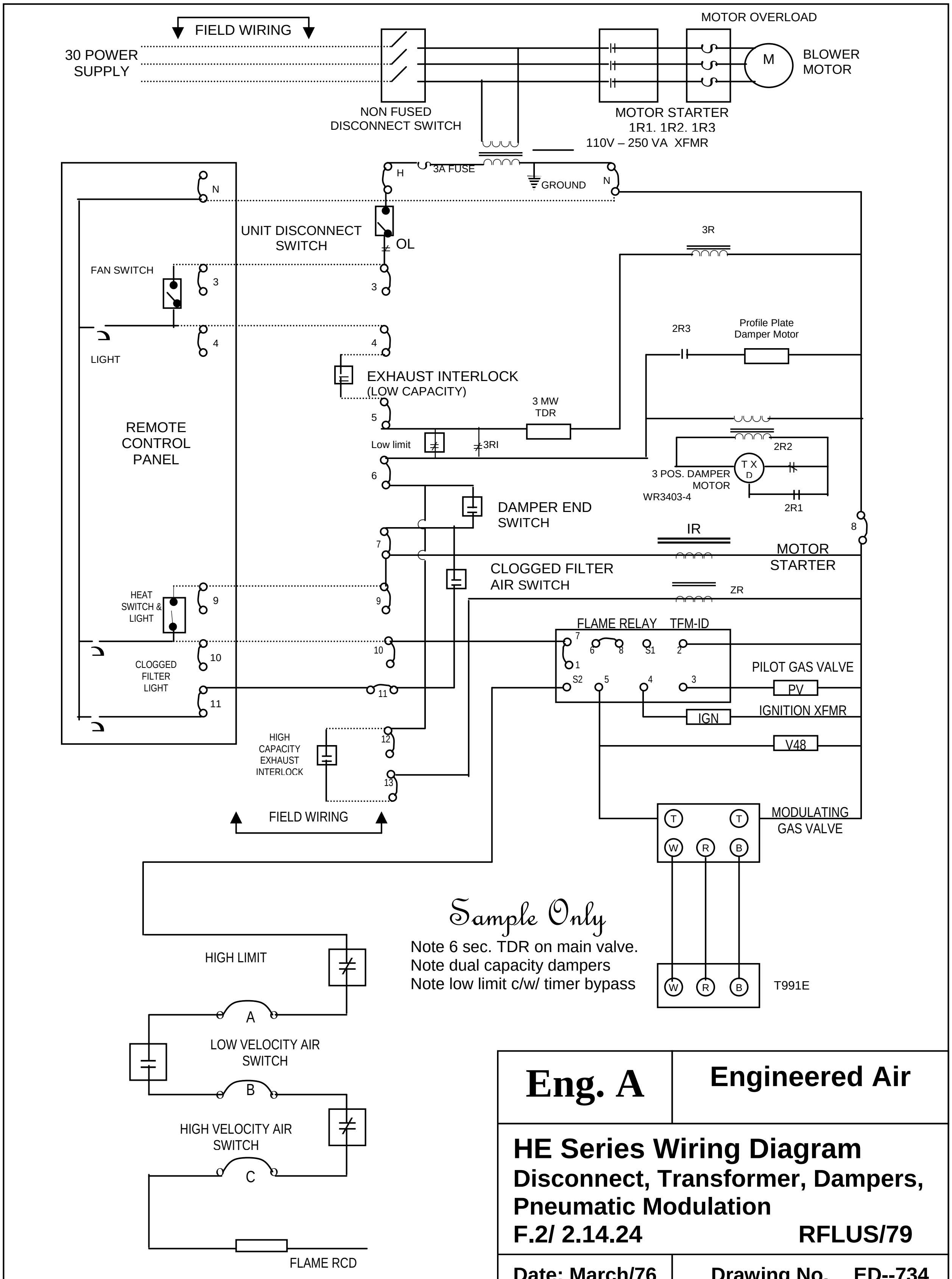
Eng. A | **Engineered Air**

HE Series Wiring Diagram
Disconnect, Transformer, Dampers, Pneumatic Modulation
F.2/ 2.14.24 RFLUS/79

Date: March/76 | **Drawing No. ED--734**



MOTOR STARTER
OVER LOAD 20L
EXH. FAN MOTOR (BY Others) (FIELD WIRING)
1R1, 1R2, 1R3
10L
FIELD WIRING
30 POWER SUPPLY
BLOWER MOTOR
NON FUSED DISCONNECT SWITCH
1R1, 1R2, 1R3
110V – 250 VAX FMR
3A FUSE
H
GROUND
N
UNIT DISCONNECT SWITCH
Sample Only
EXH. FAN SWITCH
10LI
20LI
EXH. FAN LIGHT
NOTE: No exhaust interlock between terminals 4 and 5.
NOTE: Air switch between terminals 7 and 9.
NOTE: Maxitrol Modulation (electronic)
REMOTE CONTROL PANEL
DM
DAMPER MOTOR
DAMPER END SWITCH
2R
EXH. FAN MOTOR STARTER
AIR SWITCH
HEAT & LIGHT SWITCH
IR
BLOWER MOTOR STARTER
FLAME RELAY TFM-ID
PILOT GAS VALVE
PV
IGN
IGNITION XFMR
MAIN GAS VALVE
MV
11
12
110/24V 20VA XFMR
11014 AMPLIFIER
MTI – 12/TS114 DISCHARGE AIR SENSOR
M611 ORMR 212 VALVE
HIGH LIMIT
A
LOW VELOCITY AIR SWITCH
B
HIGH VELOCITY AIR SWITCH
FLAME ROD
Eng. A
ENGINEERED AIR
HE Series Wiring Diagram
FIREYE C/W REMOTE PANEL,
DAMPERS MAXITROL SERIES 14
Revisions
Date: March/76
DRN. BY
CHKD. BY
DWG . No.



Eng. A | **Engineered Air**

HE Series Wiring Diagram
Disconnect, Transformer, Dampers, Pneumatic Modulation
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