Pilot valve and igniter does De-energize after 10 seconds.
Set air actuator to CW (switch to the right)

General Service Bulletin

SZ – SB – 55

Library	Service Literature
Product Section	UNITARY
Product	Rooftop Air Conditioning
Model	Commercial Single Zone
Literature Type	General Service Bulletin
Sequence	55
Date	December 21, 2001
File No.	SV-UN-RT-SZ-SB-55
Supersedes	NEW

SUBJECT:

SFHF, and SFHG Large Rooftop Modulating Gas Furnaces.

INTRODUCTION:

The purpose of this Service Bulletin is to discuss the Design, Set up, and Operation of the Modulating Gas Heater used in the SFHF and SFHG Large Rooftop Products.

The topics to be discussed are:

A. Discussion
   - Table 1 – Furnace Capacity

B. Design History

C. Typical Gas Train Piping and Assembly Connections
   - Figure 1 – Typical 500 MBH, 850 MBH and 1000 MBH furnace
   - Table 2 – Main Gas Pipe Sizing

D. Honeywell Ignition Control System
   - Sequence of Operation
   - Typical Wiring Diagrams
     - Figure 2 – Honeywell Natural Gas
     - Figure 3 – Honeywell Propane Gas

E. Furnace Start Up
   1. Flame Sensing and Flame Current
   2. Orifices
      Figure 6 – Main Orifice Depth
   3. Combustion Air
   4. Gas Pressure
      Table 4A – Manifold Gas Pressures, and CO2 Percentages
      Table 4B – Percentages of O2
   5. CO2 and O2 Ratios in Flue Products
      Figure 7 (Inset A) – Natural and Propane Gas Combustion Curve
      Figure 7 (Inset B) – Flue Gas Sampling
   6. Flame Adjustment

F. CFM verses Temperature Change
   - Table 5 – Delta T verses CFM

G. Flue Temperatures
   - Figure 8 – Flue Loss with Natural Gas

A. DISCUSSION

There are Three (3) optional sizes of Modulating Gas Heaters that can be incorporated in the Large Rooftop Units. They are available in Fully Modulating and Limited Modulating versions. The Fully Modulating version will modulate down to 125,000 BTU input (pilot). The Limited Modulating version will modulate down to approximately 33% of input .

The standard gas heat exchanger drum and front/rear headers are constructed of 409 stainless steel and the tubes are constructed of 304 stainless steel. This is used for both the Two Stage and Limited Modulating options. This construction can be applied when mixed air temperature across the heater is 50 F or greater.

The Fully Modulating gas heat exchanger drum, tubes, and front/rear headers are constructed from AL-6XN or 25-6MO, two of the most corrosion resistant austenitic stainless steel alloys available. This construction is capable of withstanding the highly acidic condenstate that can form with mixed air temperatures below 50 F. This is why the Fully Modulating heat option carries a 10 year warranty as standard.

Table 1 list the Rooftop Unit size, Available Gas Furnace Size, and the Ignition Control System supplied with each Furnace.

B. DESIGN HISTORY

The first modulating gas heaters were built in early 1996 as Design Specials. The design has changed little since then. The Ignition Module was upgraded to a newer version by Honeywell shortly after production began.

Table 1

Unit Size	“Low Heat”	“High Heat”	IGN Control
20, 25, 30, 40 Ton	N/A	500 MBH	Honeywell
50, 60, 70, 75 Ton	500 MBH	850 MBH	Honeywell
90, 105, 115, 130 Ton	N/A	1000 MBH	Honeywell

C. TYPICAL GAS TRAIN PIPING AND ASSEMBLY CONNECTIONS

Figure 1 shows the typical gas train for the 500 MBH - 1000 MBH furnace. The main gas piping can be piped through the base within the furnace compartment or from the outside of the unit through the 1¼ inch access provided in the vertical support panel. The gas supply line must be field connected to the elbow located inside the gas heat control compartment. To assure sufficient gas pressure at the unit, refer to unit IOM for guidelines to determine the appropriate gas pipe size for the unit heating capacity. Before connecting the Gas Train to an existing gas line that supplies other appliances, verify that the existing line is large enough to handle the additional furnace.

Locate an appropriately sized gas pressure regulator at each unit to assure that the proper gas supply pressure is maintained. Over sizing the regulator can cause irregular pulsating flame patterns, burner rumble, potential flame outages, and may damage the gas valve. If one pressure regulator serves more than one unit furnace, it must be sized to assure that the inlet gas pressure at each furnace is 7" to 8" w.c. while all furnaces are operating on "High" fire, but does not exceed 14" w.c. or 0.5 psi when all furnaces are off.

CAUTION: Inlet gas pressure in excess of 14" w.c. or 0.5 psi gauge pressure will damage the gas valve.

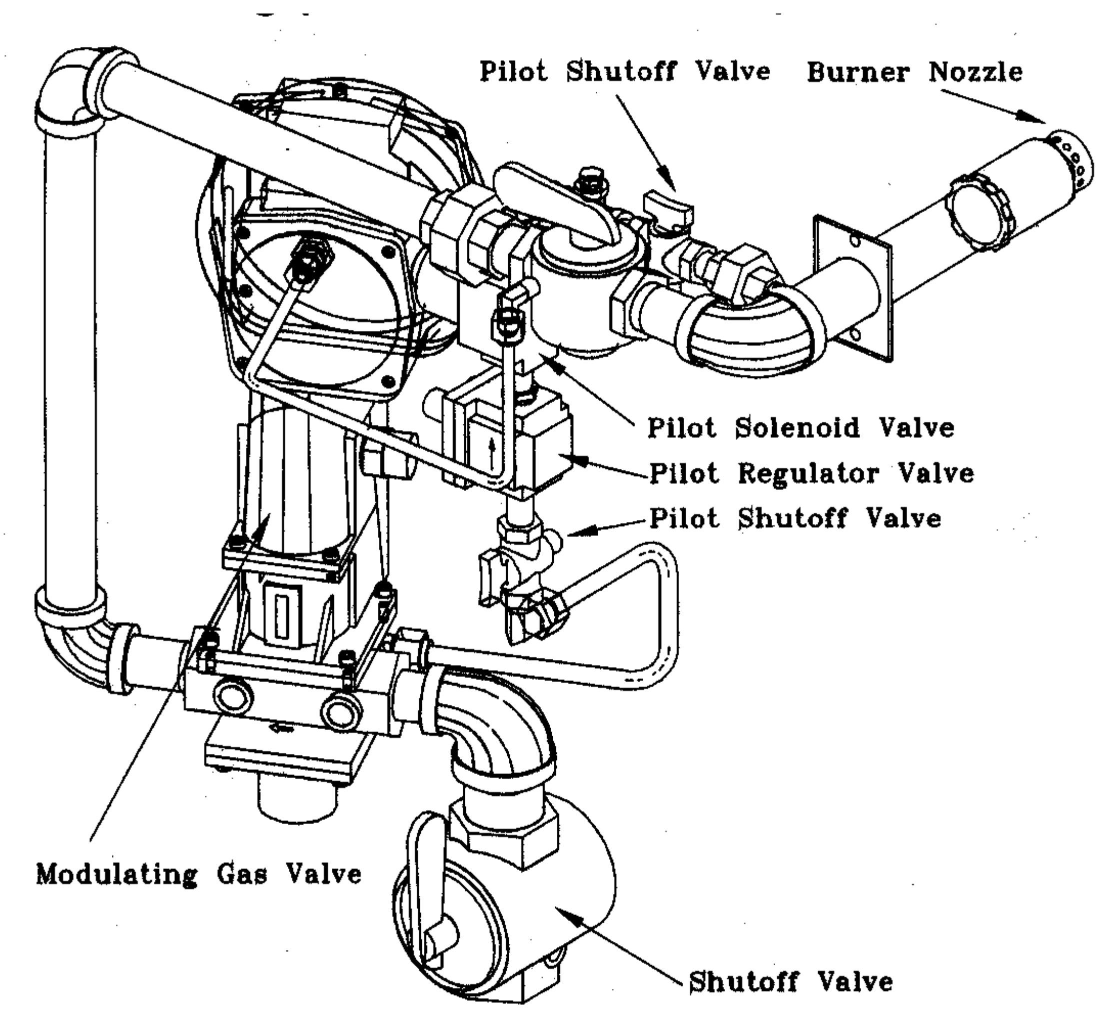
Connecting the Gas Supply Line to the Furnace:

1. Be sure the "take-off" piping is from the top or side of the main pipe to prevent moisture from being drawn in with the gas.
2. Use "ground-joint" type unions for all pipe connections. Ensure that all joints are adequately coated with joint sealant and properly tightened.

   IMPORTANT: Use a joint sealant that is resistant to LP gases.
3. Provide a drip leg in the field installed gas piping near the unit.
4. Provide adequate support for the gas piping to avoid stressing the gas train and controls.
5. Leak test all field installed gas piping using a soap and water solution.

WARNING! Never use an open flame to check for gas leaks; an explosion could result, causing severe injury or death.

Figure 1
Typical Piping 500 – 1000 MBH
Modulating Gas



CAUTION: Do not rely on the shutoff valves to isolate the unit furnace while conducting gas pressure test. These valves are not designed to withstand pressures exceeding 0.5 psi or 14" w.c..

6. Verify that the supply pressure does not exceed 0.5 psi gauge pressure or 14" w.c. before making the final connection to the furnace gas train. If the pressure is excessive, reduce supply gas pressure before proceeding to prevent potential damage to the gas train.

   WARNING! If the gas valve is damaged, the presence of a gas leak creates the hazard of an explosion.

7. Connect the field gas piping to the furnace gas train and leak check.
8. Adjust the inlet gas pressure to approximately 12" w.c. with the furnace off. This will give some margin from the maximum pressure and assist in maintaining the minimum supply gas pressure at the unit of 7" to 8" w.c. while the furnace is operating on "High" fire.

D. HONEYWELL IGNITION CONTROL SYSTEM

The Honeywell ignition control system is used in all of the large rooftop modulating furnaces with capacities of 500 MBH, 850 MBH, and 1000 MBH. This system is designed to retry for ignition three (3) times should a flame failure or a pilot ignition failure occur. The furnace control components with their respective timing delays and settings are listed below. Refer to these components as they are positioned in the wiring diagram in Figures 2 and 3 to develop an understanding of the furnace operation.

NATURAL GAS (Standard Unit)

1K16 Aux – Supply Fan Contactor
1U50 - Heat Module
3U72 - Supply Fan VFD
4B11 – Combustion Blower Motor – Supplies air to the furnace for combustion.
1725 RPM on low speed. (500 MBH)
3450 RPM on high speed. (850 and 1000 MBH)
4E1 - Electrode – Auburn spark plug igniter. Gap is set at 0.10".
4HR11 - Gas Valve Heater – 70 W at 120 VAC to warm valve during low ambient operation.
4K117 - Heat Relay
4K118 - Heat Interlock Relay
4K119 - Actuator Interlock Relay
4K120 - Heat Fail Relay
4L22 – Gas Valve Solenoid – Gas valve requires external heater when operated below 15 F.
4L9 – Pilot Solenoid Valve – Energized by the ignition control before main gas valve is energized.
4S24 – Control Circuit Switch – Disables 115 volts to the furnace section when opened.
4S25 – Combustion Air Switch – Operating range of 0.10" – 0.25" w.c. rise in differential assures combustion Fan is operating before ignition.
Contacts open at 0.02" – 0.08" w.c. differential.
4S26 – High Limit Cutout – High Temperature limit set to cutout at 250 +/- 15 degrees F, Closes at 210 degrees F.
4S38 – Supply Airflow Switch – Closes when the supply duct pressure is above 0.15" + 0.05 w.c. rise in pressure differential.
Contacts open at 0.03" – 0.12" w.c. deadband.
4S75 - Gas Valve Heater T-Stat. Closes at 20 F. Opens at 35 F.
4T7 – Ignition Transformer - 115 volt primary / 6000 volts secondary.
4U18 – Honeywell Ignition Control Board
4U19 – Auburn Flame Rod – Senses flame (remote sensing)
4 inches in length.
Normal Flame current should be at least 2 to 5 Micro-Amps.

- The control board 4U18 will de-energize the output control relay and close the gas valve when the flame currant fails to produce more than 2 Micro-Amps.

4U82 - Combustion Air Actuator

PROPANE GAS

4DL4 – Post Purge Time Delay – Allows combustion fan to purge combustion chamber on the off cycle
Normally open, 60 seconds +/- 15 sec. Timed closed. 15 seconds +/- 10 sec. Timed open when de-energized.

1. SEQUENCE OF OPERATION

Honeywell Ignition System
Natural Gas

As you review sequence of operations below, refer to the heat schematic Figure 2 or 3 and keep these points in mind:

1. The furnace will not light unless the manual gas valves are open and the control circuit switch 4S24 is closed.
2. The control systems are wired to ensure that heating and cooling cannot occur simultaneously.
3. The unit supply fans must run continuously so air flow switch 4S38 will stay closed.
4. The Combustion Air Actuator (4U82) drives closed when not actively heating or Actuator Interlock Relay (4K119) is open. This opens the combustion air damper to provide a complete pre-purge of the heat exchanger prior to ignition. The combustion air damper auxillary switch (4U82 AUX) is closed when the actuator is fully closed (damper full open).
5. The Combustion Air Actuator (4U82) is reverse acting.
6. The heat exchanger fires on high and then is allowed to modulate to the commanded position.

When a heating requirement exists, K1 contacts on the Heat Module (1U50) close and energizes the heat relay (4K117). The heat relay (4K117) starts the combustion blower motor (4B11) on low speed for 500 MBH or high speed for 850 and 1000 MBH. The heat relay (4K117) also provides power to the remainder of the heating circuit through a second set of contacts. The supply airflow switch (4S38) and the combustion air switch (4S25) close. Power is applied through the high limit cutout (4S26), combustion air actuator end switch (4U82 AUX) and the Gas Valve proof of closure switch (4L22 P.O.C.) to the Honeywell ignition control board (4U18). The ignition control board (4U18) starts a 60-second prepurge timing cycle. At the end of the prepurge cycle, the ignition transformer (4T7) and the pilot solenoid valve (4L9) are energized. This starts a 10-second trial for pilot ignition. When the pilot flame is established and sensed by the flame sensing rod (4U19), the main gas valve (4L22), Heat Interlock Relay (4K118), and Actuator Interlock Relay (4K119) are energized. The Heat Interlock Relay (4K118) bypasses the 4U82 AUX and the 4L22 POC switches so that power is not interrupted when they modulate. The Actuator Interlock Relay (4K119) contacts allow the command signal from the Heat Module (1U50) to modulate the Combustion Air Actuator (4U82). If the flame rod (4U19) does not detect a pilot flame within a 10 second trial for ignition period, the control will shut down and lockout.

At this point the furnace is operating. The feedback signal from the discharge temperature sensor will cause the Heat Module (1U50) to change the damper position as required to maintain the outlet temperature within the desired band. The Gas Valve (4L22) monitors gas pressure and combustion air pressure and modulates to maintain the proper air/fuel mixture as the combustion air damper is modulated.

If a flame failure occurs during operation, the gas valve (4L22), the Heat Interlock Relay (4K118) and the Actuator Interlock Relay (4K119) are de-energized. The system will purge and attempt to re-light the pilot once the Combustion Air Actuator (4U82) and the Gas Valve (4L22) close. If the flame is not detected after this attempt, the Honeywell ignition control (4U18) will lock out. The combustion blower motor will continue to operate as long as a heating demand exists and the system switch (4S24) is on.

Once the heating demand has been satisfied, the combustion blower and the Honeywell ignition control board (4U18) is de-energized by the Heat Module (1U50), shutting the system off.

PROPANE GAS

Units that operate on propane gas have one (1) additional control that affects the combustion blower motor operation.

With the post purge time delay relay (4DL4), the sequence of operation is as follows:
Once the heating demand has been satisfied, the Honeywell ignition control board (4U18) and the post purge time delay relay (4DL4) is de-energized. The combustion blower motor will continue to operate for approximately 15 seconds to purge the heat exchanger on the off cycle.

E. FURNACE START UP

1. FLAME SENSING and FLAME CURRENT

In the Honeywell ignition system, flame is sensed by the “flame rectification” method. This method relies on the flame’s ability to conduct current when an AC voltage is applied across two points within the flame. The AC current flows from the flame rod through the flame to the grounding surface and back at a rate of 60 cycles per second. Flame heat causes the molecules between the flame rod and the grounding surface to collide, causing displacement of electrons. This process is called “Flame Ionization.” Positive charged ions will flow to the negative charged pole while negative charged ions will flow to the positive charged pole. Because the ground surface area is designed to be greater than the flame rod, more current flows in one direction than the other. For effective operation, the area of the ground surface must be at least 4 times that of the flame rod. When the flame rod is positive, more current flows to the negative ground surface. With the current flow in one direction so much larger than the current in the other direction, the resultant current is, effectively, a pulsating direct current or rectified current referred to as “Flame Current” which operates the electronic network. The flame relay pulls in, indicating the presence of a flame and allowing the burner sequence to continue. The strength of the “Flame Current” gives a good indication of the efficiency and flame stability with reference to flame rod placement within the flame pattern.

Typically, the flame current for a Honeywell ignition system will operate between 2 to 5 micro-amps. The control will close the gas valve and restart ignition sequence should the current fall below 2 micro-amps.

Checking Flame Current: Measure the DC voltage on the ignition module as shown below. The voltage Should be between 2 and 5 VDC.

Low flame signal can be caused by: 1. Low Gas Pressure. 2. Dirty flame rod. 3. Flame rod insulator too hot (should be less than 500 F) 4. Poor electrical connections.

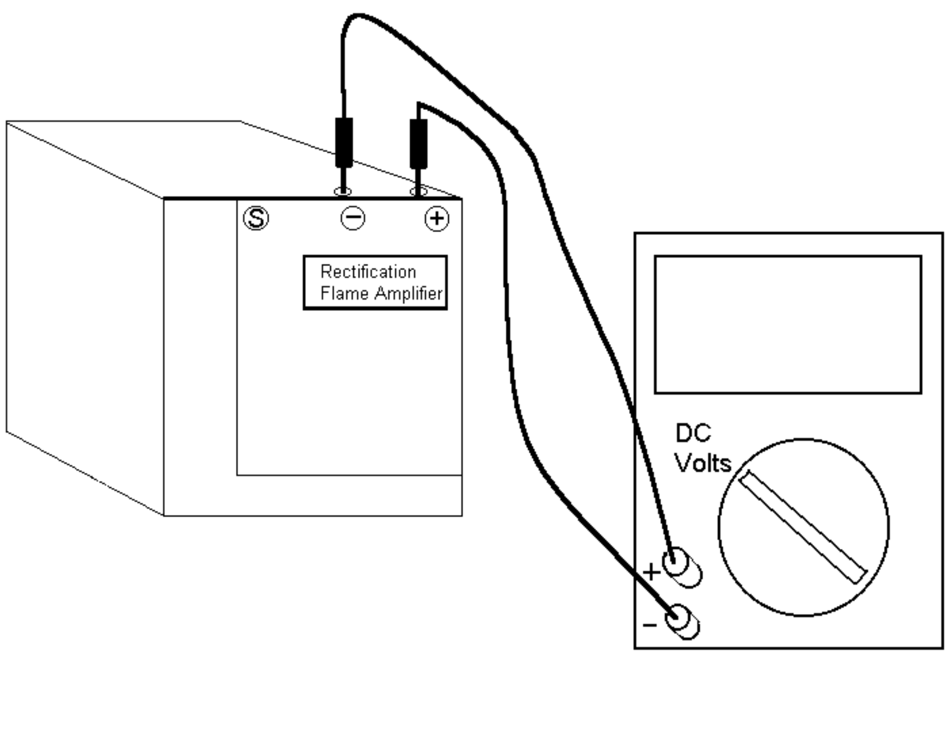


Figure 2 – Heat Control Schematic - Natural Gas

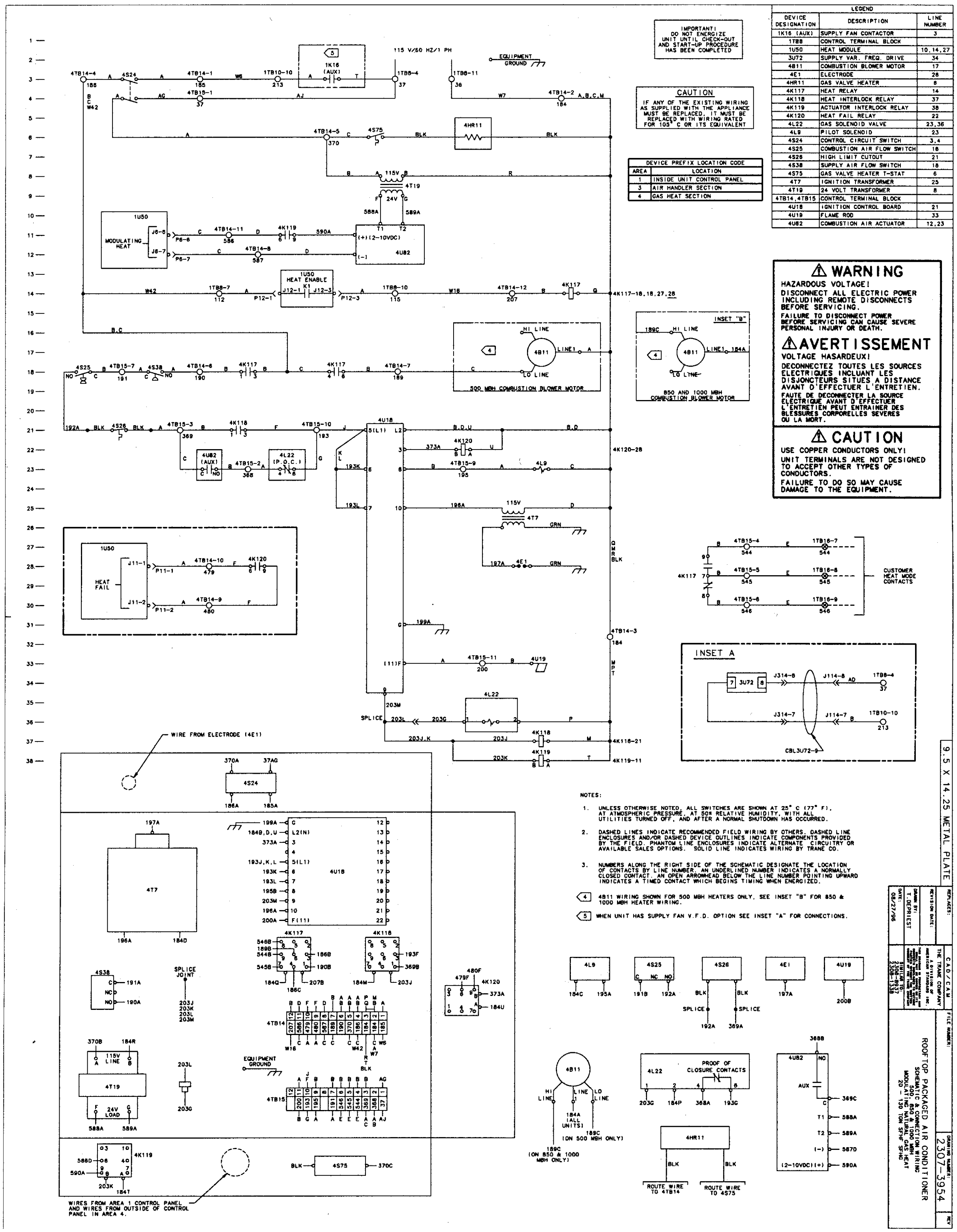
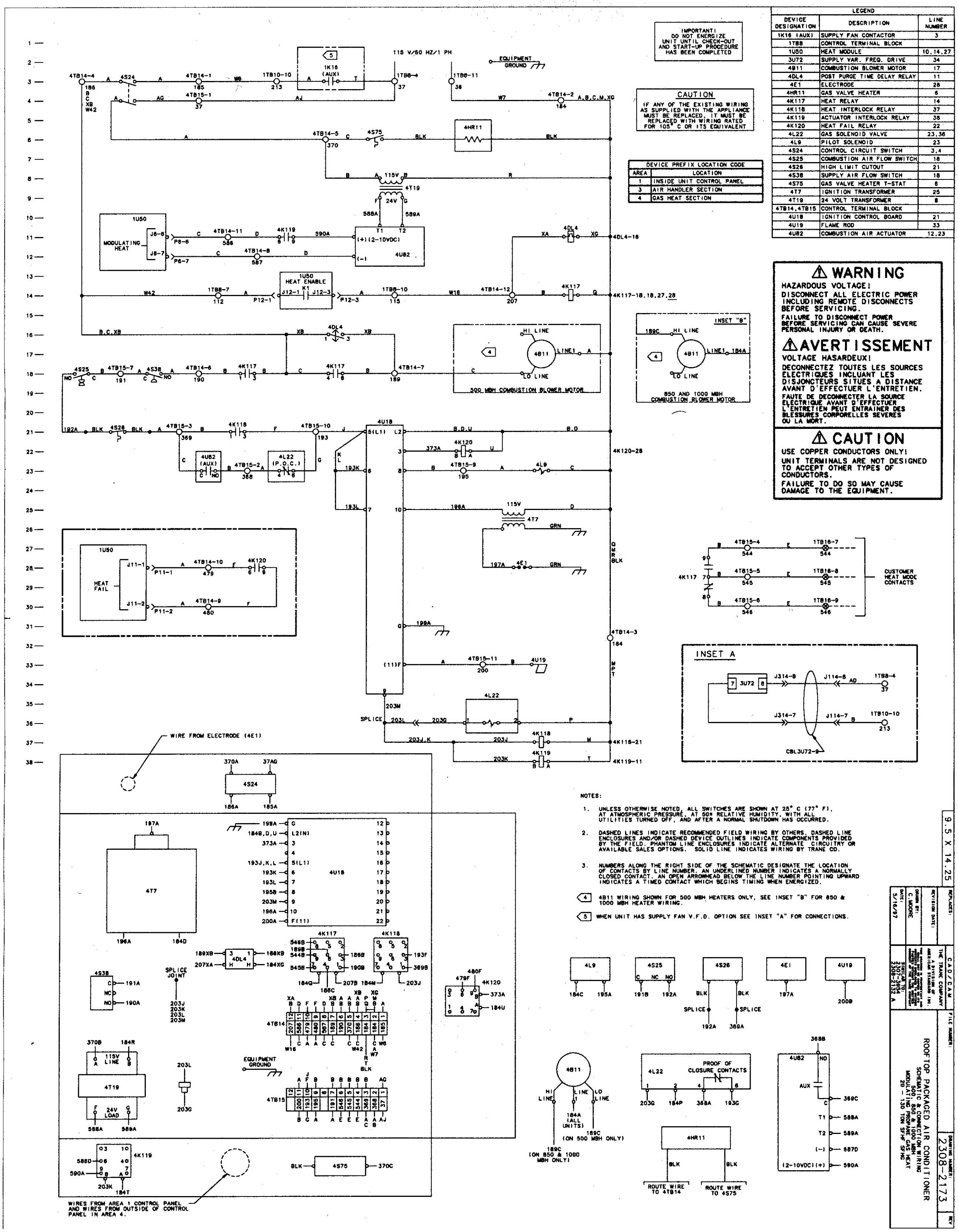


Figure 3 – Heat Control Schematic - Propane



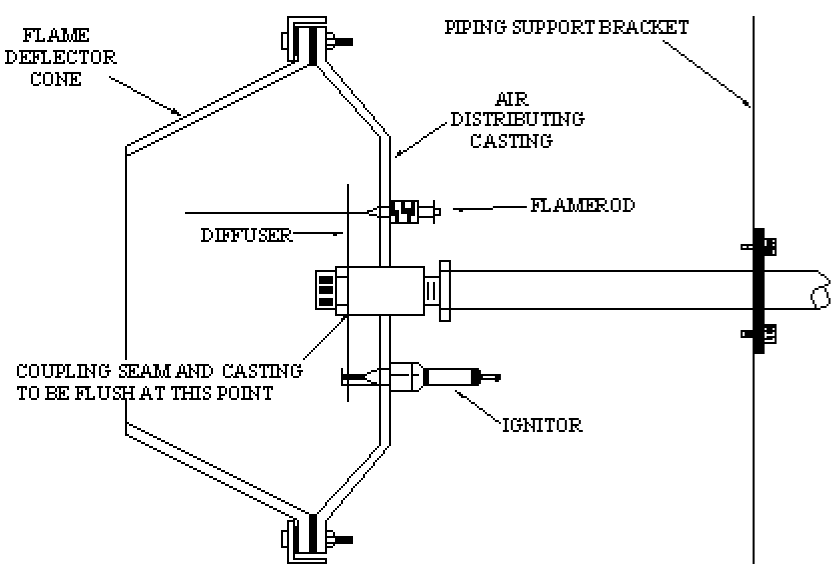
2. ORIFICES

The proper orifice for a given furnace is very important. An oversized orifice can over fire the furnace, causing pulsating (rumbling) combustion and possible sooting. An orifice too small will give an excessively lean fuel mixture resulting in a very hot flame around the igniter and flame sensing rod causing component break down.
Each orifice assembly is comprised of several orifice holes located around the outer perimeter of the assembly. The size of the orifice in conjunction with manifold gas pressure determines the "rate" or "amount" of gas flowing into the furnace.
The depth of the main orifice into the burner assembly has a direct bearing on the flame shape and a successful ignition process. Figure 6 illustrates the proper orifice depth with relation to the air diffuser plate.
When the orifice is inserted correctly into the burner assembly, the seam between the brass and the mating coupling will be aligned flush with the air diffuser plate. This is accomplished by measuring the distance from the outside opening in the combustion air chamber to the inside of the air diffuser plate. Using this measurement, measure from the inside of the welded metal support bracket on the gas train tot he orifice/coupling seam. Screw the coupling (on the pipe end) In or Out as required to match the proper measurement. Tighten the locknut against the coupling after adjustments are complete.

3. COMBUSTION AIR

It is important to establish and maintain the appropriate air/fuel mixture to assure that the gas furnace operates safely and efficiently. The volume of air supplied by the combustion fan determines the amount of oxygen available for combustion, while the manifold gas pressure establishes fuel input. By measuring the percentage of carbon dioxide produced as a by-product of combustion, the amount of oxygen used can be estimated. By modifying the manifold gas pressure using the adjustment screws on the Gas Valve (4L22), the proper air/fuel ratio can be obtained. By arriving at the proper air/fuel mixture, the furnace produces rated output, limited production of carbon monoxide, and a steady flame that minimizes nuisance shut downs.

FIGURE 6
Main Orifice Depth
Natural and Propane Gas



Picture shown is for 500 MBH, 850 MBH, and 1000 MBH Furnace for Natural and propane Gas. Orifice Depth and alignment procedure for 235 MBH and 350 MBH Furnaces are identical.

Possible causes of low combustion airflow:

1. Improperly installed combustion air damper
2. Improper fan speed
3. Incorrect direction of rotation
4. Dirty or obstructed fan wheel
5. Gasket between the air distributor plate and burner cone leaking

These problems can be diagnosed and corrected as follows:

1. Check CO2 and O2 air/fuel ratio according to Table 4A and 4B.
2. Check the blower RPM. The RPM's are stamped on the motor nameplate. All blowers are two speed direct drive fans.
3. Check for proper blower rotation and blade profile.
4. Check blower for accumulation of dirt and other debris on the blades which results in reduced air supply.
5. The gasket around the burner cone should also be checked. If the gasket does not cover the full circumference of the cone, leaks will occur and the air pattern becomes distorted causing poor flame patterns and ignition problems. Check the burner cone for cracks and/or broken sections. This could cause furnace rumble and ignition problems due to distorted air and flame patterns.

4. GAS PRESSURE

Table 4A list the minimum and maximum manifold gas pressure and carbon dioxide (CO2) percentages for natural and propane gas units. Table 4B list the oxygen (O2) percentages for natural and propane gas units. The manifold gas pressures are not to be confused with supply pressures mentioned earlier. Establishing the proper manifold gas pressure with in the minimum and maximum allowable range is dependent on the specific BTU content of the gas for a given locale. For this reason, furnaces should be set up according to CO2 and O2 levels rather than just manifold gas pressure.

5. CO2 AND O2 RATIOS IN FLUE PRODUCTS

In a given heat exchanger, by maintaining a constant manifold gas supply and varying the combustion air flow, carbon dioxide (CO2) and oxygen (O2) percentages can be obtained. Zero percent of O2 means that the volume of air supplied is the exact amount required to completely burn a given volume of air supplied is the exact amount required to completely burn a given volume of fuel. However, to achieve a good flame, some excess oxygen (O2) is required. Figure 7 (Inset A) represents the combustion Curve for both Natural gas and Propane gas. Notice that as the percent of O2 increases, the percentage of CO2 decreases.

A good flame at "HIGH FIRE" should support a CO2 percentage of 9.0 to 9.5 for natural gas and a 10.0 to 10.5 percent for Propane gas. In the same way, a good flame should support an O2 percentage reading of 5.25 to 4.5 for natural gas and a 6.0 to 5.5 percent for propane gas. Table 4A and 4B list the appropriate CO2 and O2 percentages for both "High" and "Low" fire for each furnace capacity.

High CO2 readings which result from incomplete combustion produces carbon monoxide (CO), a lethal gas which can reach dangerous levels. The flame will appear bright yellow and sooting occurs. In extreme cases, flame roll-out occurs due to it seeking oxygen (O2) to sustain combustion brought on by the sooting backing up the flue gases and starving the flame within the heat exchanger. In this case, the flame will be a hazy blue with an undefined shape or contour.

Table 4A
Minimum and Maximum Manifold
Gas Pressures
Natural and Propane Gas

Furnace stage	MBH	Firing rate	% CO2 Natural	% CO2 Propane	Manifold Natural	Pressure Propane
High Fire	235	100%	9.0-9.5	10.0-10.5	3.0-3.5	9.5-10.5
Low Fire	117	50%	6.5-7.0	7.5-8.0	0.9	2.5-3.0
High Fire	350	100%	9.0-9.5	10.0-10.5	3.0-3.5	9.5-10.5
Low Fire	175	50%	6.5-7.0	7.5-8.0	0.9	2.5-3.0
High Fire	500	100%	9.0-9.5	10.0-10.5	3.0-3.5	9.5-10.5
Low Fire	250	50%	6.5-7.0	7.5-8.0	0.9-1.25	3.0-3.5
High Fire	850	100%	9.0-9.5	10.0-10.5	3.0-3.5	9.5-10.5
Low Fire	500	60%	6.5-7.0	7.5-8.0	0.9-1.25	3.0-3.5
High Fire	1000	100%	9.0-9.5	10.0-10.5	3.0-3.5	9.5-10.5
Low Fire	600	60%	9.0-9.5	10.0-10.5	0.9	3.0-3.5

TABLE 4B
Minimum and Maximum %O2
Natural and Propane Gas

Furnace Capacity	Firing Rate	% O2 Natural	% O2 Propane
235 - 850 MBH	High	5.25-4.5	6.0-5.5
	Low	9.5-8.75	9.75-9.0
1000 MBH	High	5.25-4.5	6.0-5.5
	Low	Same as High	

Note: %O2 is listed as its relation to %CO2 is listed in the above chart.

6. FLAME ADJUSTMENT

An incorrect content of either carbon dioxide (CO_2) or oxygen (O_2) indicates combustion is incomplete. The carbon dioxide (CO_2) content is controlled by adjusting the manifold gas pressure. The oxygen (O_2) content is controlled by the adjustment of the combustion air damper. Because of the correlation the oxygen has with the amount of gas being introduced into the combustion chamber, too little oxygen with too much gas can put the carbon dioxide (CO_2) content on the negative side of its curve. The carbon dioxide (CO_2) analyzer does not have the capability of reading negative of positive content. Therefore, by using an oxygen (O_2) analyzer, the CO_2 position on the curve can be established.

NOTE: If the CO_2 is on the negative side of the curve, as the combustion air is increased, the CO_2 measurement will rise and then start to fall on the positive side of the curve as the O_2 content increases.

A. Burner Adjustment

The modulating heaters are pre–adjusted in the factory to give proper air–fuel ratio at firing rates from minimum to the nameplate value for most areas in the country.

1) Set the controller to the test mode.
2) Start the burner and set the firing rate at 90% for at least 15 minutes.
3) To achieve the nameplate capacity, the inlet gas pressure should be between 6-8" w.c. and measured at the modulating valve inlet.
4) Measure the CO_2 content in the flue stack. If the CO_2 is between (7.5-9.5%) then no adjustments are required.

If the CO_2 is outside of the above range, then proceed to the regular adjustment instructions below:
When the CO_2 is adjusted within the proper range at 90% rate, reduce the firing rate to 5%. Let it run for 10 minutes, then check the CO_2 again.

Note: It is normal for the CO_2 to be lower (6-8%) at the minimum rate.

If an adjustment at the minimum rate is needed, it is made by turning the #2 screw in Fig. 1 in the + direction to increase the CO_2 and in the - direction to decrease.

Regulator
The pressure ratio and bias adjustment screws are located on top of the regulator under a sealable plate. The actual settings can be seen through windows on each side of the regulator.

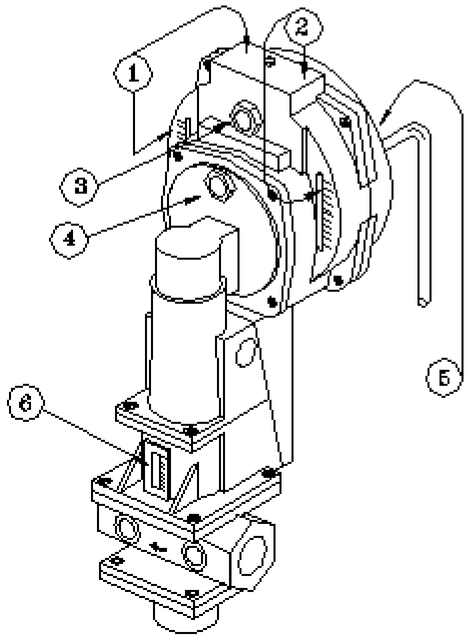
Note: The burner capacity is controlled by the movement of the air damper. This has been preset at the factory and normally does not need field adjustment. The combustion quality (air-gas) is controlled by the settings on the regulator (the + and - indications relate to the change in gas flow).

1. Set the gas to air ratio to the desired value using the adjusting screw 1 (course setting).
2. Start the burner and run it at approximately 90% of full capacity.
3. Measure the CO_2 or O_2 content in the flue gases and correct the ratio by adjusting screw 1 until optimum values between (8.0 and 9.5%) are obtained (course setting).
4. Return to low fire and measure the CO_2 or O_2 content in the flue gases. If necessary, correct the settings by adjusting screw 2 until optimun values are obtained. (6.0-8.0%)

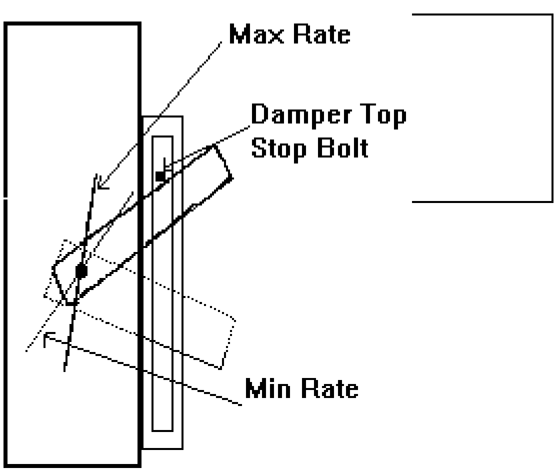
Note: It is normal for the low fire CO_2 to be lower than the high fire.

5. The damper blade touches the right side wall for low fire operation. If considerable parallel displacement was necessary to achieve optimum combustion, repeat the procedure from step 3.
6. Run the burner to the 100% fire position and recheck the CO_2 or O_2 value.
7. Check the flue gas values at several intermediate output levels. If corrections are necessary, note the following:
   Adjust the pressure ratio screw 1 at high fire operation only.
   Full: Adjust the bias screw 2 at low fire operation only.

Connections and Adjustments in Figure 1:



1. Adjustment and indication of the gas to air ratio.
2. Adjustment and indication of the bias.
3. Connection for the Ambient compensation line.
4. Connection for the gas pressure sensing line.
5. Connection for the air pressure sensing line
6. Stroke indication.



If the burner is operating within a normal CO_2 range but the flame is excessively yellow, use an oxygen (O_2) analyzer to measure the O_2 content. Several samples should be taken to assure an accurate measurement. If the O_2 measurement is low, the CO_2 could be on the negative side of the curve, (too much gas) and rated capacities and efficiencies are down. Increase the amount of combustion air by adjusting the air damper located on the combustion air duct. If the air can not be increased, decreasing the manifold gas pressure will increase the O_2 percentage while the CO_2 content will decrease. Refer to Table 4A and 4B for proper balance and operating tolerances. If the manifold gas pressure is set to the lower operating range listed in Table 4A but the oxygen (O_2) content is operating in the upper range listed in Table 4B, increase the manifold gas pressure (Do not exceed the upper limit specified in Table 4A). The CO_2 content is on the proper side of the curve, however, the amount of gas entering the combustion chamber with respect to the amount of air is too low. If the proper CO_2 content can not be obtained within the values listed in Tables 4A, decrease the amount of combustion air by adjusting the air damper located on the combustion air duct.

Modulating Gas Heat Settings

Natural Gas

Heater Size (MBH)	Gas Orifice	Full Modulation Air Damper Actuator Voltage Range (VDC)	Partial Modulation Air Damper Actuator Voltage Range (VDC)	Valve Actuator Left (Coarse) Setting	Valve Actuator Right (Fine) Setting
500	#21	7 - 10	7 - 9.7	2.3	-1
850	#H	6 - 10	6 - 8.7	1.3	-1
1000	#N	5 - 10	5 - 8.7	0.9	0

LP

Heater Size (MBH)	Gas Orifice	Full Modulation Air Damper Actuator Voltage Range (VDC)	Partial Modulation Air Damper Actuator Voltage Range (VDC)	Valve Actuator Left (Coarse) Setting	Valve Actuator Right (Fine) Setting
500	#34/#53	7 - 10	7 - 9.7	6	1
850	#32	6 - 10	6 - 8.7	3.2	1
1000	#29	5 - 10	5 - 8.7	1.9	0

Note: Valve Actuator settings are approximate and may require "fine-tuning" to properly set. Right (Fine) settings given are in notches from the "zero" midpoint location on sight gage.

Air Damper Arm/Auxiliary Switch Diagrams at Fully Closed Position

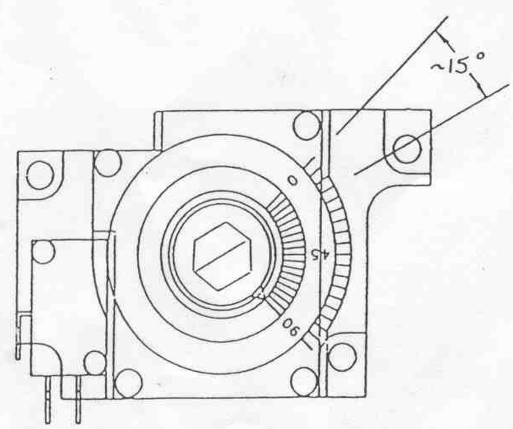


Figure 1

Damper
Shaft Alignment

Damper shaft notch should approximately align with third notch down from 0 position (~15 degrees) on Auxiliary Switch body.

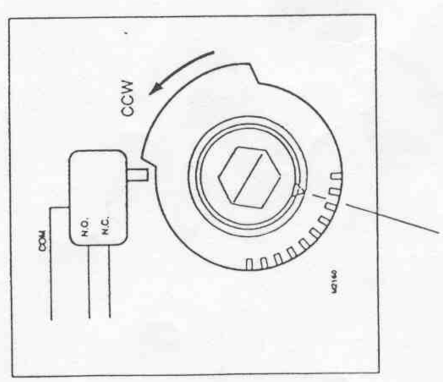
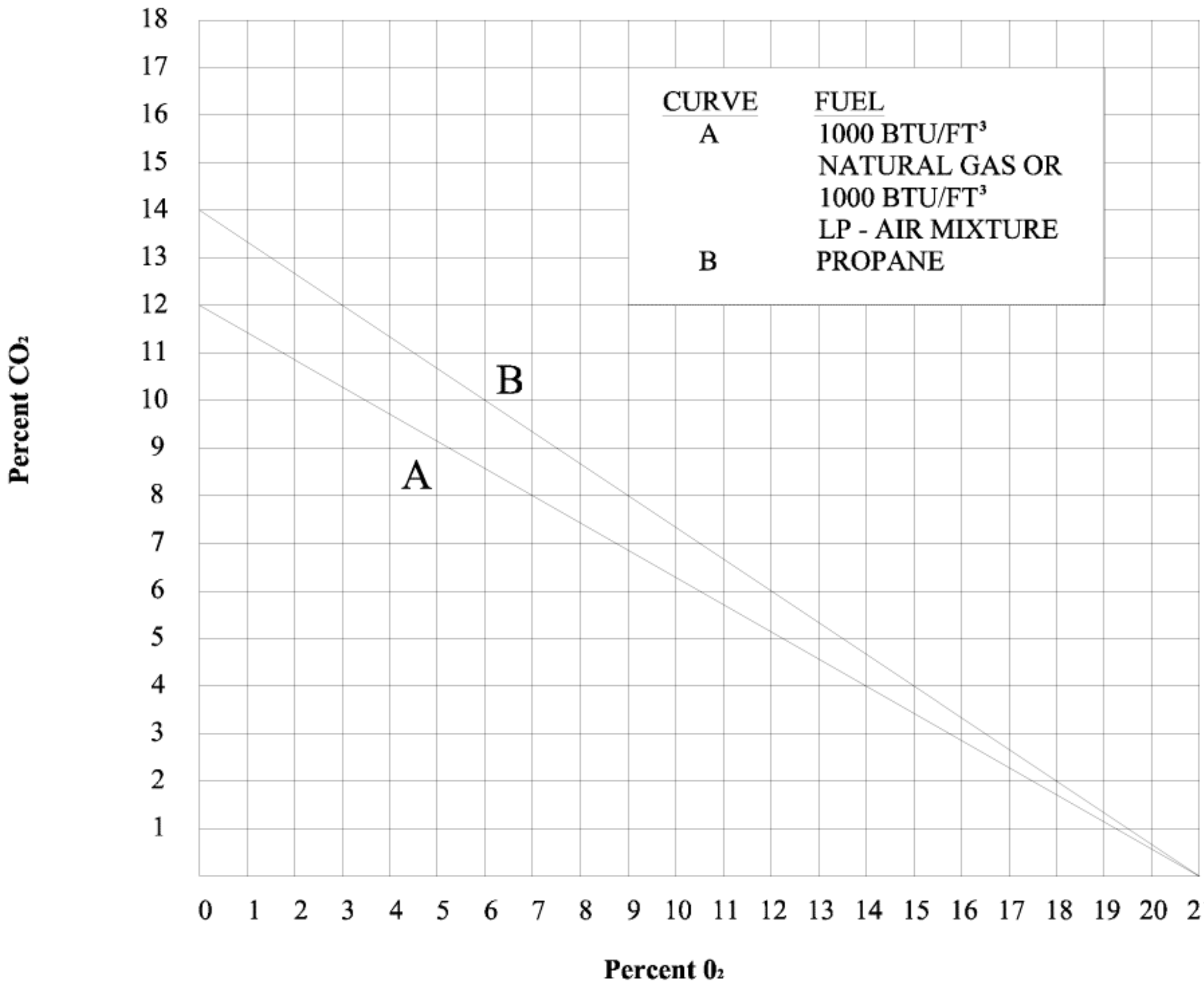


Figure 2

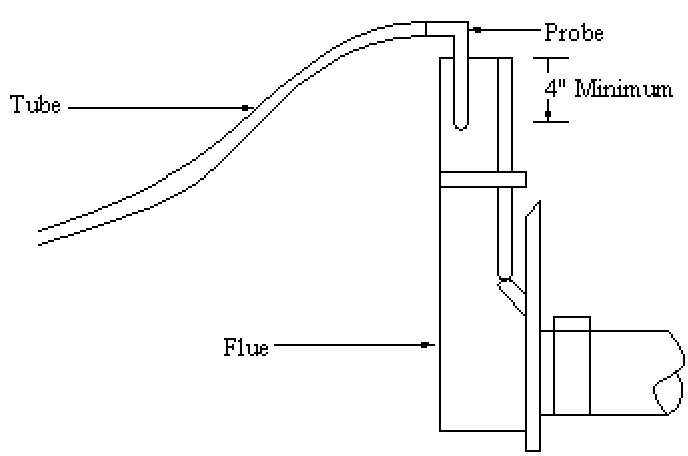
Auxiliary
Switch Alignment

The pointer notch on the white center hub should approximately align with the second notch on the tan Auxiliary Switch adjuster.

Figure 7 (Inset A)
Combustion Curve
Natural and Propane Gas



(Inset B)
Flue Gas Sampling



F. CFM verses TEMPERATURE RISE

To determine the operating temperature rise of any furnace, the actual operating CFM must be known. Inversely, the actual CFM can be determined if the operational temperature rise is known.

Note: Temperature Rise is based on the allowable CFM across the heat exchanger.
Unit minimum and maximum CFM's must not be violated.

Air Temperature Rise = Heat Output (BTH) / (CFM* 1.085)

G. FLUE TEMPERATURES

Flue temperatures can play a vital role in determining whether the air/fuel ratio is properly adjusted to obtain maximum furnace out-put. Maintaining proper flue temperatures is also important for continued reliability. Due to the 81 plus percent efficiency operation obtained by the drum and tube configuration of the heat exchanger along with better turbulators and air/fuel mixing, flue temperatures approach condensing conditions. Several factors, as an individual condition may be within the operational envelope, when combined with other factors, can cause flue gases to condense which leads to flue tube and/or heat exchanger failures. It is this total operational evaluation that makes setting up a furnace a science, not luck. Some of the factors that can affect flue temperatures are:

1. Poor air/fuel mixture – Too much combustion air and not enough gas. Causes furnace to be under fired reducing flue temperatures.
2. BTU's per cubic foot of gas – Gas can very not only from job to job in a given area but from geographical location as well. Low BTU content causes too lean a mixture which lowers flue temperatures when furnaces are not set-up according to location.
3. Entering air temperature over the heat exchanger is too low- The higher the efficiencies of a furnace, the lower the natural flue temperatures and higher the minimum entering supply air temperature limits.
4. High CFM across heat exchanger – A high CFM produces a lower Temperature Rise across the heat exchanger but reduces flue temperatures due to the increased number of air changes.

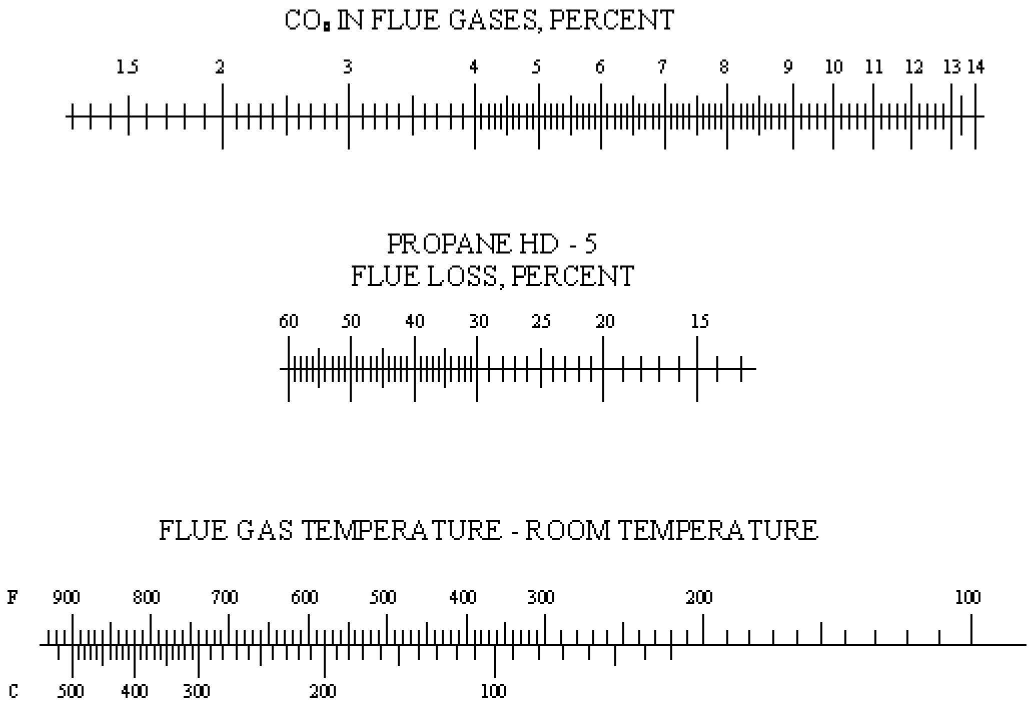
All gas has a certain sulfur content. Some areas have more than others. Moisture is brought into the combustion process with the air that is introduced by the combustion blower. These two ingredients put together make up sulfuric acid. The strength or concentration of the acid is governed by the amount of sulfur in the gas and the amount of moisture condensing out of the flue gases. The flue temperature governs the point at which the moisture within the flue gas begins to condense. By properly adjusting the system, i.e. CO2, O2, and Flue Temperatures, with relation to gas quality and air entering over the heat exchanger, condensing can be minimized and furnace operation and reliability can be enhanced.
By operating within the specifications listed in Tables 4A and 4B with the proper interring supply gas pressure, measuring the furnace stack temperature and the entering air temperature over the heat exchanger (100% RA or Mixed Air Temp) allows total "system" evaluation.

Note: Averaging measurements should be taken to obtain a more accurate temperature.

Figure 8 is a graph that is used to determine flue losses. Plotting the CO2 operating level and the stack temperature (minus) the entering air temperature over the heat exchanger yields an efficiency percentage.

Note: The furnace should operate between 80 to 81 percent efficient on both "Low" and "High" fire.

FIGURE 8
Flue Loss with Natural Gas



TRANE®

Literature Order Number	SZ-SB-55
File Number	SV-UN-RT-SB-55 -122102
Supersedes	New
Stocking Location	Inland – La Crosse

Since The Trane Company has a policy of continuous product data and product improvement, it reserves the right to change design and specifications without notice. Only qualified technicians should perform the installation and servicing of equipment referred to in this bulletin.