

# TECHNICAL TRAINING

## Manufactured Housing Furnaces

036-60800-001 REVB ( 0800)

Includes Standing Pilot and  
Hot Surface Ignition Models



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Recommended additional materials: MSADG and 035-16328-001 REV F (0900)

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## Mobile/Modular Furnaces

### Installation

Mobile/Modular home furnaces are installed in a variety of mobile, modular, or sectional houses. They are installed in new homes or are a replacement for an existing furnace. In either case the application must be carefully surveyed to consider every aspect of the installation to insure that the customer receives a well performing system and the contractor obtains a good review from his customer.

This instructional course is not meant to take the place of the installation instructions that come with each furnace and/or the components that make up the installation of that furnace. In other words this text will not repeat all the various warnings that appear in the text of the installation instructions. We will merely re-emphasize particular instructions.

### Nomenclature

DGAH056ABTAX

where

D = Down flow

G = Natural Gas (L= Liquefied Petroleum, LP)

A = Automatic Ignition; P = Pilot Ignition

H = Heating Only, A = A/C Ready

056 = Btuh s input, 70K,77K or 90K

A = Efficiency; A = 78%; B = 80% AFUE

B = Major revision

T = Tall Casing, S = Short casing

A = Revision

X = no doors

In all 26 models of various configurations.

Serial Numbers: The first two digits indicate the year of manufacture and the next two digits the month of manufacture.

One of the first considerations about deciding to install a new furnace is: Will it fit? The tallest manufactured housing furnace is 76" tall, by 19.5" wide and 24" deep. Of course if you are designing or building a completely new structure then, you'll be able to design the structure around the furnace. Is the furnace going to be

installed in a closet or alcove? If its in a closet then care must be taken because the return air of this furnace is the front upper door of the furnace. Failure to allow for enough air into the furnace will shorten its life and could create an unsafe condition. The distance that a furnace must be installed from any combustible material is called combustion clearance. Pay particular attention to the bottom of the furnace. The down flow air conditioning ready furnaces have a coil cabinet built into the bottom of the furnace and do not require a non-combustible base to set the furnace on. The short furnaces 60 inches tall require the installation of a duct connector which serves as a non combustible base. All furnaces regardless of whether they heat by gas, oil, wood, electric or whatever energy source, have a clearance to combustibles chart in the instructions. The clearances in Table 1, must be observed, they cannot be overlooked.

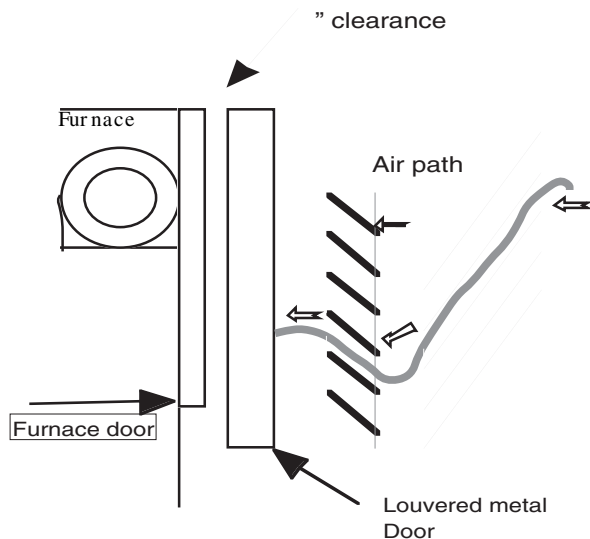
### Minimum Combustion Clearances

Table 1		
	Closet	Alcove
Furnace back	0 inches	0 inches
Furnace sides	0 inches	0 inches
Furnace front	6 inches	24 inches
Furnace top	2 inches	2 inches
Roof Jack	0 inches	0 inches
Duct	0 inches	0 inches

Combustible materials usually mean wood, or wood products, paper or paper products and plastics. Typical non-combustibles would include masonry, metal and fire rated sheet rock.



If the furnace is installed in an alcove, and a non-combustible metal louvered door is installed in front of the furnace (Figure 1), then there must be allowances made for the amount and speed of the return air back to the furnace.



**Figure 1:**

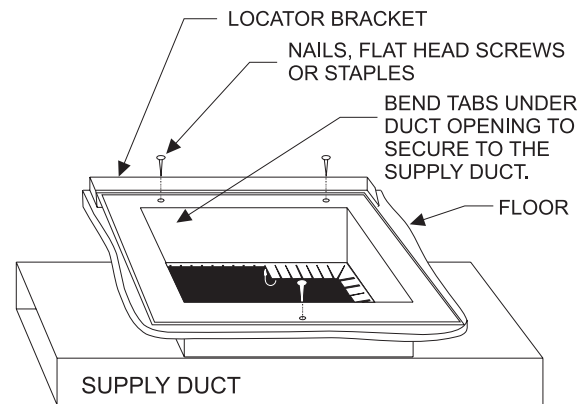
The louvers on the metal door must line up with the louvers on the furnace door so the return air can have an unrestricted path into the blower. There will be evidence of this when the furnace



**Figure 2:**

is started up and the service technician measures the Air Temperature Rise of the furnace. °T or ATR is Temp rise.

Once you've decided that the furnace will fit then the floor and roof structure have to be checked for obstructions to the duct connector and flue. The part that we use to provide an air-

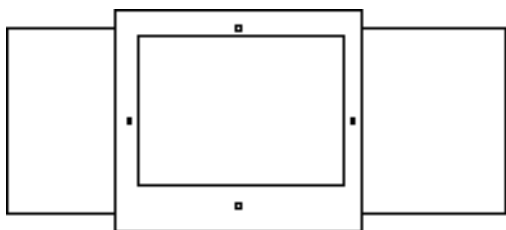


**Figure 3:**

tight seal between the furnace outlet and the duct that the air is distributed through is called a duct connector. It is connected by tabs to the duct, and should be screwed down and may be sealed with a quality aluminum foil tape. Duct connectors come in a variety of lengths because the distance from the top surface of the floor to the duct is dependent on the type of construction used in the house as well as the type of duct system used. Tabbed connectors (Figure 3) or Flanged connectors) are 2" to 12" deep in 1" or 2" steps. (refer to Table 2)

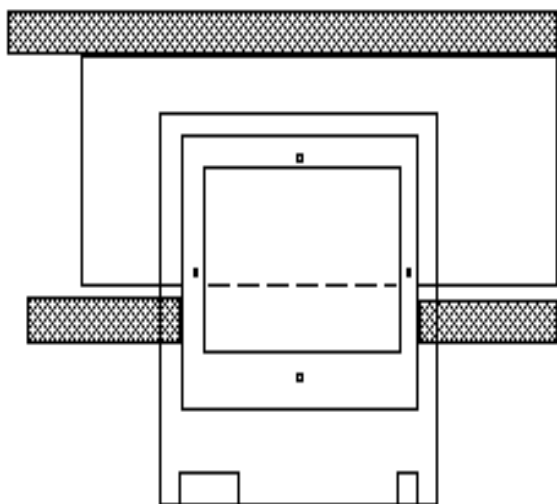
Table 2		
Flanged	Tabbed	Depth to duct
7990-6011	7990-6211	1"
7990-6021	7990-6221	2"
7990-6041	7990-6241	4-1/2"
7990-6061	7990-6261	6-1/2"
7990-6071	7990-6271	7-1/2"
7990-6081	7990-6281	8-1/2"
7990-6101	7990-6301	10-1/4"
7990-6121	7990-6321	12-1/4"

When installing a furnace in a new location it would be advisable to check out the structure under the floor and make sure that there are no ducts, floor joists, axles, I beams, blocking piers or sewer pipes obstructing or blocking the path where the gas line should be located or where the refrigerant lines should be located. If it's possible, center the duct connector over



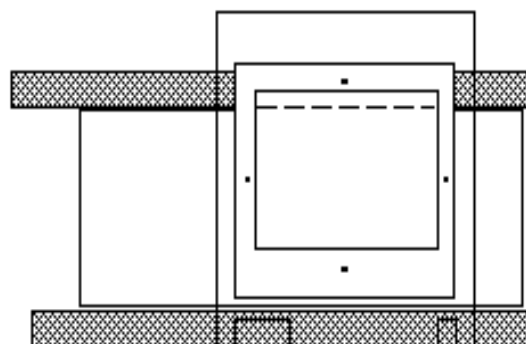
**Figure 4:**

the duct, this will provide the best airflow.(Figure 4)



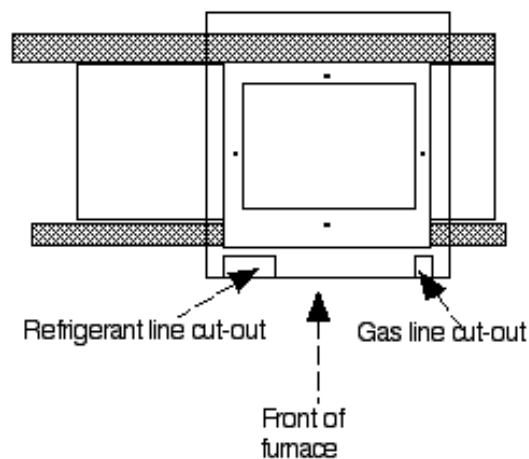
**Figure 5:**

Try to avoid off-setting the furnace to the duct if at all possible, as in Figures 5 and 6.



**Figure 6:**

Clearance must be allowed to install the gas line and or the refrigerant lines.



**Figure 7:**

This would be a preferred illustration of centered alignment of the duct connector and the furnace with clearance for the gas and refrigerant connections.(Figure 7)

Of course, you re only half through with your survey of the application. The flue installation is extremely important to the operation of the furnace. Without a properly installed flue (Figure

8) the furnace probably won't continue burning and it may not burn long enough to turn the fan on. An explosion and /or asphyxiation is also possible.

### Six ways to install a flue correctly

1. The flue assembly must be a factory manufactured flue assembly!
2. The flue assembly must not be modified in any way!
3. The flue assembly must be vertical (straight up and down)!
4. The flue assembly must be sealed! (water and air tight)
5. The flue assembly must be attached to the top of the furnace!
6. The flue assembly fire stop must be installed! (Refer to the flue installation instructions or seek assistance from Customer Service if you are unsure about how to install a flue).

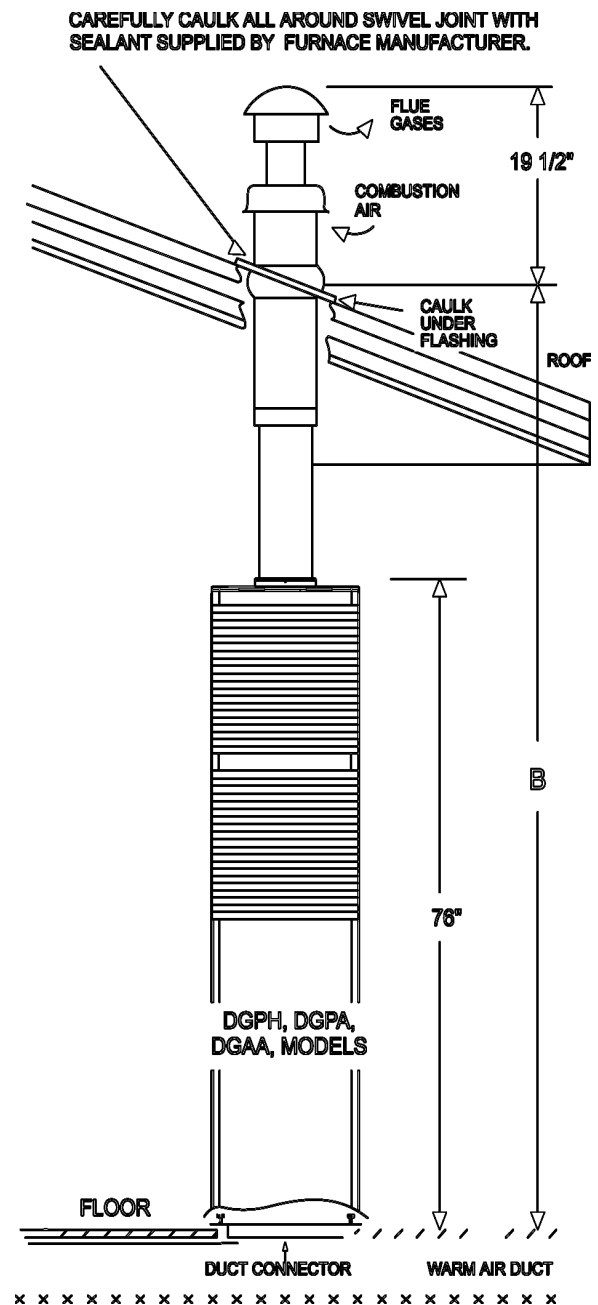
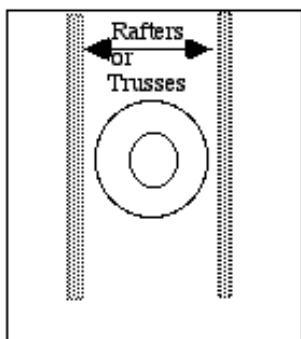


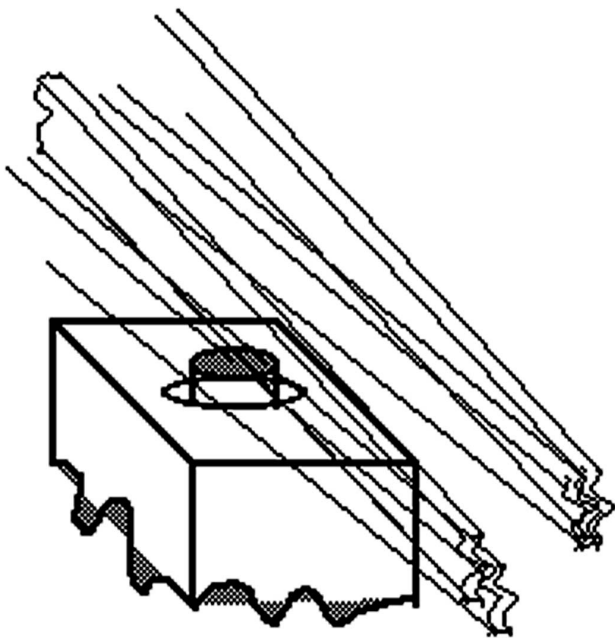
Figure 8:

The roof jack must clear any obstructions (roof

## Flue Assemblies and Accessories



**Figure 9:**  
structure or electric wires) running through the attic area.



**Figure 10:**

**Table 3**

Fixed Flashing	Adjustable Flashing	Adjustable height range	Floor to top side of roof
4000-6101/A	4000-7101/C	86 -95	86 -95
4000-6121/A	4000-7121/C	91 -102	91 -102
4000-6141/A	4000 - 7141/C	99 -120	91 -120
4000-6151/A	4000-7151/C	106 -132	106 -132
4000-6171/A	4000-7171/C	143 -173	143 -173
4000-9161/A	4000-8101/C	101 -117 Removable crown	
4000-9181/A	4000-8181/C	115 -145 Removable crown	
	7680B6541	Exterior extension 18	
	7900-3991	Chemcaulk 900 Sealant	
	7660-2841	Ceiling Ring (Fire stop)	
	7900A6111	11 Interior Extension	
	7900A6171	17 Interior Extension	
	4000-5441	Top crown Assembly	
	4000-6941/C	Removable Crown upper Assy.	
	7900-6771	Package unit Back draft damper	

Once the location for the furnace is determined and the structure above and below where the furnace is to be installed has been surveyed, then we can mark the center line of the flue and duct. Each furnace package has a template printed on the bottom piece of cardboard. This is used along with a plumb-bob to line up the flue and duct. (Figure 10).

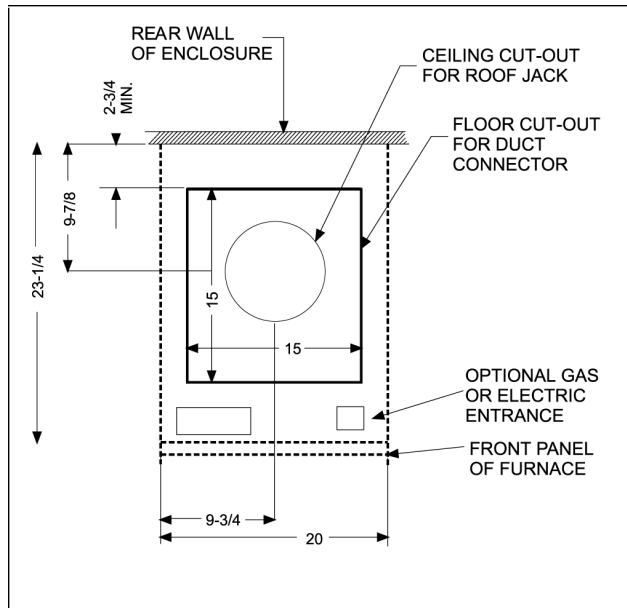


Figure 1

1:

Using the drawing in Figure 11, mark the center of the flue opening and the duct opening, then line the flue opening up over the center of the duct, make sure you are square with the walls. In other words make sure the front of the furnace is parallel and perpendicular to the walls that surround or across from the front of the furnace. Use a drill or awl to mark the four corners of the floor cut-out line then connect the four corners.

Use a plumb line to find the flue center. The plumb is held against the ceiling and moved around until the point is exactly centered over the flue center on the duct, then mark where the plumb line is being held by the installer and cut the roof opening at the center of the upper mark.

After both flue and floor cut-outs have been located and both have been checked to be sure there are no obstructions then the floor and roof can be cut to install the duct connector and the roof jack. Don't forget to cut an opening for the

gas and refrigerant lines. Cutting up a customer's floor or roof and finding out that you can't locate the furnace there can be a costly mistake! Check out the belly of the MH for obstructions. Pay particular attention to the roof structure when replacing an electric furnace with a fossil fuel furnace. (Figures 9 and 10)

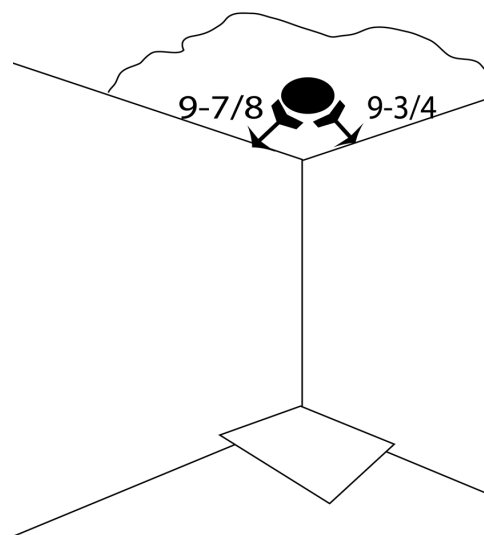


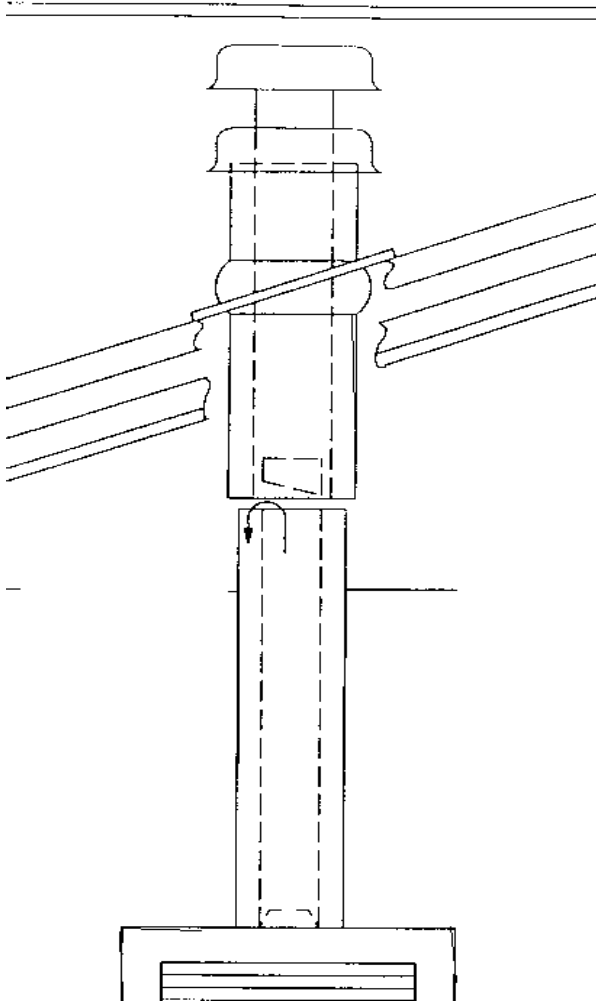
Figure 12:

Once the flue and floor openings have been made then the duct connector may be installed and sealed. After the furnace is in place then the flue assembly may be installed. Always make sure the flue assembly is vertical (straight up) and not leaning or tilting in any direction. And the crowns are straight and perfectly parallel with each other.

The swivel joint and the flashing of the roof jack both must be sealed. Use Chemcaulk 900 (4000-4241-24 pack) for the swivel joint and an appropriate sealer for the type of roof you are installing the roof jack assembly on. The installer must insure that the sealant is forced into the gap between the rounded part of the flue and the flashing for a water tight seal.

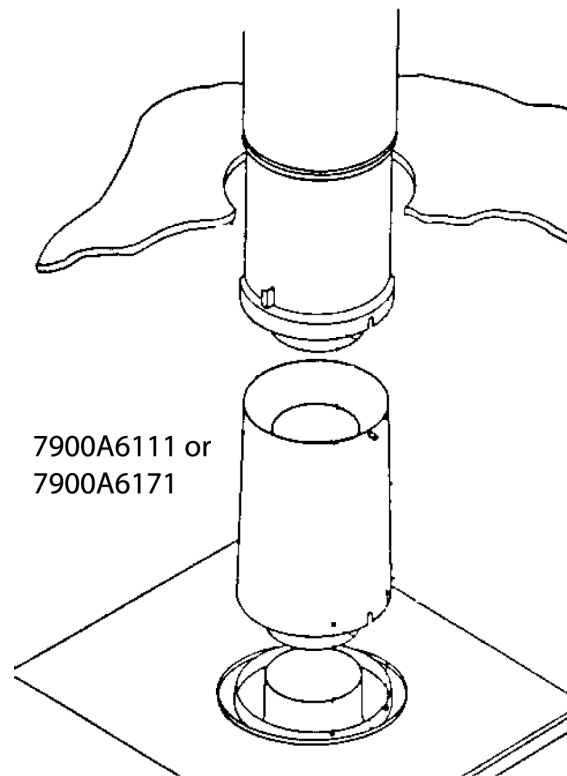
## Types of flue installations to avoid

The flue assembly is manufactured to not pull



**Figure 13:**

apart. Do not alter this construction. Remove the upper crown assembly and inspect the interior of the flue with a very strong flashlight or a drop light to check the integrity of the transition joint in the flue. (Figure 13) This is also a good time to check the walls of the inner flue and make sure that it is not perforated with corrosion as a result of being under fired.



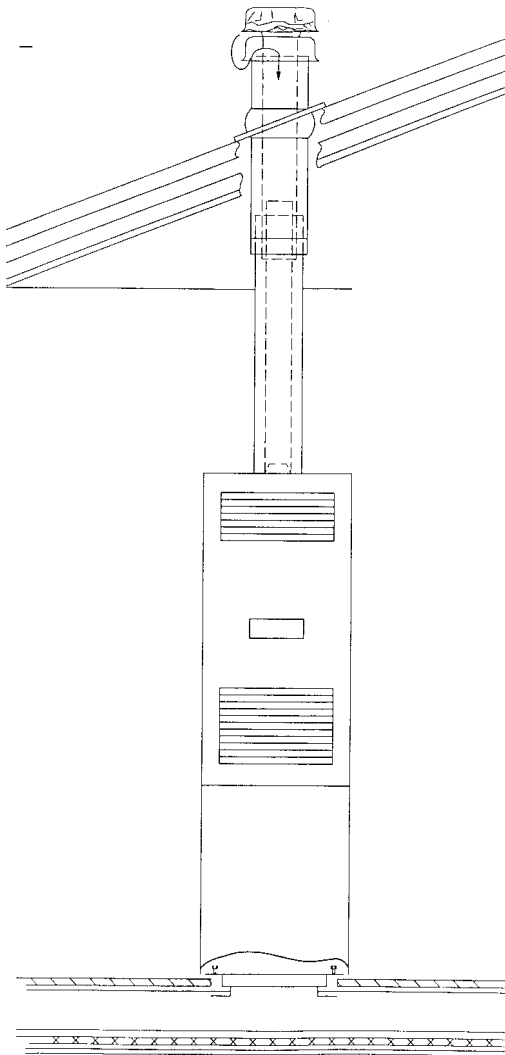
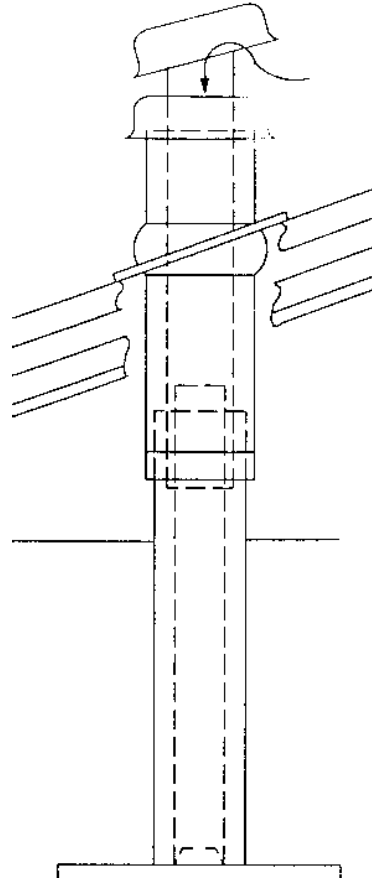
**Figure 14:**

In the unlikely event that a roof jack is installed that is too short to reach the furnace, two separate interior extensions are available, a 7900A6111 is 11 inches in length and a 7900A6171 is 17 inches in length. (Figure 14)

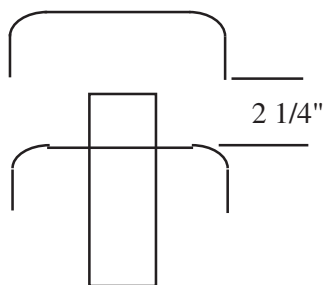
Any short circuiting of the flue gases into the incoming combustion air will produce incomplete combustion, it may cause a furnace to soot up since the flame will be too rich (starved for oxygen).

Using the top of the roof jack crown for a stool to take a break on may cause a furnace to have pilot outage, cause incomplete combustion, or delayed ignition. Check the crown assembly for shipping damage also. On older 7900 roof jack assembly's check to make sure the flue crown and the combustion air crown are exactly 2 1/4 apart all around the crowns.

## Tilted Crown

**Figure 15:****Figure 17:**

A roof jack cap that has been bent and is tilted can cause pilot outage, incomplete combustion, delayed ignition and the furnace to try to burn backwards. This condition must be avoided! (Figure 17)

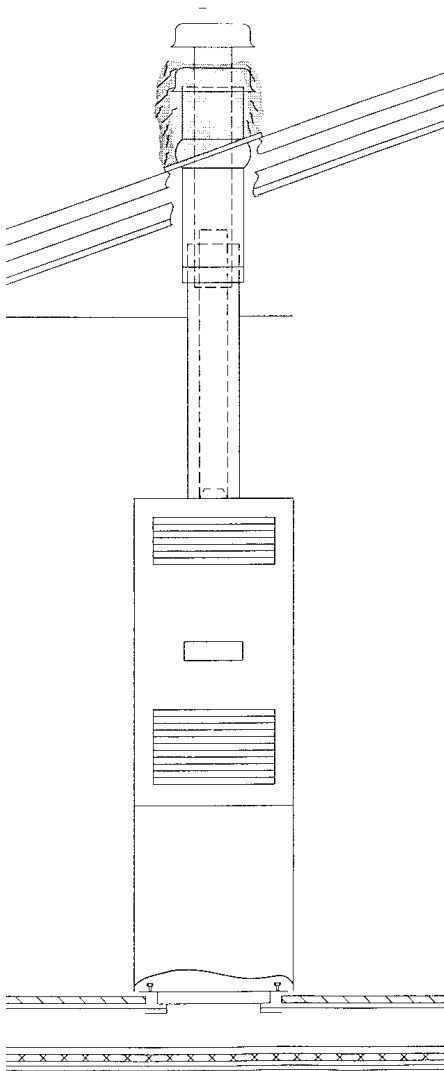
**Figure 16:**

This condition can also be related to pilot outage in a lot of circumstances. The service technician will not be able to determine this condition from standing on the ground in many cases. A ladder must be used to access the roof and visually inspect the crown.

burner. Newer burner designs have eliminated the air shutter on the burner.

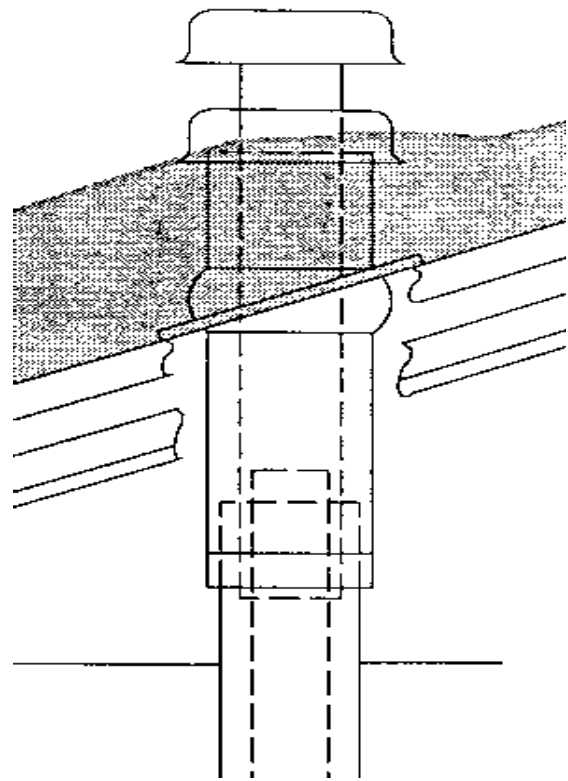
Exterior extensions are provided by the home manufacturer when they are to be located in a snow area.

In areas where snow may accumulate one or two exterior roof jack extensions may be used to elevate the Flue above the snow levels.



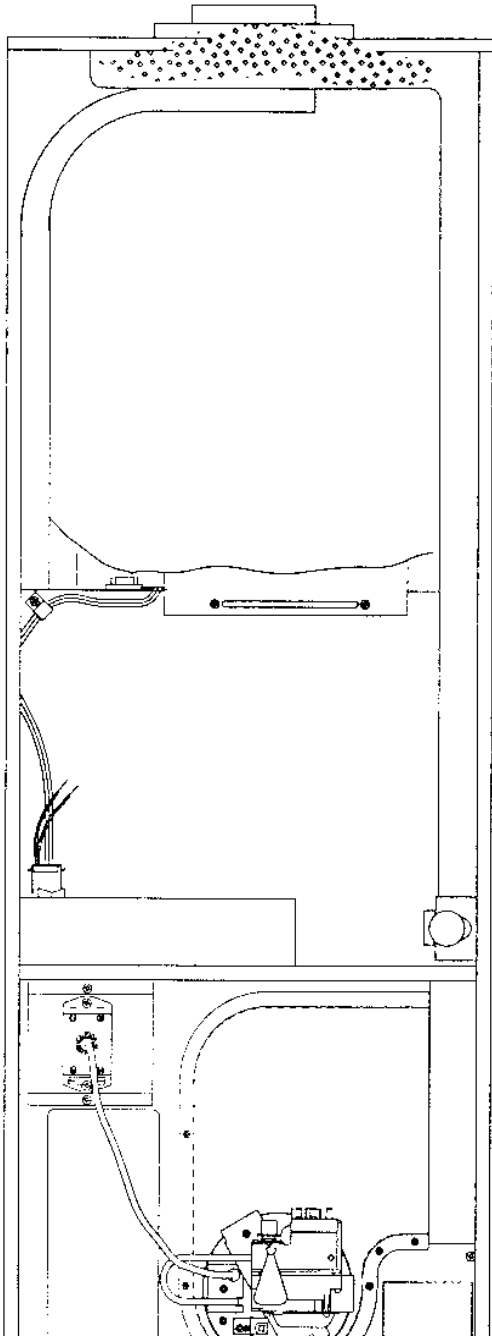
**Figure 18:**

Ice or snow build up on the roof jack can also cause pilot outage and incomplete combustion. (figure 18) Water vapor is a product of normal combustion and excess ice probably means that the furnace is under fired or (on older furnaces) the burner air adjustment shutter is open too far allowing too much air into the



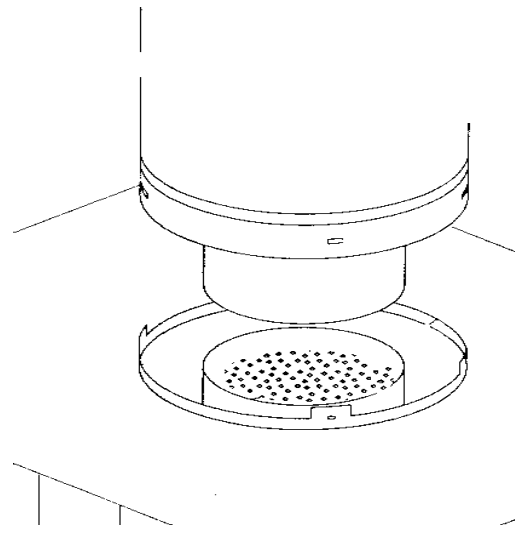
**Figure 19:**





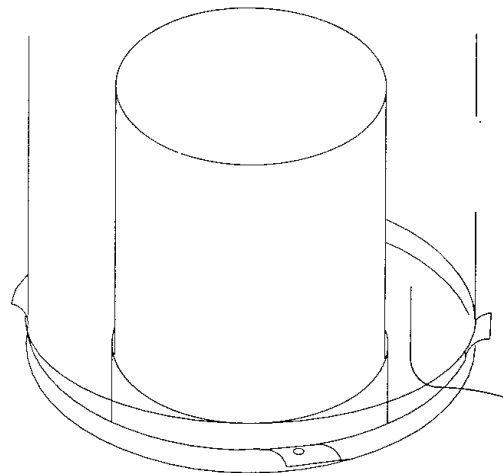
**Figure 20:**

Always use part of the shipping carton to cover the top of the furnace when cutting the roof jack opening to prevent construction debris from entering the furnace. This will interrupt the combustion process and could lead to carbon monoxide poisoning or incomplete combustion.



**Figure 21:**

Construction debris inside the flue outlet can have the same effects such as pilot outage, incomplete combustion, delayed ignition. A mis-



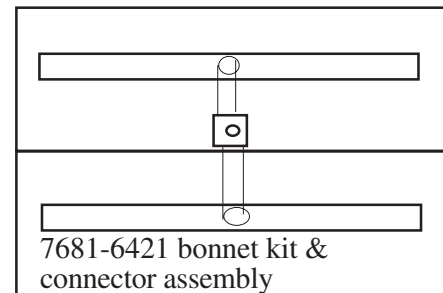
**Figure 22:**

aligned roof jack can cause pilot outage, incomplete combustion, and introduce products of combustion into the structure. (Figure 22)

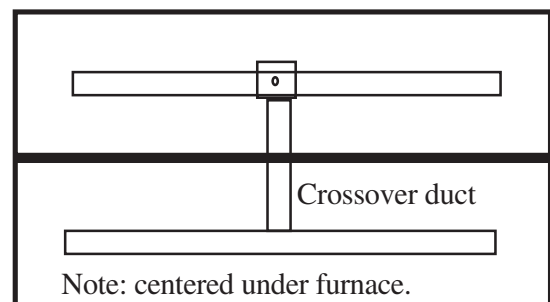
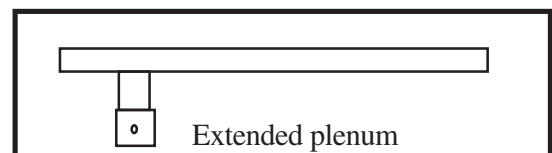
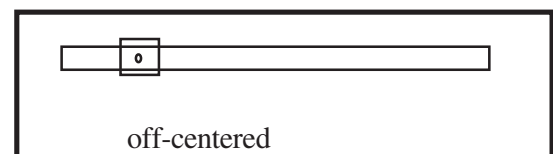
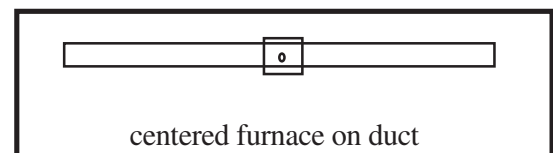
An incomplete installation can cause incomplete combustion. Incomplete combustion is the formation of dangerous gases that could cause death or disability. Carbon monoxide is a product of incomplete combustion. CO, as it is also known, is not to be taken lightly. It is the installers responsibility to insure that the flue is installed correctly!

In some installations the owners of the mobile/modular home may have constructed a secondary roof structure on top of the existing roof. In this type of application the roof jack assembly should be installed on the secondary roof. The roof jack should never be terminated under a secondary roof. The roof jack must not be modified with anything other than a factory Interior or exterior extension.

The retrofit application of the mobile/modular furnace usually won't involve the duct system except to check it and insure that the required amount of air will be delivered. In new applications the design of the duct system is just as important as any other consideration. The duct system for any heating or air conditioning application is always based on the results of a heat gain-heat loss calculation on the structure in question. The location of the furnace in a mobile/modular house probably should be near the center so that equal airflow can be maintained. Refer to Figure 23. Installing a furnace at the very end or beginning of the duct system can lead to constant customer complaints.



Angled plenum (bonnet kit) is used when furnace is not over the duct.



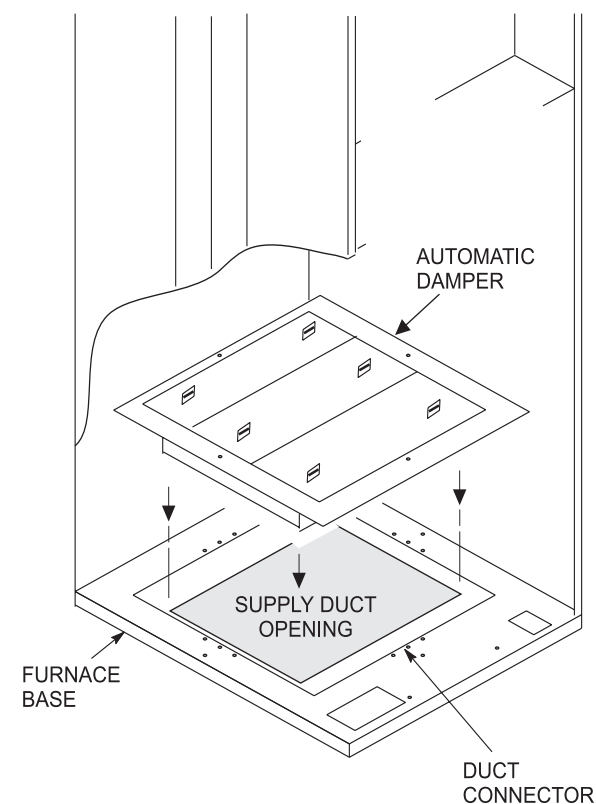
**Figure 23:**

When the mobile/modular furnace is installed with a self contained air conditioner, a back flow damper (Figure 23) must be installed to keep

the very cold air from coming in contact with the heat exchanger of the furnace which will cause it to get cold enough for moisture from outside the home to migrate down the flue and condense inside the heat exchanger and cause premature failure. This type of failure of the heat exchanger can cause carbon monoxide to be introduced into the house.

## Gas Piping Natural Gas

The gas line to the furnace must conform to all local and national codes. Make sure to use the appropriate material, and that the supply line is of the proper size. Refer to Table 4 for natural gas.



**NOTE: FOR BEST AIR DELIVERY INSTALL DAMPER WITH BLADES PARALLEL TO SUPPLY DUCT.**

**Figure 24:**

Table 4				
equal length of	1/2"	3/4"	1"	1-1/4"
10 feet	132	278	520	1050
20 feet	92	190	350	730
30 feet	73	152	285	590
40 feet	63	130	245	500
50 feet	56	115	215	440
60 feet	50	105	195	400
70 feet	46	96	180	370
80 feet	43	90	170	350
90 feet	40	84	160	320
100 feet	38	79	150	305
125 feet	34	72	130	275

Cubic foot of Natural Gas Capacity @.65 specific gravity

### Liquefied Petroleum

This chart is based on 11" water column pressure and schedule 40 pipe. Last regulator stage is at 11" W.C.

Capacity of supply piping:

Distance from last stage of regulator to furnace.

Table 5								
BTUH' S	10'	15'	20'	25'	30'	40'	50'	60'
50000	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
62000	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
75000	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
100000	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
125000	1/2	1/2	1/2	1/2	1/2	3/4	3/4	3/4
150000	1/2	1/2	1/2	1/2	3/4	3/4	3/4	3/4

## Troubleshooting the Mobile/Modular Down flow furnace

The mobile/modular furnace is referred to as a sealed combustion furnace because that is what it is, regardless of where it's installed. These types of furnaces bring outside air for combustion in from the flue assembly. The combustion air is pulled through the flue which channels the air into the mono port burner where the velocity of fuel in the burner causes some of the combustion air to mix with the fuel. This air that is mixed with the fuel inside the burner is called primary air and the mixing is aspiration.

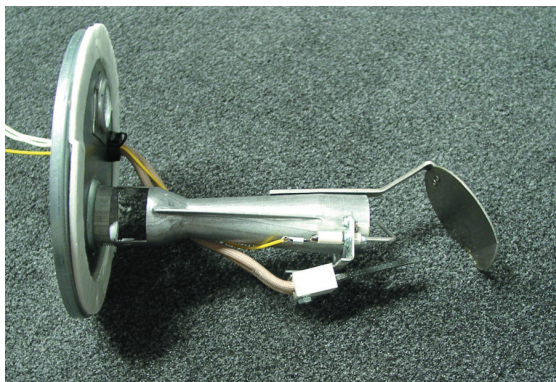


Figure 1:

The fuel-air mixture is ignited and secondary air flows around the mono port burner and continues to oxygenate the combustion process. If this combustion process is successful then very clean and efficient combustion products will draft up the heat exchanger and around the secondary radiators and up the inner flue pipe and exit at the top cap of the flue assembly.

If there are any cracks or leaks in the flue assembly then the furnace will fail to draft properly and there probably won't be enough air to support combustion. The combustion process must have oxygen, fuel and an ignition source to survive and in the event that the fire is not

getting enough oxygen to burn, then the flame will move in whatever direction that it can to find oxygen. The flue assembly of a mobile/modular furnace is a delicately balanced draft system. Failure to properly install or even check a flue assembly could lead to property damage and injure someone.

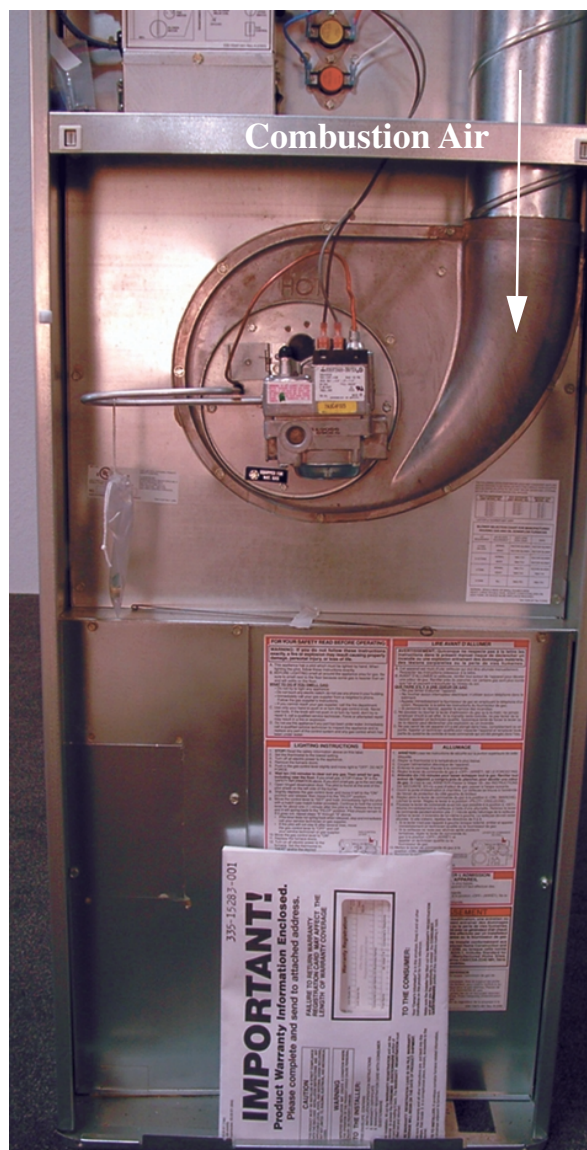


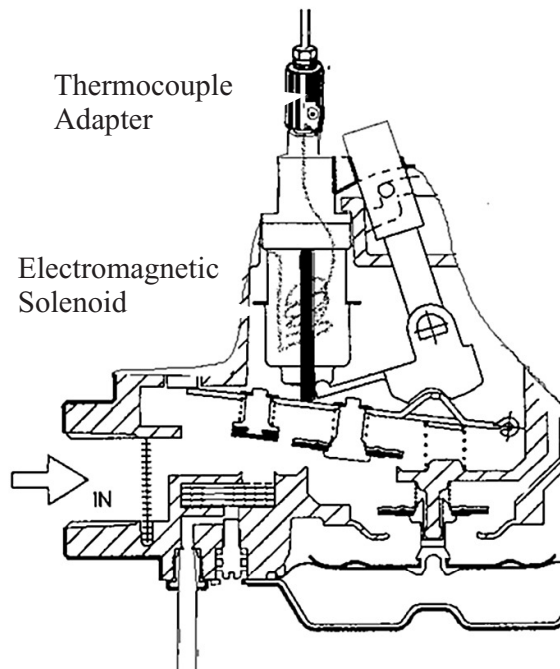
Figure 2:

## Standing Pilot Furnaces

For several years these furnaces have been manufactured with a 100% safety type of gas valve. A thermocouple generates a direct current that is measured in millivolts D.C. When

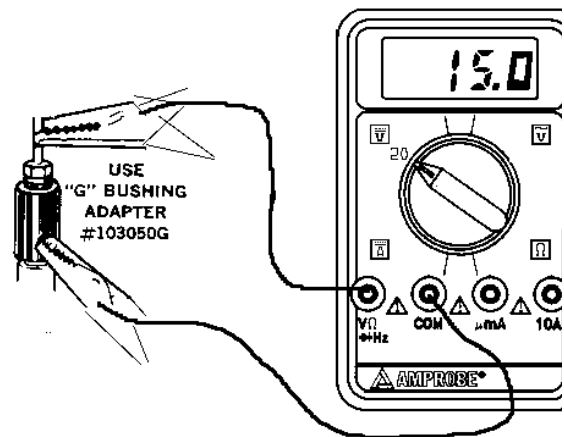


the pilot burner is maintaining a stable, clean burning flame, the thermocouple will generate 15-20 millivolts (closed circuit). This powers up an electromagnetic solenoid coil which keeps the pilot gas flowing to the pilot burner.

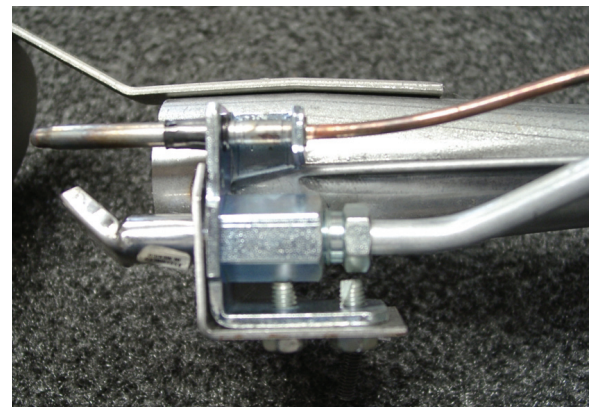


**Figure 3:**

While the circuit is closed the amount of millivolts the thermocouple is generating is checked with a meter and an adapter. The thermocouple must be tested while it is in use and the main burner is operating.

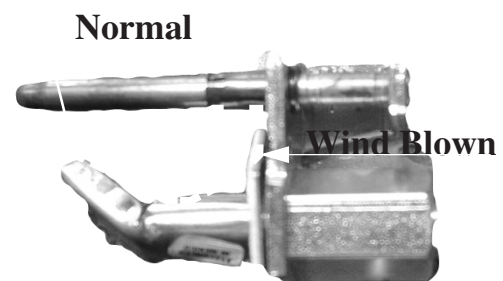


In the event that the fuel supply is cut off or a



**Figure 4:**

high wind condition causes instability then the millivolts that the thermocouple is producing

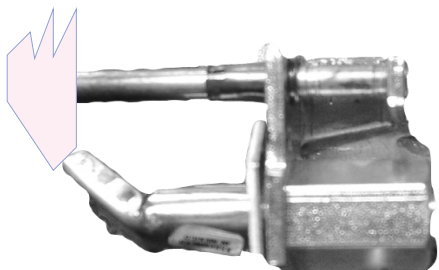


**Figure 5:**

drops and the solenoid will stop all gas from going through the gas valve. The force that causes the operator to close is usually spring pressure and each time the gas valve knob or lever is moved to the set position it is this spring pressure that is overcome. The drop out millivolts is approximately 3 millivolts, the average

time that it takes to reach 3 millivolts depends on the temperature of the air around the burner. Typical time is 1 to 1 1/2 minutes.

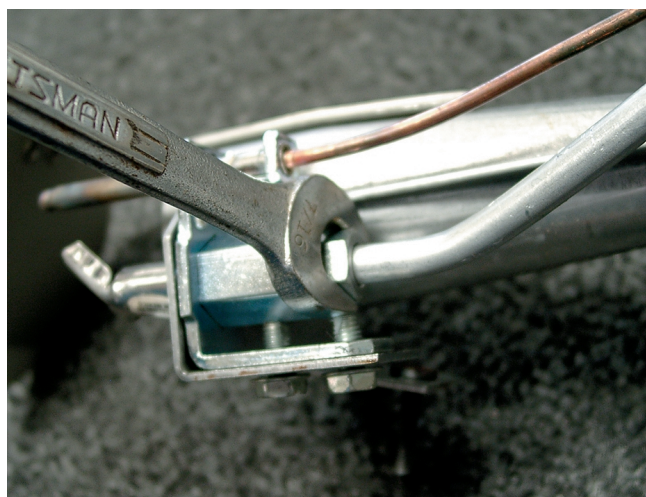
The pilot flame must completely surround the upper 3/8 to 1/2 of the thermocouple. An



**Figure 6:**

adjustment screw is provided to make minor adjustments in the pilot flame. Adjustments should always be checked with a millivolts meter. A thermocouple that is heated so intensely as to cause the tip to glow red will fail in a short period of time. Using a millivolt meter or a multi-meter (a meter that performs multiple functions-measures volts, ohms, D.C. amperage) is the only recommended method to test and evaluate a thermocouple. The correct method to test a thermocouple is with a millivolt adapter and with the furnace gas valve cycling on and off and with all other gas burning appliances on at the same time. To remove a pilot orifice, release the compression nut with an open end wrench only! Then remove the pilot and clean out or replace. The non-aerated pilot burner assembly contains a universal pilot orifice (an orifice that is used on LP or Natural

gas).



**Figure 7:**

The adapter is screwed into place and the pilot is re-lit. A millivolt or multi-meter is connected and the millivolt readings are recorded. It is



**Figure 8:**

recommended to only accept a millivolt reading of 15 millivolts or greater when the gas valve is first opening and until it has burned for several minutes (a complete cycle with the thermostat setting just one or two degrees higher than room temperature) and also with any other gas appliances also turned on and operating.

This reading is accomplished by setting the meter scale at the next highest scale that you think the reading will closely approximate and

watching the values displayed by the instrument. If the pilot or gas valve drops out and there is a high reading (15 M.V.) then the solenoid coil in the gas valve must be open. If the gas is turned off while the meter and adapter are connected and the meter is watched the gas valve should make an audible clunk when the pilot safety solenoid closes. This closing point should be 3 MV (millivolts). If it occurs at say 4 MV or higher then maybe the gas valve solenoid is requiring more power to hold open than it should, which will require a replacement gas valve.

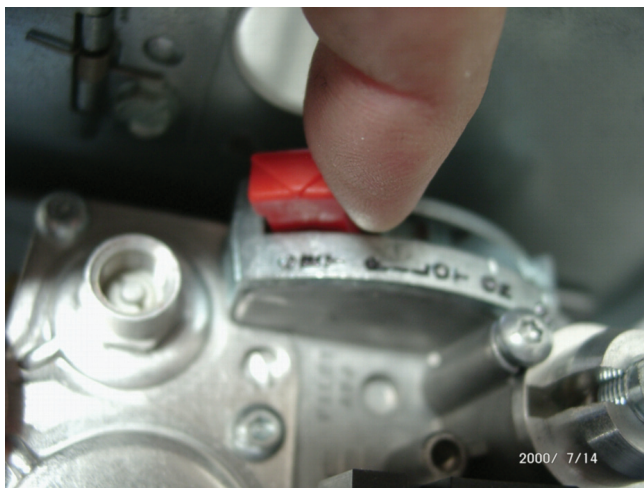
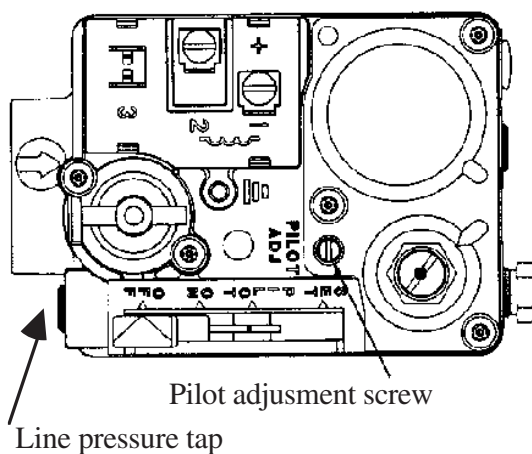
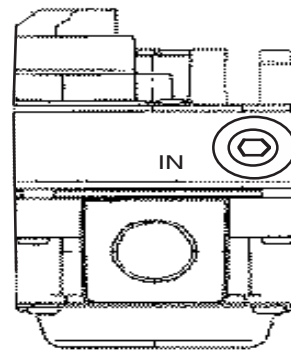


Figure 9:



The pilot flame should be large enough to surround the thermocouple tip, if it does not then possibly the gas valve does not have enough gas pressure. If the burner is under fired by the



fuel pressure being too low it can cause the flame to burn down in the burner and may over-heat the cold junction of the thermocouple causing intermittent pilot outage. If the burner has a visible area on it midway between the end and orifice where the galvanizing is discolored, it's a sure sign of a pressure problem. Gas pressure on gas burning appliances is measured in inches of water column. The gas pressure displaces a column of water in the instrument and the number of inches is recorded. A gage type of instrument allows you to read inches of water column. This type of device is known as a manometer. A manometer is a pressure reading device.

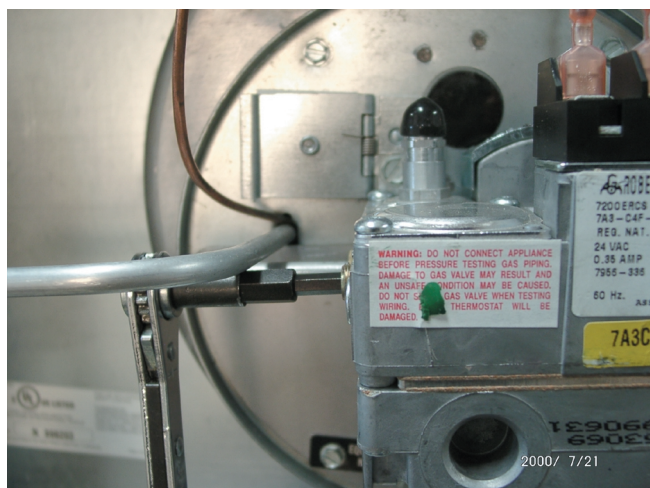
The water column manometer is a device that is filled with water and calibrated each time it is used. Some service technicians will only use the water column manometer because they may have used a gauge type and it wasn't calibrated and it gave false information



Figure 10:

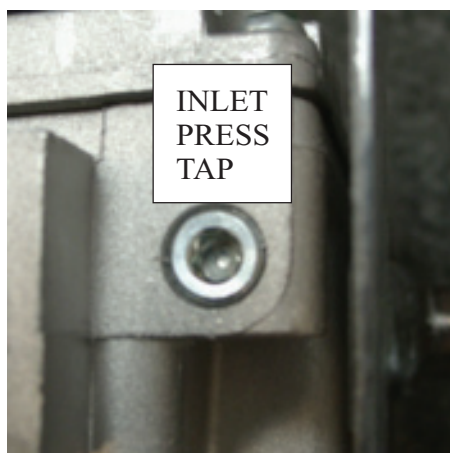


Most gas valves have a 1/8" pipe thread port to screw in an adapter to connect a pressure reading manometer. The above gas valve has a plug with a 3/16" hexagonal (Allen wrench)



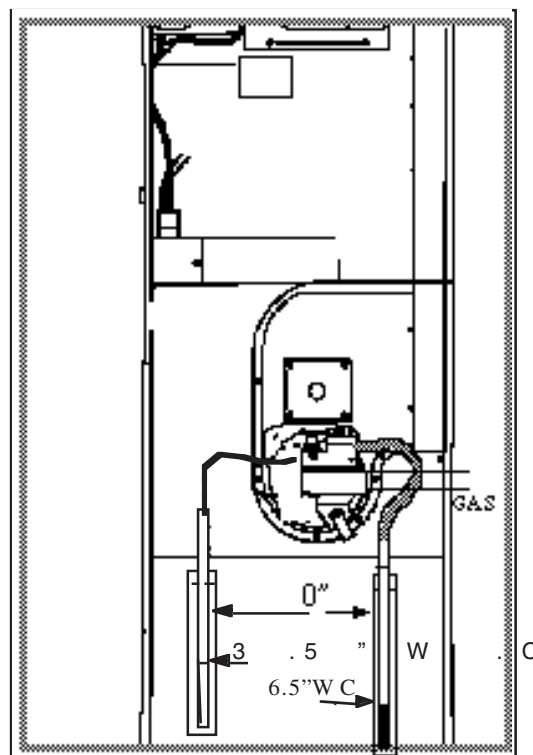
**Figure 11:**

opening in it to remove the port. A similar plug opening is provided on the outlet side (manifold side) of the gas valve. Other ports may be avail-



able on the gas supply piping, external regulators and even some brands of gas stop valves (cocks). The flexible hose that comes with the manometer is pushed over the barbed end of the adapter. Some manometers even come with a small tapered plug that can be inserted into any type of opening to obtain a pressure reading. You may also use the manometer to read the pilot line pressure. The reason for this is that most gas valves have some type of filter built in to catch small particles that would other-

wise stop up a pilot orifice. This filter may also become restricted.



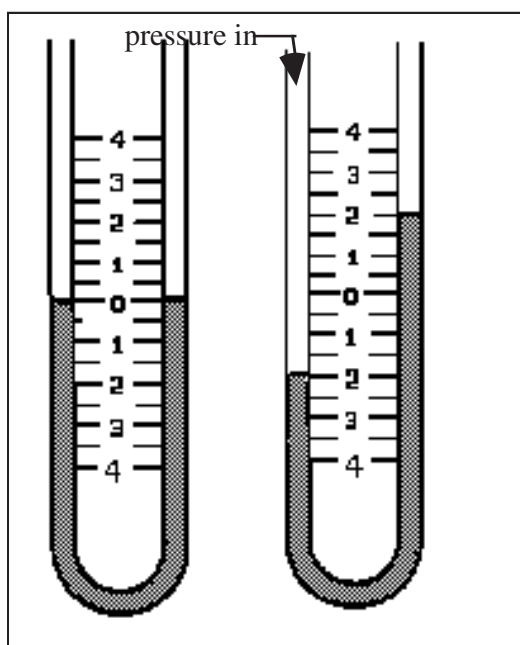
**Figure 12:**

Every service technician must use a manometer to accurately check the line and manifold pressures of the furnace in question. This is a definite method to insure that the gas regulator, meter and piping are adequate to provide the fuel necessary for the furnace to do the job it was designed to do. Fuel volume and pressure should always be tested with all other gas appliances on at the same time and should all be performing at a normal rate.

The Firing rate of a furnace is the number of input BTU's per hour. If a furnace is used on natural gas it's rate may be checked by measuring the Air temperature difference between the supply air (discharge) and the return air of the furnace and comparing that figure with the data plate. Assuming that a furnace has the proper orifice and that the service technician has used a manometer to check the fuel pres-

sure and that the blower assembly is moving the correct amount of air; (that the duct system is not too small for the volume of air); then the A.T.R. method will confirm the firing rate.

The usual fuel pressure for natural gas is 6"-7 W.C. line pressure and 3.5" W.C. manifold pressure. For LP. (Liquefied Petroleum) the line pressure should be 11"-13 W.C. and the manifold should be 10 W.C. minimum. These measurements must always be taken when the fuel system is under a load. All appliances that are being served by the fuel system must also be on and operating at their normal capacity.



The typical u-tube manometer is illustrated above. Note that in order to obtain a reading, the deflection of each tube must be added together to obtain the total pressure.

Another method to check the rate, or how much work is actually being performed by the furnace is to clock the gas meter. This almost always only applies to natural gas systems, since they usually have a meter attached. In the event that an LP system needs to be checked a meter may be installed on the line serving the furnace and its consumption of LP checked. Most gas meters have a small dial that mea-

sures in 1/2, 1 or even 2 cubic foot. All the service technician must do is to measure how many of the rotations the dial makes in a given period of time and then mathematically convert that time frame to an hour. B.T.U.'s are related to the time of performing the work.

**EXAMPLE:** Suppose you were working on a 100,000 B.T.U. per HOUR Furnace, the furnace was on, and the fuel pressures were correct. Then the service tech would measure the revolutions of the two(2) cubic foot dial and find that in 5 minutes (1/12 of an hour) the two cubic foot dial did rotate 4 times. This means that he consumed  $(4 \times 2 \text{ cubic foot}) = 8 \text{ cubic foot}$  of gas at about 1000 B.T.U.'s per Cu. Ft. for each 5 minutes the furnace is on. Then converting 5 minutes into an hour of time means multiplying  $(5 \text{ minutes} \times 1/12) = 8 \text{ cu. ft.} \times 12 \text{ parts} = 96,000 \text{ B.T.U. per Hour}$ .

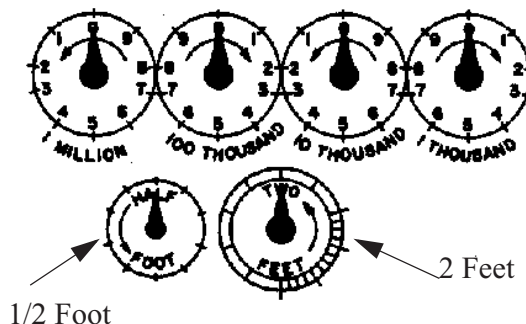


Figure 13:  
Typical Gas Meter Face

The gas valves that are used on mono port burners are **usually** step-opening. Induced draft burners usually use **snap-opening** valves. A step-opening gas valve will open at a lower pressure then gradually increase its pressure to the designed operating pressure. The operating pressures are for:

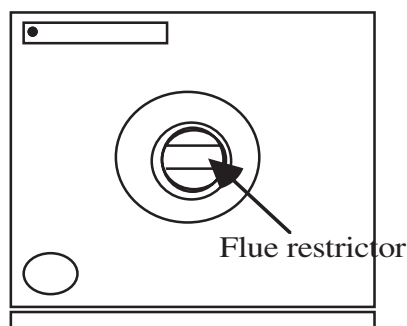
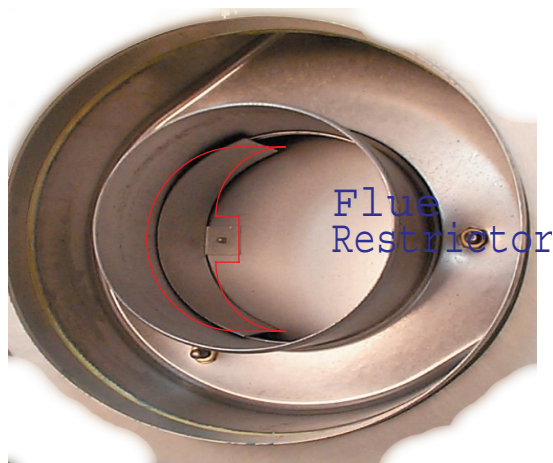
Natural Gas	0.3" W.C. First step 3.5" W.C. Final
LP Gas	5-6 W.C. First step 10" W.C. Final

The time it takes the valve to transition from its first step to its final step is a few seconds, and 2-6 seconds is OK. A cold gas valve or one with nominal operating pressure or volume may cause the time to vary somewhat. A gas valve that does not step at the above pressures, (with all appliances on and under a load) has probably failed. Warning! Any gas supply system that applies a pressure of 1/2 pound per square inch gauge will cause the gas valve to close off and lock up! A gas valve that does not step properly can cause a great amount of difficulty for the service technician. If the stepping is in question, make sure to cycle the valve through its steps with all other appliances on and off. Repeat several times.

Several of the mobile home furnaces have installed in the outlet of the flue what is commonly referred to as a flue restrictor. The pur-

pose of the flue restrictor is to slow down the draft of combustion products that contain heat and keep them in the heat exchanger a little longer to squeeze the extra heat out of the combustion products. This flue restrictor is held in place by a stainless steel rivet. In the event that a heat exchanger has to be replaced, the flue restrictor needs to be transferred to the new heat exchanger (on older models). It should be installed with a stainless steel rivet, a stainless steel screw would do just as well. If the rivet becomes loose and the restrictor happens to rattle then a second rivet or screw may need to be installed.

These flue Restrictors come in various shapes and sizes for the variety of models of furnaces that they are installed in. They should never be removed!



**Figure 1:**

Troubleshooting a sealed combustion furnace is not difficult if you are armed with the necessary tools to repair any furnace. Those tools include the knowledge of how to do it as well as the actual hand tools and instruments.

## Electrical Troubleshooting

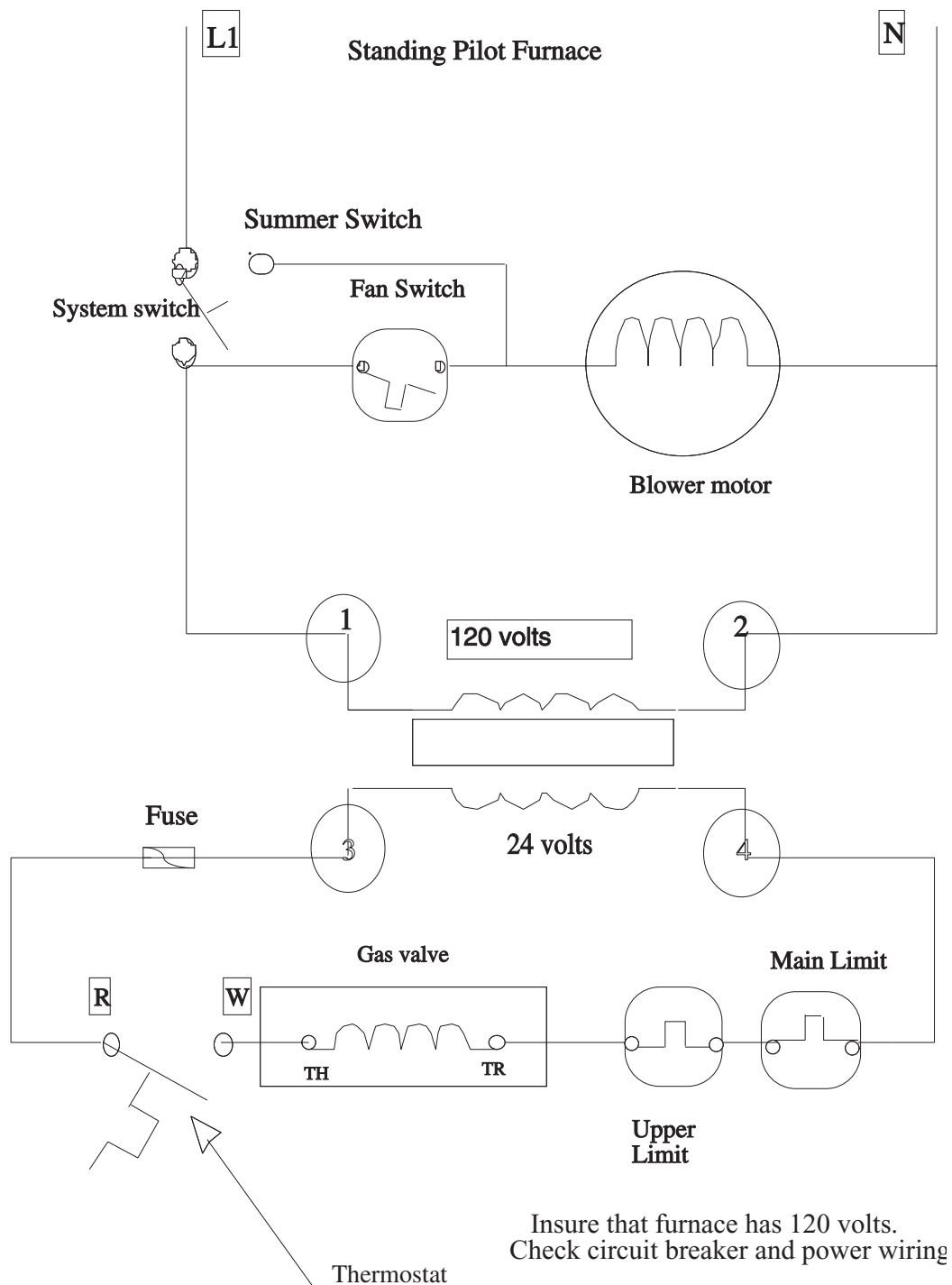


Figure 1:

Notice Figure 15 only shows the theory of how the current flows through the loads and controls. It does not show physical placement

or where the components are located on the furnace. Alternating current theory states that

electricity moves at the speed of light, 186,000 miles per second, so we probably won't notice how long it takes the 24 volts to get from the transformer to the thermostat and back to the gas valve.

We are going to use Figure 15 to indicate where a service technician might begin troubleshooting a furnace.

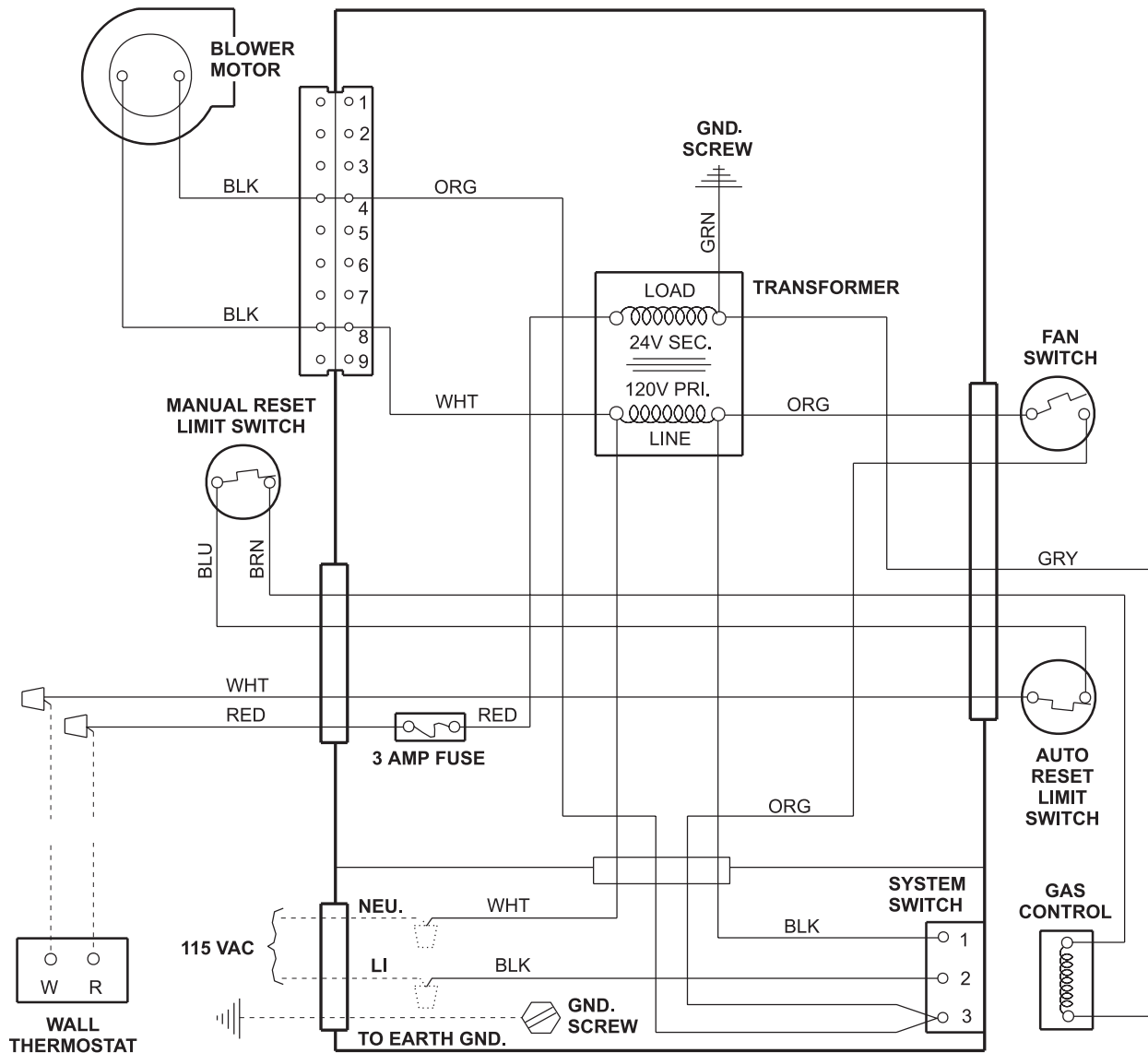


Figure 2:

**Standing Pilot Furnace (not power vented) (no air conditioning)**  
**Customers Complaint: No heat, furnace doesn't come on.**

**Does the Furnace have power?**

Use a multimeter, set on volts A.C., check electrical (circled) points 1 and 2 (physically these are the primary terminals of the transformer, one spade terminal has black wires on it and the other has white wires on it.)

**Do you have 120 volts?**



Check system switch, power wiring into the furnace and then back to the electrical panel. If no power at furnace. Call in an electrician.

**Do you have 24 volts?**

Move voltmeter probes to secondary side of transformer -these are the spade terminals on the transformer that has at least a red wire on one and a gray wire on the other, they are points 3 and 4 (circled) electrically on the previous diagram and physically Figure 17.

**Do you have 24 Volts?**



The transformer must not be producing 24 volts.

Replacetransformer. Check physical wiring to insure that there are no shorts to ground. You may use the voltmeter set on "ohms" and the furnace power completely disconnected and check the wiring to the thermostat and control circuit for any shorts. Remove the secondary wires from the transformer and ohm from electrical points 3 and 4, there should be resistance, check the multimeter and set the ohms scale at R x 1. Check wiring.



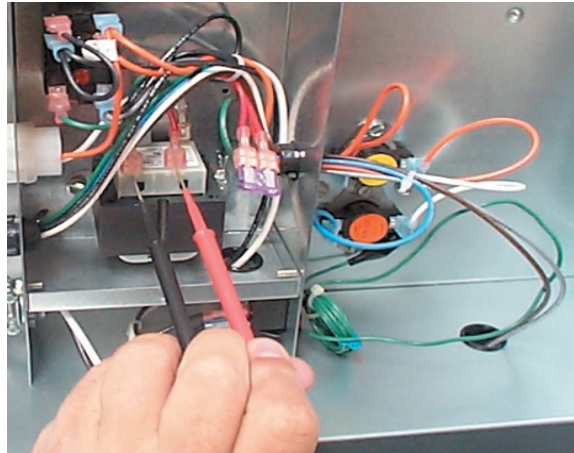
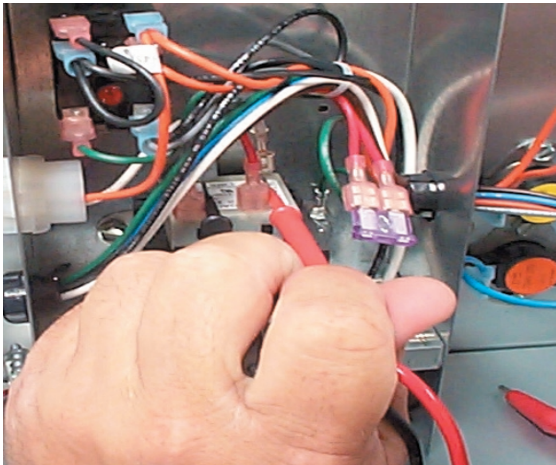


Figure 3:

**Is there 24 volts output on the secondary side of the transformer?**

**Do you have 24 volts?**

Yes ←

→ No

Connect the common probe of the multimeter to the common wire (circled #4) on the transformer with an alligator type of clip. Now take the other probe and check at the short red wire coming out of the wire bundle by the system switch (not pictured). Do you have 24 volts? If not The fuse or wire is open. Do not replace fuse until you have checked the control circuit for shorted thermostat wires touching the furnace cabinet. Repair short

**Is there 24 volts present where the short red wire connects to the thermostat wire?**

Yes ←

→ No

Connect the probe of the voltmeter to the connection of the short white wire and the thermostat.

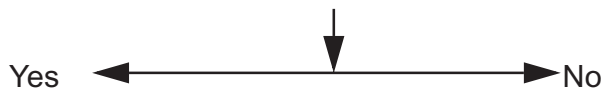
**Do you have 24 volts?**

Yes ←

→ No

**STOP** either thermostat wire is open or thermostat is not set higher than room temperature. Confirm wiring or thermostat setting and proceed.

**Do you have 24 volts at the Gas Valve terminal?**



The wire is open, repair or replace.

If 24 volts are present, then move probe to the other terminal of the gas valve.

**Do you measure 24 volts on the other terminal of the gas valve?**



If 24 volts is **not** present then the gas valve is open. Turn power off! Confirm with the multimeter set on Rx1 and replace.

If 24 volts are present at the gas valve terminal, then move the probe to one terminal of upper limit switch.

**Is there 24 volts present at limit?**



If 24 volts are not present, then the wire from the Gas valve terminal to the limit is open. Correct wiring.

IF there are 24 volts present at limit, then move probe to other terminal of limit.

**Are 24 volts present?**



The limit is open or it is tripped. It should be a manual reset limit switch. Reset switch and check ATR or check fan motor and fan switch. If the Air Temperature Rise is at the middle of the range specified for this furnace then possibly the limit switch is out of calibration and should be replaced. Only replace after you have confirmed the **Air Temperature Rise!**



If 24 volts were present at both terminals of the limit, then move the probe to the lower or main limit and check for the presence of 24 volts to the main limit from the upper limit.

**Are there 24 volts at the gray wire to the lower limit?**



If not gray wire is open. Repair or replace wiring.

If 24 volts are present at the lower limit then either the limit is open or the gray wire from the limit to the transformer is open. Repair or replace.

This troubleshooting segment has been performed without the 9-pin blower motor connector pictured in the schematic. The 9 pin connector can be confirmed with the voltmeter just as well and should be checked to insure wiring integrity.

Customer's Complaint: No heat, fire comes on, doesn't blow out hot air.

Conditions: Main burner is igniting and upper limit switch trips.

**Is there 120 volts at female (mounted on control box) pull-apart connector. Leave voltmeter connected to 120 volt Neutral (white wire) at transformer and use moveable probe to check pin #4 at 9-pin connector. (see diagram)**

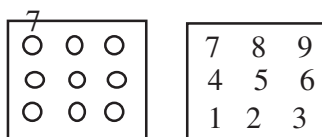


Figure 4:

**Are 120 volts present?**



If not correct wiring.

If yes, plug connector back in and check wire from #4 of connector to fan switch.

**Are 120 volts present?**



If not check wiring integrity.

If 120 volts are present move probe to other side of fan switch.



If not then fan switch is open, confirm that the furnace is firing at the correct rate, fuel pressure, main burner orifice, clock the gas meter (Natural gas).

### **Is it hot enough to cause the fan switch to close?**

**Warning:** Do not touch the bi-metal with your fingers and do not push in on it. The spring tension inside the switch can easily be ruined by pushing in on the bi-metal disc. If the furnace has heated enough to cause the limit to trip, then it's probably hot enough to close the fan switch. If this is the case replace fan switch.

If 120 volts are present to both sides of fan switch, then check for power at pin #9 of 9 pin connector. If 120 volts are not present then correct wiring. Check for 120 volts on male side of 9 pin connector.

### **If 120 volts are available and motor is not running, is the motor hot?**

If the motor is not warm or hot then the internal overload may be open. If the motor is hot and the bearings and blower wheel are free the motor may have an internal short. If bearings and blower wheel are free, allow time for motor to cool. Install multimeter probe in the female side of #9 pin on the 9 pin connector and allow furnace to heat until fan switch has made and check for 120 volts. If blower motor is cool to the touch and it is a shaded pole motor (one without a capacitor), set the multimeter to ohms and check the motor. If the motor is open then replace it. If it is a capacitor type of motor, and the motor runs and gets hot then check the capacitor with the ohm meter and make sure that it is not shorted (check terminal to case), If it's not shorted then replace the capacitor with a new one and power up the fan motor and measure the amp draw. It should be within the limits set forth on the furnace data plate.

The larger BTU input furnaces require more oxygen for combustion, therefore a draft inducer is added and the diagram below shows the draft inducer, a relay to turn it off and on and a draft proving switch. The draft proving switch could be a centrifugal switch or a pressure switch. The switch closes a set of normally open contacts when the motor speed approaches its rated RPM or the inducer develops its rated pressure. The control voltage passes through this set of contacts and turns on the gas valve. When the thermostat is closed on a fall in temperature the draft inducer relay is energized which feeds 120 volts to the draft inducer and when it gets up to speed the draft proving switch closes and completes power to the rest of the control circuit. The diagram below shows the circuitry that is added on. The troubleshooting would be the same as the preceding troubleshooting except for the added circuit and devices.

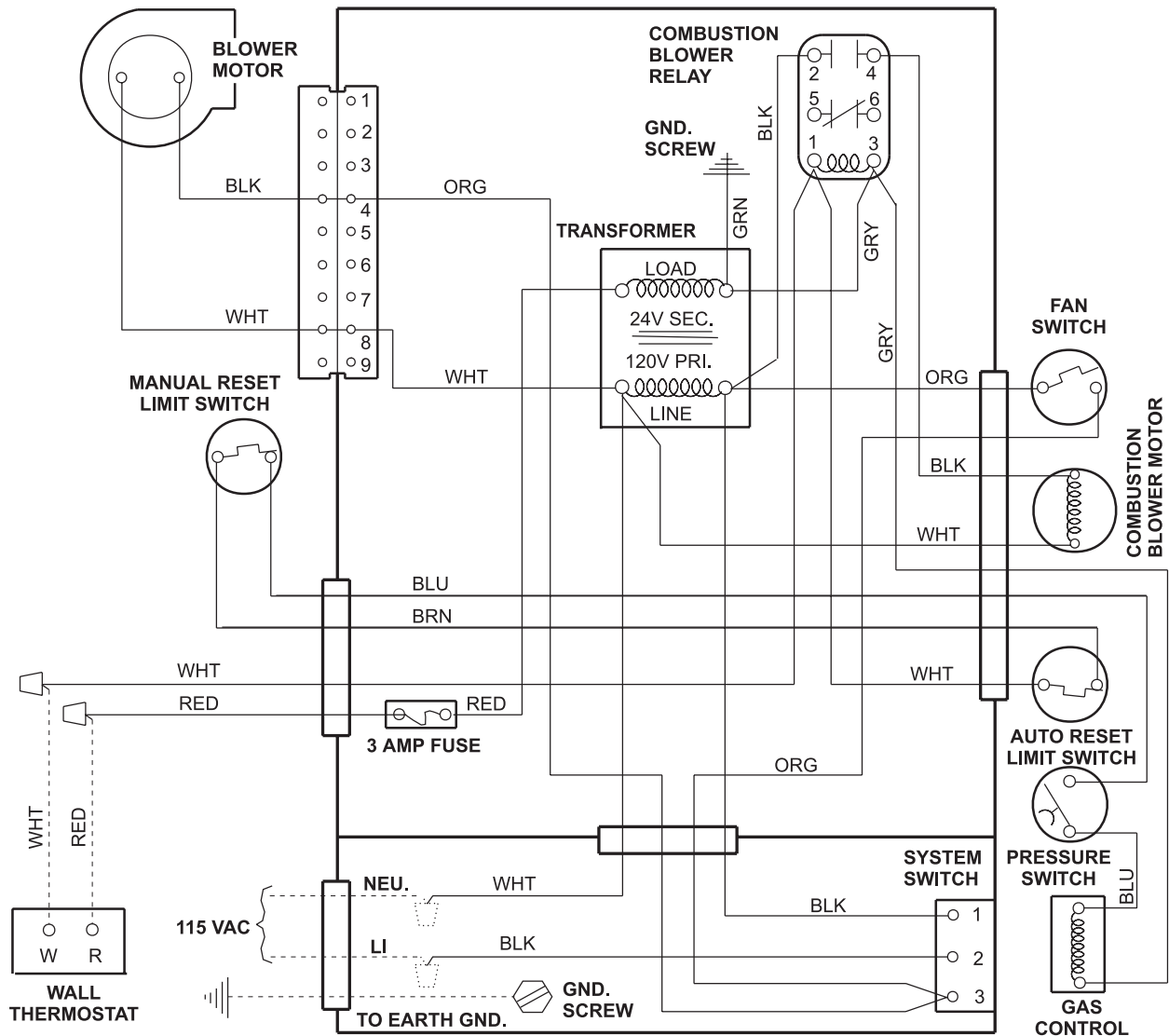


Figure 5:

**Customer complaint: No heat, furnace doesn't come on.**

This is in addition to the previously stated troubleshooting section (Booster Relay Circuit).

**Is there 24 volts at terminal 1 of the Booster motor relay coil (heat relay)?**



If not correct wiring.

**Is there 24 volts at terminal 3 of Booster motor relay coil (heat relay)?**



Replace relay, it is open.

Proceed to correct wiring from terminal #3 to common.

**Is the heat relay energized?**



If not go back to troubleshooting the control circuit.

If yes go to line voltage side of circuit and continue checking.

**Is there 120 volts at terminal 2 of the heat relay?**

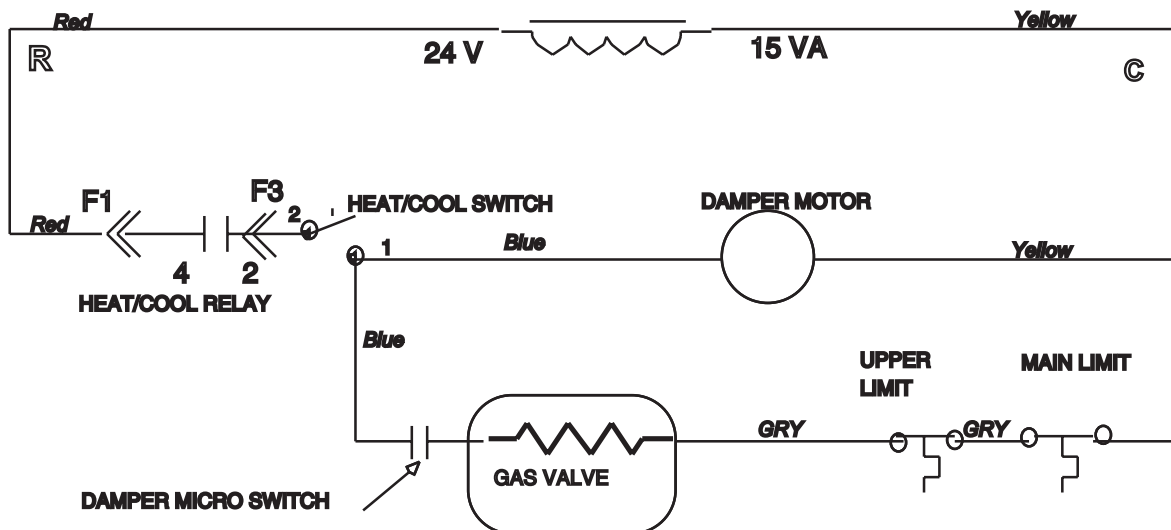
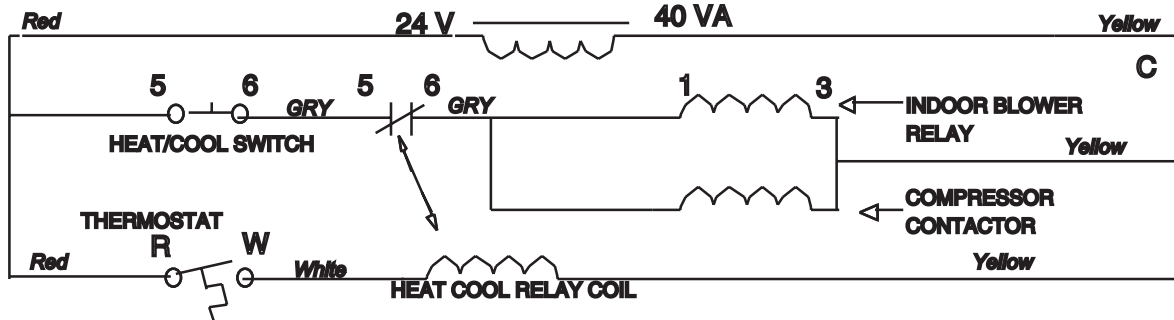
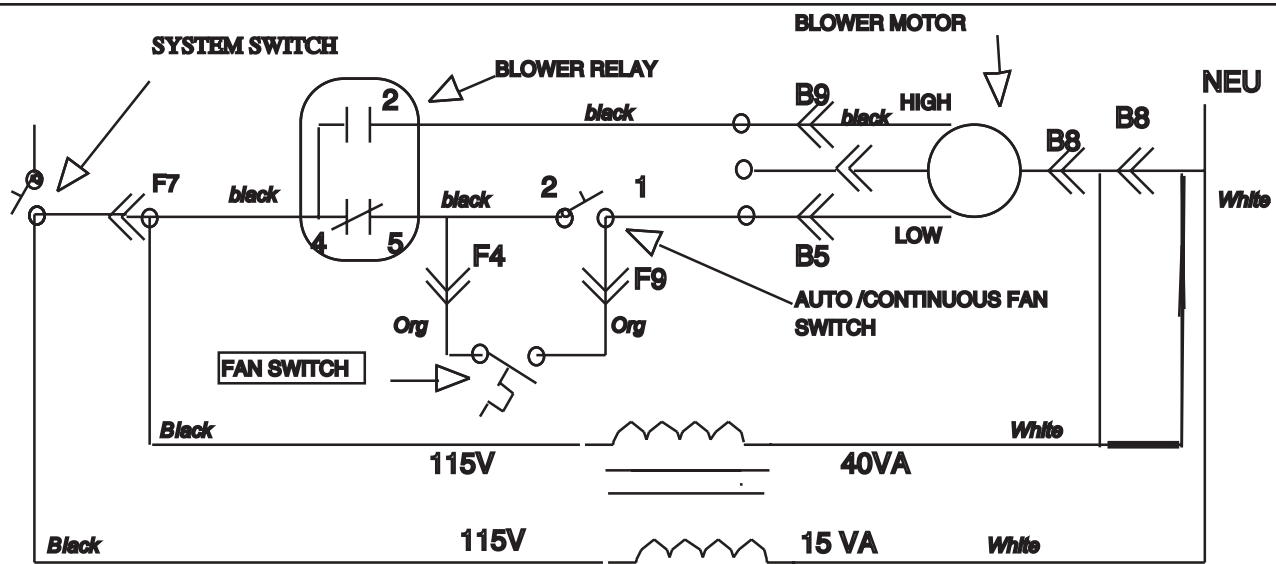


Move probe over to terminal #4 of the heat relay.  
Correct wiring

**Is voltage present at terminal #4?**



There is voltage present at terminal #4 or the heat relay and the motor is not running. If the motor is cool to the touch it may have an open winding, open overload or open connection. Use the ohmmeter section of the multimeter and with the motor completely disconnected electrically, check the windings for resistance. If there is none replace the motor. The draft inducer is replaced as an assembly. Correct as necessary.



### 7900-6021/A 2 WIRE THERMOSTAT CONTROL BOX.

◀ = FURNACE "F" MEANS FURNACE 9 PIN CONNECTOR AND "B" MEANS BLOWER 9 PIN CONNECTOR

Wire colors are in Italics.

## PILOT MODEL FURNACES 7900A6021 A/C CONTROL BOX

NOTE: Some segments refer to older model furnaces with components that may not be present on all furnaces. Troubleshoot in sequence regardless and skip over components that are not present on your model.

1. Insure line voltage is available to primary side of both transformers. Check all fuses or breakers and switches.
2. Restore power to unit.
3. If there are 0 volts at secondary side of transformers, replace transformer and check for electrical short before turning power back on.
4. If 24 volts are present on transformer secondary, attach one voltmeter lead to yellow terminal of control box transformer. With other lead check voltage to red wire of thermostat.

**Is there 24 volts?**

Yes ←————→ No

Insure wiring integrity from transformer to blower plug. Repair/replace as required.

**Is there 24 volts at white lead to thermostat?**  
Go to thermostat, set below room temperature.

Yes ←————→ No

If 24 volts are available; R-W thermostat is open, replace.

If 24 volts is not present, R-W thermostat wire is open, replace wire.

**Is there 24 volts to #1 terminal at Heat/Cool Relay?**

Yes ←————→ No

Insure wiring integrity from white thermostat wire to #1 terminal Heat/Cool Relay. Repair/Replace as required.

**Is there 24 volts to terminals 1 and 3 of Heat/Cool Relay?**

Yes ←————→ No

Insure wiring integrity #3 terminal Heat/Cool relay to secondary of transformer. Repair/Replace as required.



Go to 15 VA transformer, attach one voltmeter lead to yellow terminal of transformer.

With other lead check voltage to #4 terminal of Heat/Cool Relay.

**Do you read 24 volts?**

Yes ←————→ No

Insure wiring integrity from transformer to #4.  
Repair/Replace as required.

**Do you read 24 volts to #2 terminal Heat/Cool Relay?**

Yes ←————→ No

Heat/Cool relay coil is open (contacts 4 to 2).  
Replace as required.

**Do you read 24 volts at #2 terminal Heat/Cool Switch?**

Yes ←————→ No

Insure wiring integrity #2 Heat/Cool relay to #2  
terminal Heat/Cool switch. Repair/replace as  
required.

**Do you read 24 volts at #1 terminal Heat/Cool Switch?**

Yes ←————→ No

Heat/Cool switch is open. Replace.

**Do you read 24 volts to blue wires at orange wire nut to damper motor?**

Yes ←————→ No

Damper switch is open. Replace damper assembly.

**Do you read 24 volts at gas control through damper switch?**

Yes ←————→ No

Insure wiring integrity from transformer to lower  
limit switch. Repair/replace as necessary.

Attach one voltmeter lead to damper switch side of gas control..With other lead check voltage to yellow terminal of lower limit switch.

**Do you read 24 volts?**

Yes ←————→ No

Insure wiring integrity from transformer to lower limit switch. Repair/replace as necessary.

**Do you read 24 volts to gray wire to lower limit switch?**

Yes ←————→ No

Lower limit is open. Allow time to reset and determine why limit opened. If limit does not reset, replace. Check ATR of furnace against furnace data plate. Should not exceed ATR rating.

**Follow gray wire to upper limit switch. Do you read 24 volts to upper limit switch?**

Yes ←————→ No

Insure wiring integrity from lower limit to upper limit. Repair/replace as required.

**Do you read 24 volts to other side of upper limit?**

Yes ←————→ No

Upper limit is open reset when cool and determine why limit opened. If limit will not reset when cool, replace it. Check ATR and set at middle of range shown on furnace data plate.

End of this troubleshooting section.

## PILOT MODEL FURNACES 7900A6021 A/C CONTROL BOX

System Switch	Heat/Cool Switch	Gas Valve	Room Thermostat	Pilot
"On"	"Heat"	On Position	ABove Room Temp.	"On"

### Customer Complaint: No blower motor, furnace is on.

**Caution:** If blower motor is hot, check for tight bearings. If blower motor is equipped with a capacitor, check capacitor for open, shorted, or grounded condition. If motor is off on internal overload allow time to reset. Install one voltmeter lead to neutral (white) side of 40 VA transformer. Insure 120 volts to primary side of control box transformer. Insure that furnace is operating at correct firing rate.

#### Is there 120 volts?

Yes ←————→ No

Insure wiring integrity #4 terminal blower relay to transformer. Repair replace as necessary.

#### Is there 120 volts to #5 terminal of blower relay?

Yes ←————→ No

Blower relay open. Terminal 4 to 3. Repair/replace as required.

#### Is there 120 volts to orange wire of fan switch? (through pin #4)

Yes ←————→ No

Fan switch is open. If fan switch does not close in 3-4 minutes. Replace fan switch.

#### Is there 120 volts to #1 terminal of Cont./Auto Switch?

Yes ←————→ No

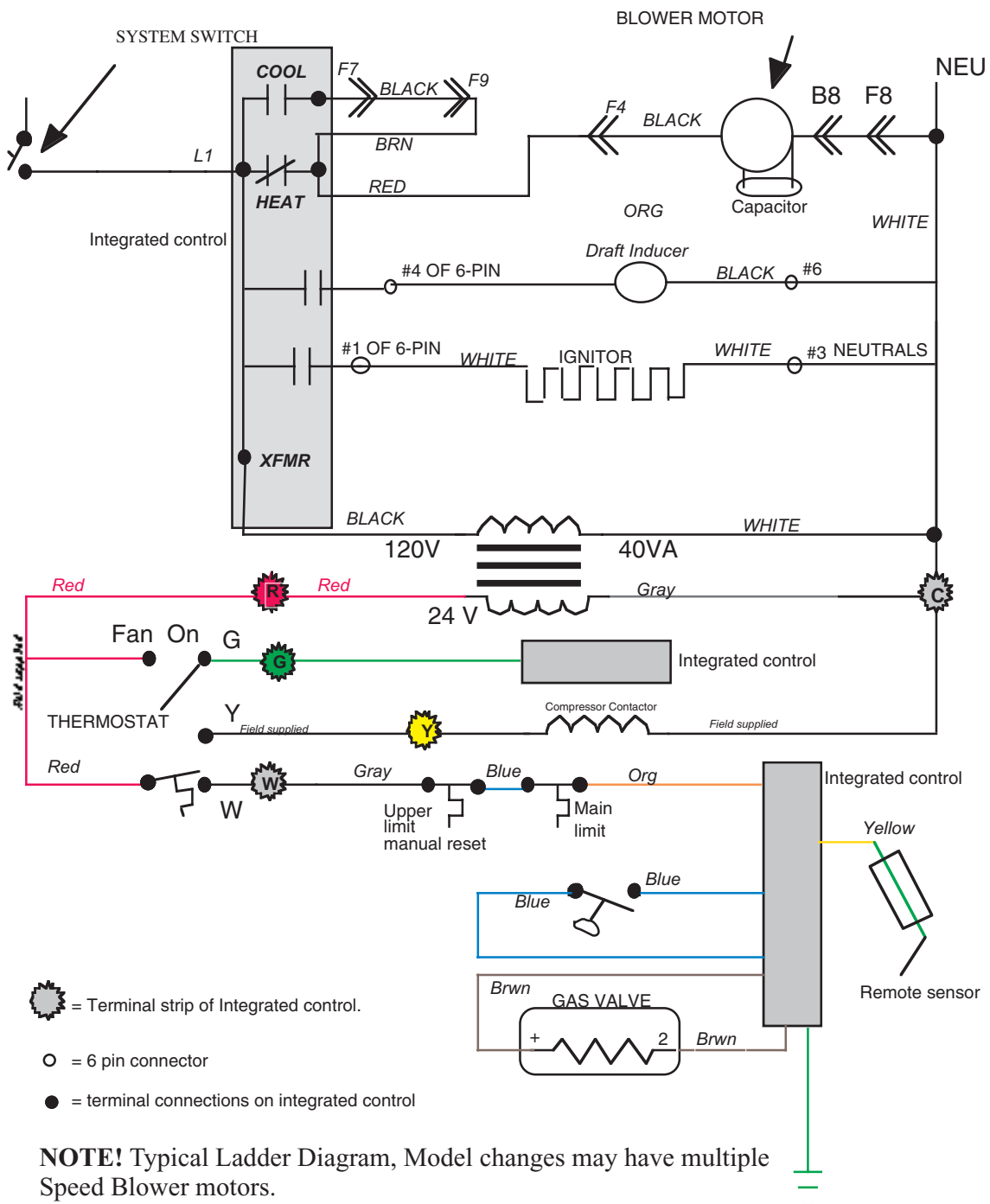
Check wiring integrity from fan switch #1 terminal at Cont./Auto switch. Repair/replace as required

**Is there 120 volts to heating speed at terminal block?**

Yes            No

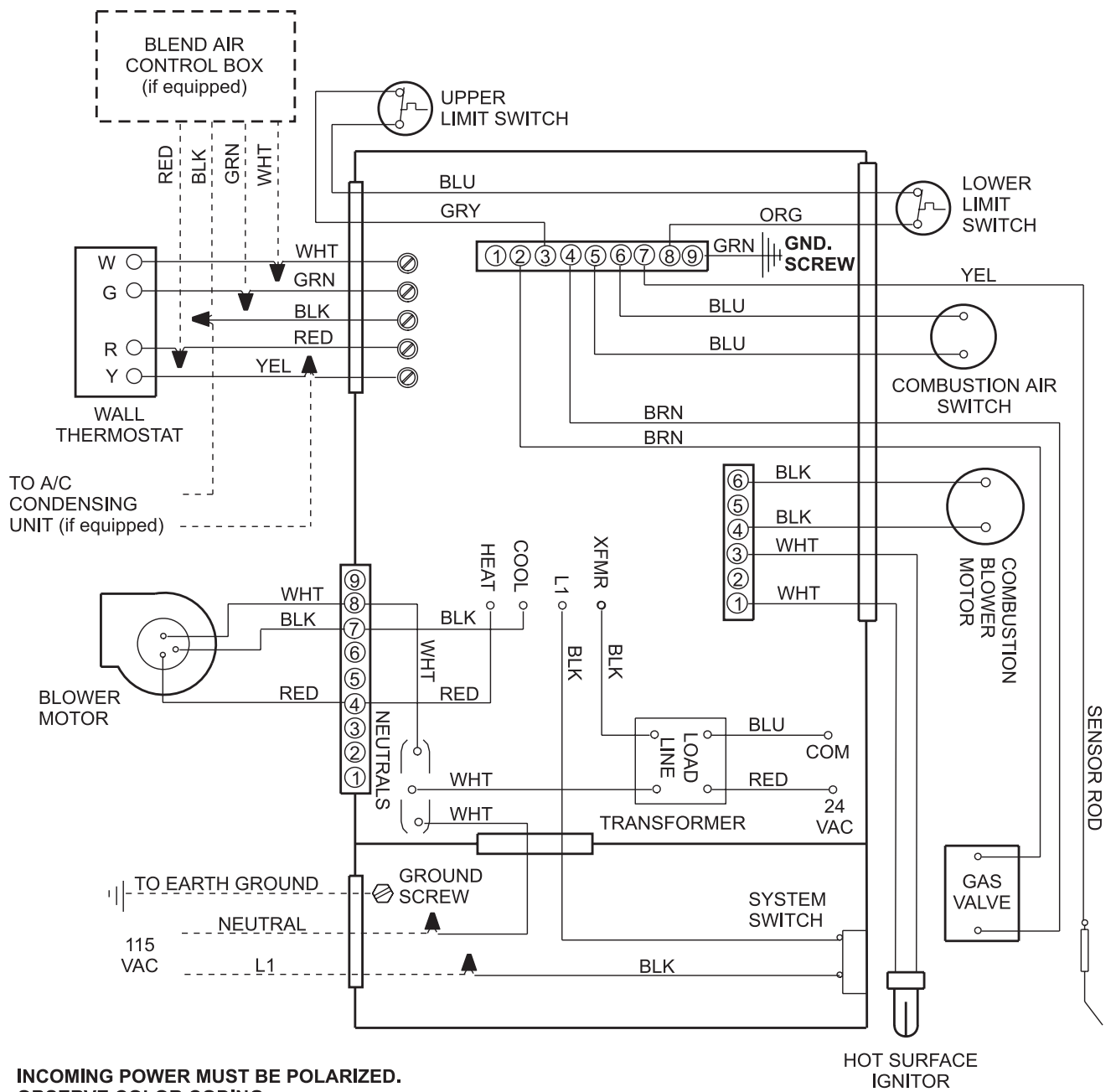
Check wiring integrity from fan switch #1 terminal at Cont./Auto switch. Repair/replace as required

## IFC SERIES SEQUENCE OF OPERATION



**Figure 6:**

Figure 7:





## HEATING SEQUENCE OF OPERATION

1. Two second system check when thermostat makes for heating.
2. Draft Inducer starts.
3. When draft proving switch closes, 30 second pre-purge starts. (needs 0.20 Water column)
4. Ignitor heats for 35 seconds (120 volts / 3- 6 amps).
5. Gas valve opens, Burner lights.
6. After flame is detected blower timing starts. (adjustable 60,75,90 second delay on startup).
7. When the thermostat is satisfied, circuit is open to W terminal.
8. Gas valve closes.
9. Draft Inducer continues to run for 15 second post purge period.
10. Blower continues to run for selected off delay (120, 150, or 180 seconds).

### NOTE:

The IFC will try three times for ignition then soft lock out. Retries for ignition after 60 minutes. If the burner sequence has been initiated for 15 seconds, then terminated by the operator, the blower will cycle through one complete cycle.

## COOLING SEQUENCE OF OPERATION

1. Terminals Y and G on IFC receive signal from thermostat.
2. Indoor blower energized through Cool terminal on IFC. Contactor holding coil energized by Y terminal on IFC.
3. When thermostat reaches set point, signal is removed terminals Y and G. Blower will continue to run for 18 second off delay and outdoor unit will cycle off immediately.

## VENTILATION SEQUENCE

1. Thermostat is set to Ventilation, G terminal on IFC energized by thermostat.
2. Indoor blower operates continuously.
3. Blend air operates continuously. (If applicable)
4. Thermostat set to Auto, G signal removed from terminal board.
5. Blower cycles off after 18 second delay and Blend Air cycle's off immediately.

## INTEGRATED FURNACE CONTROL (IFC) FUNCTIONS

The Integrated Furnace Control is polarity sensitive, will flash a six flash sequence if not wired correctly. A difference of 3 volts between L1 and Neutral, and from L1 to ground may cause intermittent flash codes. Also equipped with a three (3) amp automotive type fuse in the control circuit to protect the board from short circuit damage. Igniter resistance is 50-400 Ohms. Minimum micro amps 0.9 a.

The Draft Inducer will purge for thirty seconds before the igniter is energized. IFC will try for ignition three times then lock out for one hour. Diagnostic light will flash one flash sequence. After one hour unit will repeat ignition sequence.

If the manual (automatic on production 8/1996 UNTIL 4/2000) reset upper limit switch opens, gas valve closes, Draft Inducer and indoor blower run until upper limit is reset. Diagnostic light flashes a four flash sequence. When upper limit switch is reset, with thermostat calling for heat unit will initiate try for ignition. With demand for heat removed and upper limit is reset, blower will run for one timed off cycle (120, 150 or 180 seconds). Upper limit is a safety in the event of blower motor failure. Momentary power interruptions, probably won't cause limit trip.

If lower limit switch opens, gas valve closes and the Draft Inducer and blower motor will run until limit resets. Diagnostic light flashes four flash sequence. When lower limit switch closes, booster motor runs for a thirty second purge then ignitor is energized. Blower may cycle off if timed off cycle is set to 120 seconds.

If there are five faults in a given call for heat, control locks out for one hour. Draft Inducer is off and blower runs for timed off cycle then stops. After one hour lock out, the system will repeat ignition sequence.

If Draft Inducer proof switch will not close on a call for heat, the Draft Inducer motor will run for thirty seconds and diagnostic light will flash three flash sequence.

If Draft Inducer proof switch opens during heating cycle, the gas valves closes. Blower motor cycles off after selected off delay. Draft Inducer motor continues to run and diagnostic light flashes three flash sequence.

If Draft Inducer proof switch is closed on call for heat Draft Inducer motor will not run and diagnostic light flashes two light sequence.

If flame is sensed or gas valve is powered when there is no W signal, Draft Inducer and blower motor will run. Diagnostic light flashes a five flash sequence.

(NOTE: The Integrated Furnace control does not have memory. It does not remember if a trouble code happened and the trouble has passed and/or corrected itself. It Therefore reacts to an existing fault only.)

## **DGAA SERIES FURNACE WITH INTEGRATED FURNACE CONTROL**

### **Customer Complaint: NO HEAT**

#### **Conditions:**

**CAUTION:** The Integrated Furnace Control (IFC) is polarity sensitive. L1 source must go to L1 on control. The furnace must be grounded according to National Electric Code.

Diagnostic Light:	
No light:	No power or open fuse.
Steady Light:	Control has power.
One flash:	Ignition failure.
Two flashes:	Draft proving switch shorted.

Three flashes:	Draft proving switch stuck open.
Four flashes:	Limit switch open.
Five flashes:	Flame signal present with no call for heat.
Six flashes:	Incorrect polarity wired at furnace or no ground.(sometimes Rapid Flashing is same code)

- 1.Ensure line voltage is available at L 1- N on Integrated furnace Control (IFC). Check all fuses / breakers and switches. Insure line voltage is available at XFMR - Neutral on IFC.
2. Ensure 24 volts to secondary side of transformer.
3. If 0 volts on transformer secondary, replace transformer and check for an electrical short before powering unit.
4. If 24 volts are available on transformer secondary, check for 24 Volts at COM to 24 volts on IFC. If 0 volts insure wiring integrity - transformer to COM - 24 VOLTS on IFC.
5. If 0 volts at R-C on terminal block, check 3 (5 on early models) amp fuse for open circuit. If fuse is good replace IFC.
6. With 24 volts at R-C on terminal block, attach one voltmeter lead to C terminal. With other lead check voltage to W terminal and upper and main limits as well. (stat calling for heat)



Remove thermostat and check sub-base R-W, if 24 volts are present, replace thermostat. If 0 volts R to W, thermostat wire is open from furnace to thermostat, replace wire.

### **Customer Complaint: NO INDOOR BLOWER MOTOR**

IFC is set up with either a 120, 150, or 180 second time delay, motor will energize after the gas valve is energized.

If motor is equipped with a run capacitor, check capacitor for an open, shorted or grounded condition before proceeding. Check blower plug (White) pins 4, 7, 8 & 9 to insure good connections.

If motor is **hot** to touch, it may be off on internal overload. Allow time for the overload to reset before condemning motor. Spin impeller by hand, if it does not spin freely you must replace the motor.

From 1 to 1 1/2 minutes after gas valve is energized and with flame proven, attach one voltmeter lead to heat terminal on IFC with other lead check voltage to Neutral terminal.

### Do you read line voltage?

Yes ←————→ No

Motor has malfunctioned. Replace motor.

Integrated furnace control has malfunctioned. Replace control.

End blower motor trouble shooting

### Customer Complaint: No Draft Inducer motor

1. Diagnostic light will be flashing a three flash sequence.
2. Draft Inducer motor should be energized within two seconds after thermostat closes.
3. If 0 volts present at pins 4-6 (the two black wires) on 6-pin connector, IFC has malfunctioned, replace IFC.
4. If line voltage is present across pins 4 and 6 on 6-pin connector, insure Draft Inducer turns freely.
5. If Draft Inducer impeller turns freely, replace Draft Inducer assembly. **CAUTION!!!** Low current flow because of a small thermostat wire or low line voltage can cause the IFC relays not to have enough current available to keep them energized and can lead to random flash codes. If voltage at the thermostat terminals W and C drops to as little as 22 Volts this condition can occur. It is best to use 18 Gauge wire that has not been damaged or pinched.

### Customer Complaint: Limit trip:

Determine conditions under which it trips. (always check limit trip condition with all doors in place and in a normal position). Check Air Temperature rise (ATR) to data plate rating. Check ATR by placing one thermometer lead in return air flow, other lead in register closest to furnace. The difference in temperature is ATR. If ATR is higher than rating, furnace is over fired or CFM is too low (Check orifice size or duct connections). If ATR is within rating, check the blower on time, it should be 60 to 90 seconds (adjustable) from flame on. Adjust blower on time by either the dip switches or the jumper pins and set to Middle point of ATR. If Blower on time is correct, check Blower off time. Should be 120-180 seconds (adjustable).

Manual reset upper limit will trip if blower motor fails while burner is firing. Check and reset upper limit. Confirm IFC timing and check blower motor for weak internal protector by locking wheel down by mechanical means (screwdriver wedged between wheel and housing) and let motor pull locked rotor amps. A weak protector (overload, winding thermostat) will trip in a minute or less. A room temperature motor will pull locked rotor amps for 5-6 minutes before the protector trips.

Fuse: If open check control wiring for short, staples etc.

**CAUTION:** Never wire terminal board with furnace power on. Momentarily touching two adjacent wires will open the fuse on IFC.

Symptom	Possible Cause	Remedy
No Flame	No Fuel	Insure gas supply to inlet of valve
		Turn Gas valve “on”
	Orifice Restricted	Clean Orifice
Igniter not glowing	IFC lockout	Reset IFC by interrupting power
	No 24 VAC at IFC	Insure 24 VAC (look at LED Status) Replace transformer/fuse
	No 120 VAC to Igniter	Check 120 VAC into IFC and 120 VAC out the 6 pin connector. No Volts IFC has failed.
	Igniter Open	Igniter resistance is 50 to 400 Ohms at room temperature, replace igniter
Burner Fails to light	Polarity Reversed	Insure 120 VAC
	Furnace Not Grounded	Ground Furnace to NEC code
	Igniter Position	Confirm igniter position
	Igniter Cracked	Ohm igniter and replace
	Igniter Oxidized	Replace igniter
	Gas Valve Open	Check gas valve for current draw, if none replace valve
	High Gas Pressure	Check line pressure, must be less than 14.3” or less than 1/2 PSI
Burner Fails to stay on	Low microamps reading	Check Flame quality, adjust fuel/ air ratio
	Igniter Position	Reposition igniter
	Igniter Oxidized	Replace igniter, check fuel/ air ratio
	Sensor position	Reposition sensor
	Main Limit Trip	Check ATR, if within range, replace limit
	Sensor Oxidized	Clean Sensor with steel wool or replace
	Upper Limit Trip	Check ATR, if within range, check Fan timings, check blower motor
Burner Fails to Shut off	Gas valve sticks open	Replace valve
	Control wiring shorted	Correct wiring

Symptom	Possible Cause	Remedy
	IFC failed	Replace IFC
	Furnace Not Grounded	Ground Furnace

Checking the hot surface ignition system with Remote sensor.

The Hot Surface Ignition system (HSI) depends on flame rectification to send a very small signal in Direct Current (a, Micro amps) to the ignition module. With a furnace voltage of 115 volts this current is about 4.0 a. Figure 23 shows the typical connection of a multi-meter with a adapter on an HSI system that uses Remote Sense. Remote sense means that a separate flame rod is the flame sensor. An Alternating Current (usually around 86Volts AC) is sent out to flame rod by the IFC and the flame converts this to a Direct Current. This is flame rectification. Converting an AC current to a DC current. This current is read in micro amps which is .000001 of an amp. The multimeter displayed in Figure 23 can do almost all of the electrical troubleshooting an HVAC service technician would need.

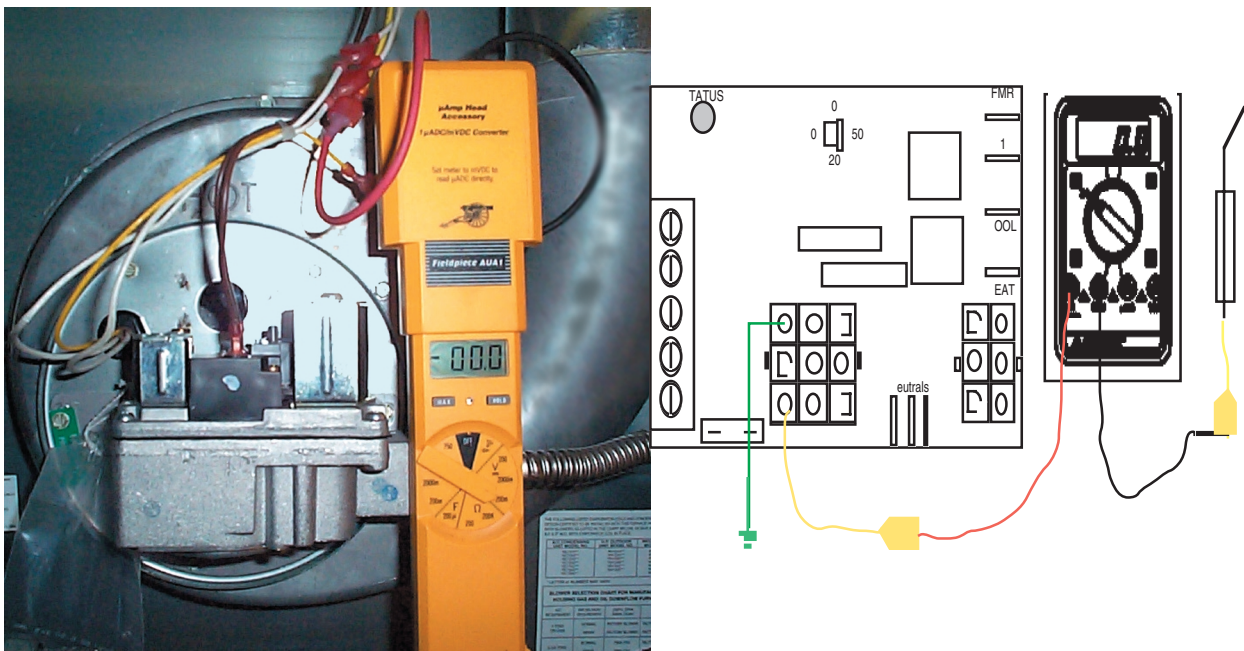
The flame rectification current that we are measuring follows a path from the module through the meter to the flame sensor, flame burner assembly, sheetmetal and back to the module through the ground screw and the Green wire attached to Pin #9 of the connector.

If the meter reads the correct microamps and the furnace won't stay lit, the IFC may have failed, but the service tech should only reach this conclusion after the flame pattern and fuel pressure have been checked. It would be obvious that if the flame burns for a few seconds and gradually decreases inside and gets dark that it is running out of oxygen. If it is running out of oxygen, then something is wrong in the flue or the air passage way to the furnace.

If you have a good flame and fuel pressure and volume is OK and the voltage has been checked, it is possible for the flame rod to have a high resistance from (rust or oxides) on the flame rod. Clean with steel wool or a file, never use Sand cloth (ALUMINUM Oxide) or the corrosion rate will increase.

Always confirm Polarity and carefully check the power supply for not only AC voltage but a DC signal as well. An uninvited DC signal coming into power wiring could enter the IFC through the ground wire and interrupt the flame circuit.

You may use the flame rectification current as an indicator of the quality of combustion, as long as the fuel pressure, orifice size and voltage, ATR are within the furnaces operating range to begin with.



**Figure 8:**

The above diagram illustrates how to connect a multi meter to the integrated furnace control. This control will sense about 4.0 a in its best operation. Lockout still occurs around 1.0 a to 0.9 a. Burner condition and the combustion process is the most difficult for the apprentice service technician. To adjust a burner strictly by color is a guess at how well the combustion process is working. Most persons will have a difference of opinion on just what color is blue or yellow so the following illustrations of burners and descriptions of where the blue or yellow should be located in the flame will assist the beginning technician in learning how to adjust the fuel and oxygen ratio. This ratio can only be adjusted by varying the fuel pressure. These furnaces do not have burners with air adjustments. The fuel pressure and volume can be changed to the standard of furnace 3.5 of Water Column Pressure for Natural Gas and 10 of Water Column for LP gas. Technicians that want to use a combustion analyzer to check for CO<sub>2</sub> should raise the flue up until the inner pipe just slips over the heat exchanger nipple by 1/2 or so and drill a sample hole in the inner flue pipe just above the nipple, take the flue sample then when the pipe is telescoped back on the nipple the sample hole will be covered back up.



**Figure 9:**



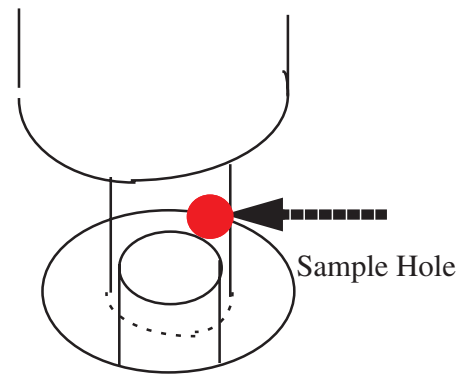
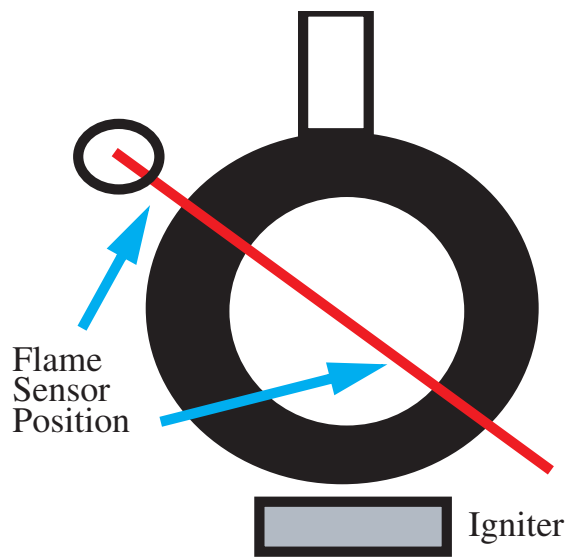


Figure 10:

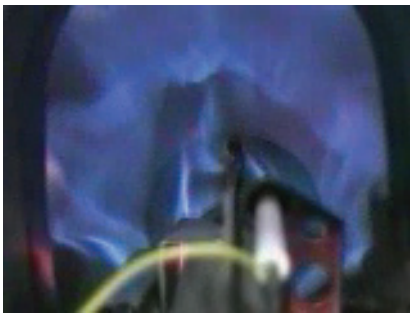


Figure 11:

In Figure 25 above the left photo shows a flame that has adequate air for combustion and the flame on the right shows a need for more air for proper combustion.



Figure 12:

In Figure 26, the flame has consumed the available oxygen out of the air and is barely supporting combustion. If this condition is present, combustion will last only a few seconds and the service

technician should turn off the gas valve, let the furnace cool down and inspect the flue and combustion air for obstructions etc. The flame condition that is depicted could become hazardous if you are peeking at the flame through the observation port under these conditions and very fast combustion were to occur.

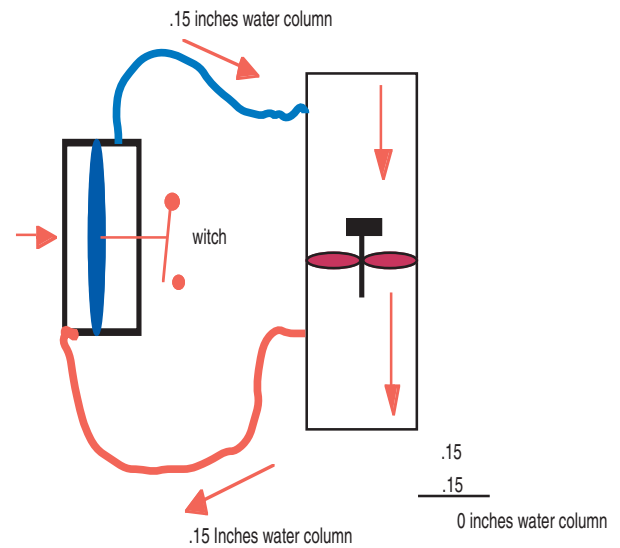
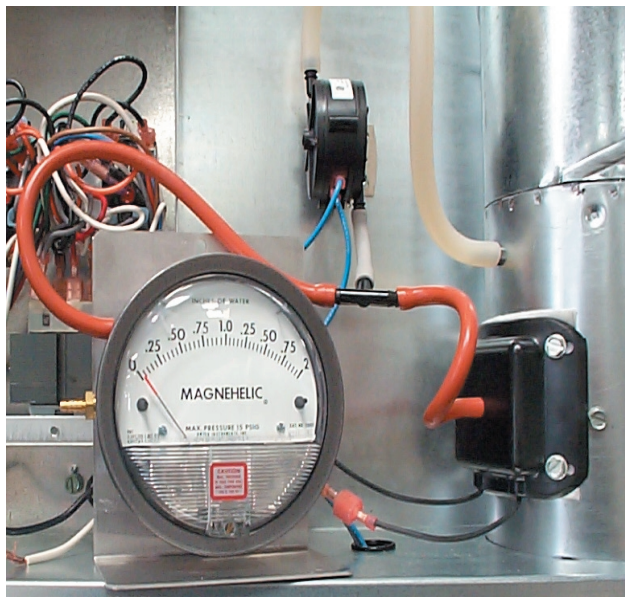
### Draft Proving Switch and Booster Assembly

The Draft proving switch activates at 0.20 inches of air pressure developed by the propeller blade. The amount of pressure depends on the flue system and the passages in the heat exchanger. If either the flue assembly or the heat exchanger is restricted the pressure developed by the draft inducer will increase. If the flue assembly is missing or is damaged the draft inducer may not develop enough pressure to close the switch. The pressure switch is normally open and the suction pressure from the intake side and the positive pressure from the output side both add up to a positive pressure on the diaphragm of the pressure switch, which causes the electrical contacts inside the pressure switch to come together completing the circuit to the IFC.



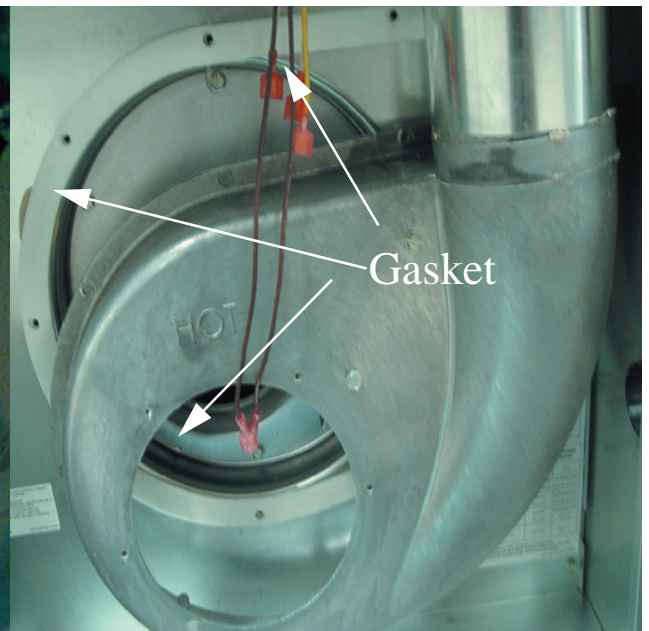
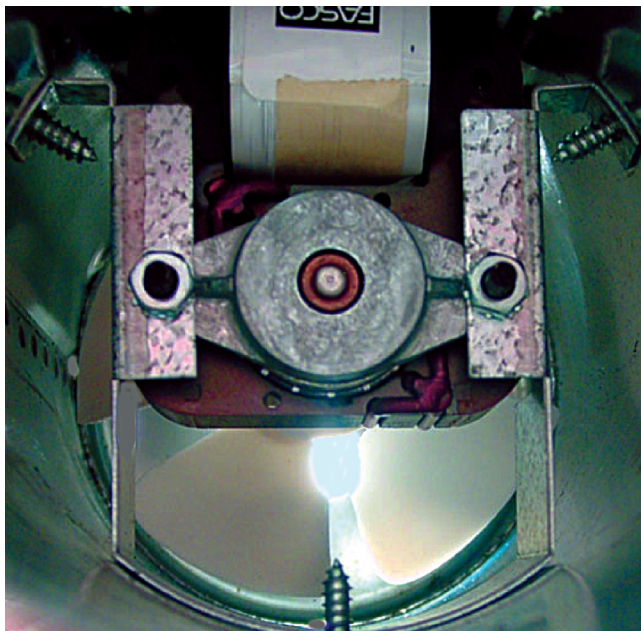
**Figure 13:**

The photo on the left shows the pressure switch with the Suction pressure hose on top and the positive pressure hose on the bottom. The photo on the right shows a magnahelic gauge hooked up to the negative pressure side. When the draft inducer starts pulling in combustion air from the roof jack it will develop a suction negative pressure on the flue. If the inducer is developing at least 0.20 inches or 1/5 inch of pressure the pressure switch should close. If there is at least that much pressure and it doesn't close, it is defective. If the inducer is not developing at least 0.20 inches of pressure then the draft inducer may have failed. The pressure must be measured on the suction side and the output side of the draft inducer. Notice Figure 28 shows that the suction and



**Figure 14:**

positive pressure add up as positive numbers to equal the amount of force necessary to close the switch and prove the inducer is running and providing air for combustion. To remove the booster



**Figure 15:**

assembly to check for foreign material or to replace the assembly the front air box may be removed. Be careful not to destroy gasket around front air box.



Booster is replaced  
as an assembly.

**Figure 16:**



## FURNACE SET-UP CHECK LIST

ONLY INDIVIDUALS HAVING PROVEN EXPERIENCE WITH THIS TYPE OF EQUIPMENT SHOULD ATTEMPT TO PERFORM SET-UP.

\_\_\_ IS CORRECT ROOF JACK INSTALLED?

\_\_\_ HAS ROOF JACK CROWN BEEN CORRECTLY INSTALLED AND WEATHER SEALED?

\_\_\_ HAS FURNACE GAS VALVE AND BURNER ORIFICE BEEN CORRECTLY CONVERTED FOR LP GAS WHERE APPLICABLE?

\_\_\_ HAS FURNACE GAS ORIFICE BEEN DE-RATED FOR ALTITUDES ABOVE 2000 FEET WHERE APPLICABLE?

\_\_\_ IS HEAT ANTICIPATOR ON THERMOSTAT PROPERLY SET?

\_\_\_ IS GAS VALVE OUTLET PRESSURE PROPERLY SET FOR FUEL TYPE? NATURAL GAS IS 3.5" W.C. LP IS 10" W.C?

\_\_\_ OIL FURNACE PUMP PRESSURE IS 100 PSI

\_\_\_ IS PRIMARY AIR PROPERLY ADJUSTED PER INSTALLATION INSTRUCTIONS? (on older furnaces)

\_\_\_ IS CROSS-OVER TAKE-OFF COLLAR DIRECTLY UNDER FURNACE?

\_\_\_ IS CROSS-OVER DUCT INSTALLED PER INSTALLATION INSTRUCTIONS?

\_\_\_ HAS FURNACE BEEN TEST FIRED, COMPLETING A FULL BURN AND BLOWER CYCLE?

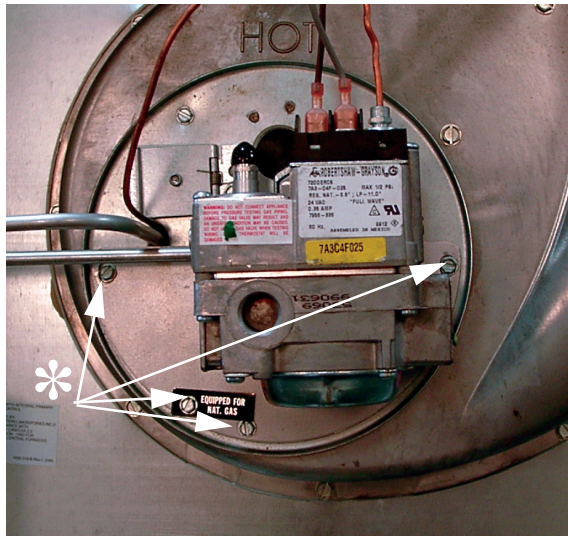
\_\_\_ HAS HOMEOWNER BEEN INSTRUCTED IN THE PROPER OPERATION OF THE FURNACE?

PROPER FURNACE SET-UP AND ADJUSTMENT IS THE RESPONSIBILITY OF THE RETAILER - HOMEOWNER AND IS NOT COVERED UNDER WARRANTY.

The above check list should be performed at a minimum on every service call, in addition the air temperature rise should also be checked. Improper set-up and adjustment is a major reason for a furnace to fail prematurely.

## Fuel Conversion

These furnaces feature a convertible gas valve and come equipped with an orifice and an identifying tag. Remove the screws in the figure below to be removed to swing the gas valve and burner



**Figure 17:**

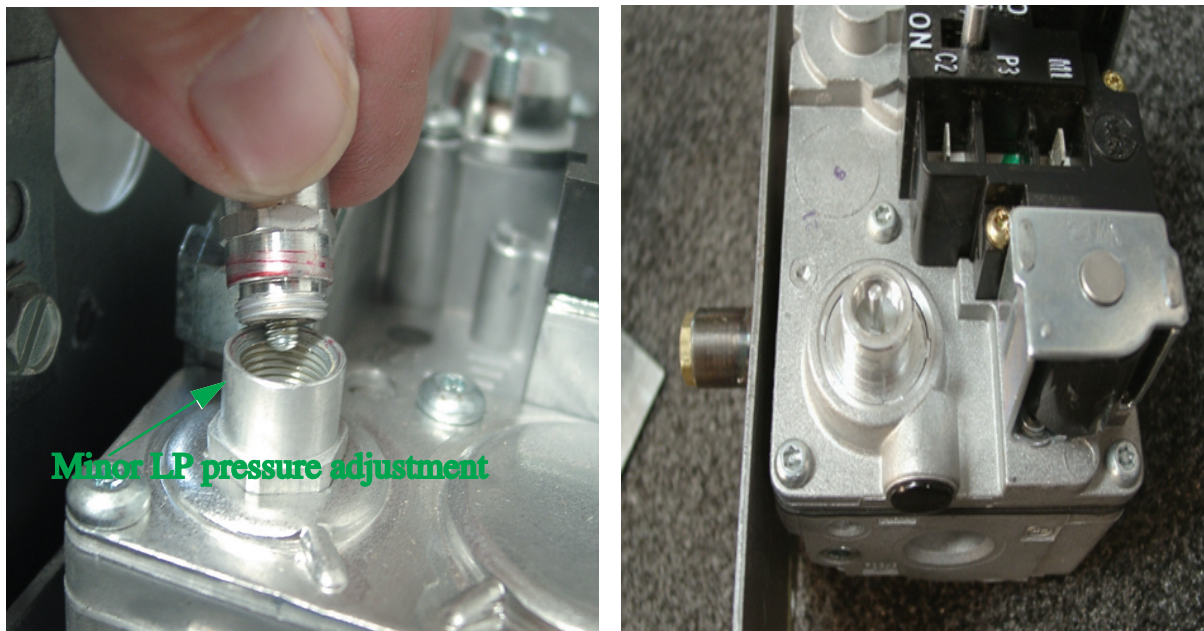
spud out (still connected to the pilot line) and use a 1/2" wrench to remove the orifice. And in the figure below notice the size of the LP orifice on the left as compared to the Natural gas orifice on the right.



**Figure 18:**

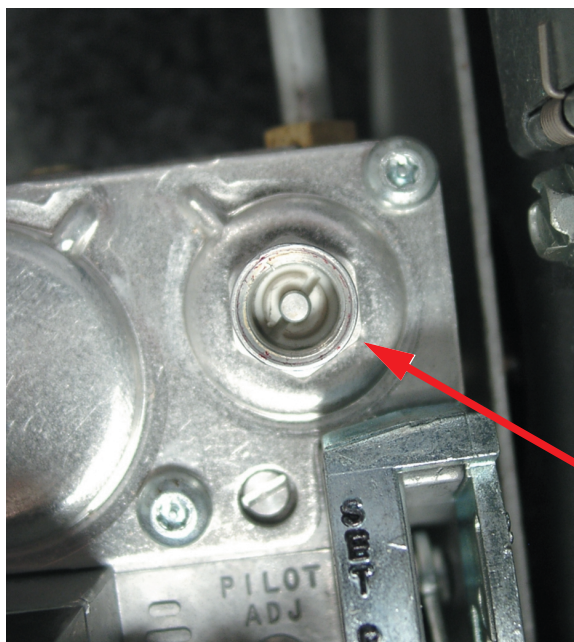
Convert the gas valve from a regulating Natural Gas pressure to a NOT-regulating LP pressure.

The conversion stem is reversed which disables the pressure regulation function of the valve.

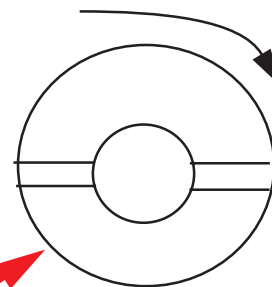


**Figure 19:**

The conversion is only complete when a manometer is connected to both the Line pressure tap and the manifold pressure tap. The fuel pressure must be checked with all other appliances on and operating at the same time the furnace burner comes on. Only with this method can you evaluate if the LP fuel system can deliver enough fuel to fire the furnace.



Natural Gas only turn Clockwise to increase Manifold pressure to 3.5"WC



Pressure adjusting ring.

**Figure 20:**

Liquefied Petroleum pressure is regulated by a first stage regulator on the tank and a lower pressure regulator on the house. The LP Supplier should be consulted on adjustment of these regulators.



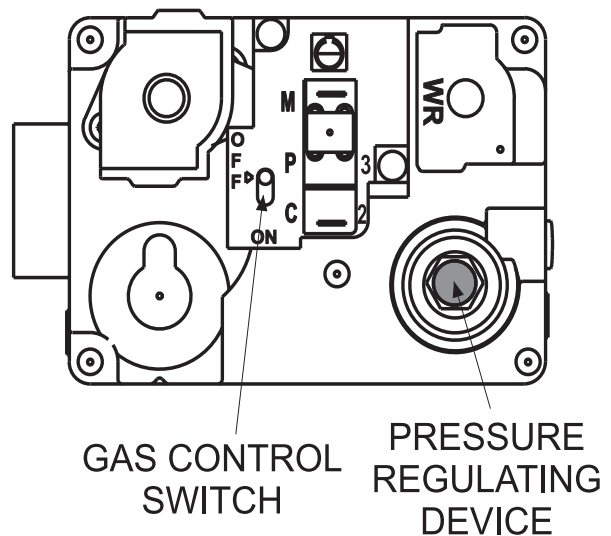
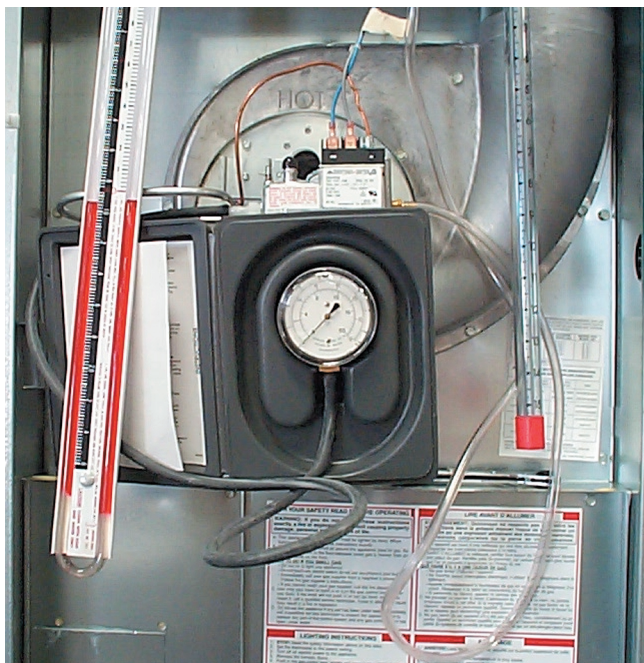


Figure 21:

### Igniter Troubleshooting

The hot surface igniter is a silicon material that gets very hot when a current is passed through it. At 115 volts the igniter draws 3-6 amps of current. To check an igniter use an ohm meter and ohm through the igniter leads. At room temperature the resistance should be from 50 to 400 Ohms. Warning ! Remove igniter carefully the slightest jarring will break it!

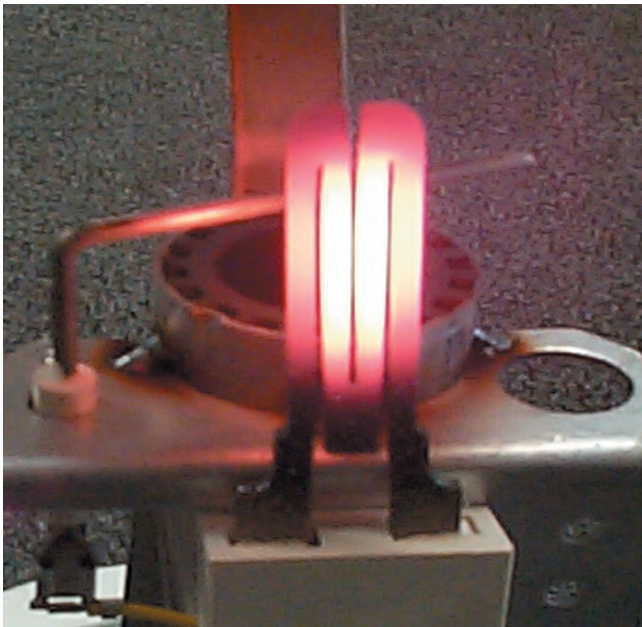


Figure 22:

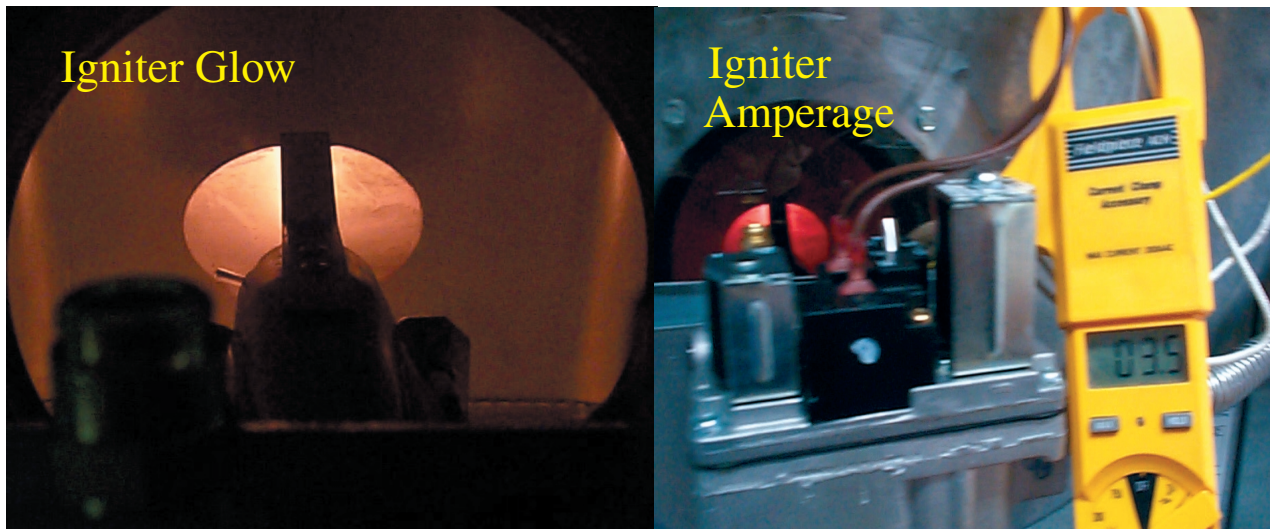
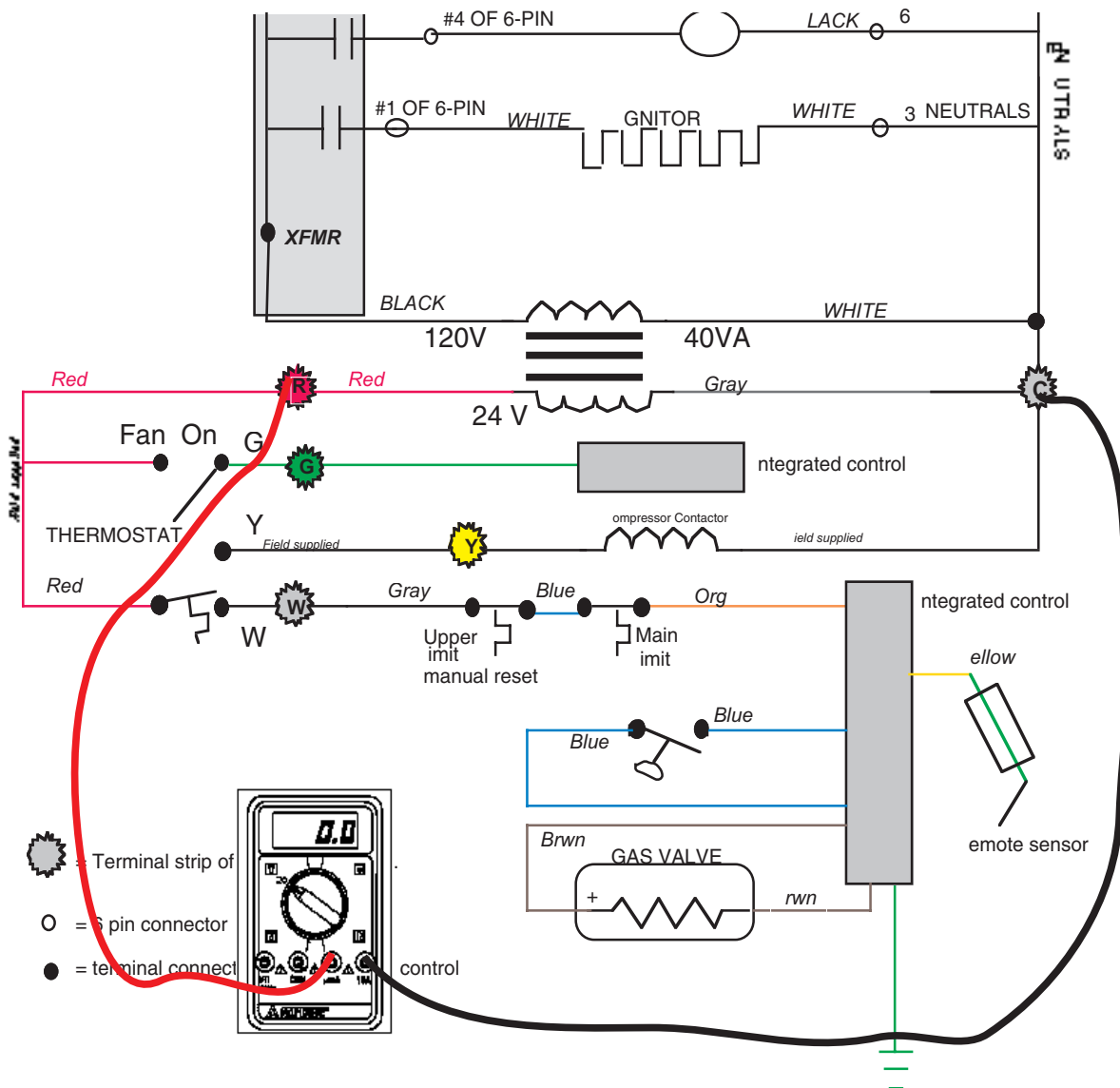


Figure 23:

## Thermostat Circuit



**Figure 24:**

When troubleshooting the furnace pay attention to the voltage at terminals W and C or heat and common or Y and C or G and C . The thermostat wire should be at least 20 Gage (AWG), if smaller wire is used or it is damaged the amount of current the IFC requires to perform its functions will not be available. A volt meter placed at: W and C ; Y and C ; G and C will show a drop in voltage to 23 volts or less. A jumper placed on W,Y or G to R will eliminate the thermostat and wire as a source of trouble. Use the meter probes carefully on the IFC terminal strip to check voltage, a slip here could blow the fuse. The common side of the transformer is grounded through the circuit board. If the fuse is open, remove power and with a multi-meter set on ohms and check from R to the cabinet, if there is continuity then you have a short somewhere. A good place to look is where the thermostat wire exits the furnace cabinet between the cabinet and the wall studs. The wire is easily shorted with screws or nails.

## MANUFACTURED HOUSING APPLICATION

### Heat Gain

Probably the most critical factor in sizing a heat pump or Air Conditioner is accurately calculating the cooling load requirements. This is probably the most difficult factor as well. Due to the variable nature of the cooling load as influenced by climate and the orientation of the home, there can be no accurate cooling load estimate without knowing the final site, location and orientation.

Basically, the heat gain and the heat loss of a structure are identical functions. In both instances, heat is moving to the colder side of a partition. During the winter, the heat inside the structure is moving to the colder area outside and during the summer, the heat outside the structure is moving to the colder area inside. Heat always moves from the warmer area to the colder area. The amount of heat that is transmitted is governed by the amount of resistance to heat flow by the construction material and the difference between the temperature inside and outside the structure. The heat flow accelerates as the temperature difference between the two areas becomes greater.

In calculating the heat gain of a structure, consideration must also be given to a number of variables besides the construction materials and temperature difference. Both the occupants and appliances inside the home produce heat that must be overcome by the cooling equipment. In addition, cool air is extracted from the home through means of positive ventilation such as range hoods and bathroom exhaust fans. All of these variables must be given prime consideration in calculating an accurate heat gain to determine the correct heat pump or air conditioner size.

On July 15, 1976, the Federal Mobile Home Construction and Safety Standard (better known as the H.U.D. Standard) went into effect, covering all manufactured homes produced on or after that date. The standard has some very strenuous regulations concerning air conditioning sizing, as it relates to duct systems. This will be covered in another section of this manual, however, it does relate to the calculation of the heat gain.

It is required by the Standard that a Comfort Cooling Certificate be placed somewhere in the home to signify what considerations were made concerning the cooling of the home at the time the home was produced by the manufacturer. The Standard allows for three alternatives in meeting this requirement.

Alternative #1 is used when the manufacturer supplies an air conditioner as original equipment with the home at the time the home leaves his factory. When meeting this alternative, he must place the following certificate inside the home.



**Alternative 1****Comfort Cooling Certificate**

Mobile Home Manufacturer\_\_\_\_\_

Plant Location\_\_\_\_\_

Mobile Home Model\_\_\_\_\_

Air Conditioning Manufacturer\_\_\_\_\_

Air Conditioning Model\_\_\_\_\_

Certified Capacity - B.T.U./Hr. in accordance with the appropriate Air Conditioning and Refrigeration Institute Standards.

The central air conditioning system provided with this home has been sized assuming an orientation of the front (hitch end) of the home facing. On this basis the system is designed to maintain an indoor temperature of 75° F. when outdoor temperatures are \_\_\_\_\_°F dry bulb and \_\_\_\_\_°F wet bulb. The temperature to which this home can be cooled will change depending upon the amount of exposure of the windows of this home to the sun's radiant heat. Therefore, the home's heat gains will vary dependent upon its orientation to the sun and any permanent shading provided. Information concerning the calculation of cooling loads at various locations, window exposures and shadings are provided in the ASHRAE Handbook of Fundamentals.

Information necessary to calculate cooling loads at various locations and orientations is provided in the special comfort cooling information provided with this mobile home. (Example 4).

Alternative 2 identifies that the manufacturer designed the home with the intention that air conditioning could be installed later. The certificate specifies the maximum number of BTU's per hour that the duct system is capable of handling based upon actual tests performed on the duct design. Under Alternative 2, the following certificate will be placed inside of the home.

**Alternative 2****Comfort Cooling Certificate**

Mobile Home Manufacturer\_\_\_\_\_

Plant Location\_\_\_\_\_

Mobile Home Model\_\_\_\_\_

This air distribution system of this home is suitable for the installation of central air conditioning. The supply air distribution system installed in this home is sized for Mobile Home Central Air Conditioning Systems of up to \_\_\_\_\_ B.T.U./Hr. rated capacity which are certified in accordance with the appropriate Air Conditioning and Refrigeration Institute Standards when the air circulators of such air conditioners are rated at 0.3 inch water column static pressure or greater for

the cooling air delivered to the mobile home supply air duct systems.

Information necessary to calculate cooling loads at various locations and orientations is provided in the special comfort cooling information provided with this mobile home. (Example 4).

If the manufacturer of the home has chosen to design to Alternative 1 or 2. He must also place inside the home information necessary to calculate the sensible heat gain (see Example 4).

#### Information Provided by the Manufacturer Necessary to Calculate Sensible Heat Gain

Walls (without windows and doors)	U	_____	_____
Ceilings and roofs of light color	U	_____	_____
Ceilings and roofs of dark color	U	_____	_____
Floors	U	_____	_____
Air ducts in floor	U	_____	_____
Air ducts in ceilings	U	_____	_____
Air ducts installed outside the home	U	_____	_____
Information necessary to calculate duct area			

#### Example 4

If the manufacturer chooses to design to Alternate 3, he did not consider the application of air conditioning at the time the home was designed nor is the duct system certified for air conditioning. At this point, it will be up to the installer to determine the information necessary to calculate the heat gain and see that the duct system is adequate.

#### Alternate 3

Mobile Home Manufacturer \_\_\_\_\_

Plant Location \_\_\_\_\_

Mobile Home Model \_\_\_\_\_

The air distribution system of this home has not been designed in anticipation of its use with a central air conditioning system.

Using the information provided by the manufacturer (Example 4) the installer can now calculate the heat gain of the home. Included in this manual is a sample work sheet that can be used by the installer to determine the cooling requirements of the structure. Also included are tables necessary to evaluate the actual site conditions and their effect on the cooling load.

If no information is available concerning the U values or any criteria necessary for calculating the cooling requirements, it may be necessary to the installer to develop the information himself.

## Manufactured Housing Heat Gain Estimate

### Sample Worksheet

Customer \_\_\_\_\_ Date \_\_\_\_\_

Address \_\_\_\_\_ Box Size (W) X (L) \_\_\_\_\_

City & State \_\_\_\_\_ Ceiling Height \_\_\_\_\_

Perimeter (2 X (Width) + (Length) ft. \_\_\_\_\_ Ceiling Area \_\_\_\_\_ ft.

Floor Area (Width)X (Length)ft.<sup>2</sup> \_\_\_\_\_ Gross Wall Area \_\_\_\_\_ft.<sup>2</sup>

### Wall Gain

1. Walls	Area	U-Value	ETD	Heat Gain
A. Gross Wall				
B. Window Area				
C. Patio Glass Door				
D. Door Area				
E. Net Wall				
	(A) Minus (B+C+D) = Net Wall See Table 4 for ETD's			
2. Ceiling	Area	U-Value	ETD	Heat Gain
A. Gross Ceiling				
B. Duct Area				
Only Duct in ceiling				
E. Net Ceiling				
	(A) Minus (B) = Net Ceiling See Table 4 for ETD's			
3. Floors	Area	U-Value	ETD	Heat Gain
A. Gross Floor				
B. Duct Area				
C. Net Floor				
	(A) Minus (B) = Net Floor See Table 4 for ETD's			
4. Doors	Area	U-Value		Heat Gain
	See Table 7			
5. Windows (Solar)	Area	U-value		Heat Gain



Facing North				
Facing South				
Facing East & West				
	See Table 5			
6. Windows (Sensible)	Area	U-value		Heat Gain
	See Table 6			
7. Patio Door (Solar)	Area	U-value		Heat Gain
	See Table 5			
8. Patio Door (Sensible)	Area	U-value		Heat Gain
	See Table 6			

9. Duct  $(\text{Area}) \times (\text{U-Value}) \times (\text{times}) \times \text{Design Temp. Diff.} =$

---

10. External Duct  $(\text{Area}) \times (\text{U-Value}) \times (\text{times}) \times \text{Design Temp. Diff.} =$

---

$$\text{Area} = \frac{(\text{Diameter} \times 3.14 \times \text{length})}{12}$$


---

11. Occupancy Load #of persons  $\times 225$  (225 is the Heat Gain Factor) =  
(2 persons per bedroom)

12. Appliance Load \_\_\_\_\_

13. Positive Ventilation  $\begin{matrix} \text{Multiplier} \\ 1.08 \end{matrix} \begin{matrix} \text{Heat Gain factor} \\ 250 \text{ CFM} \end{matrix} \begin{matrix} \text{Design Temp. Diff.} \\ X \end{matrix} =$  \_\_\_\_\_

14. Infiltration  $\begin{matrix} \text{Multiplier} \\ .35 \end{matrix} \begin{matrix} \text{Heat Gain factor} \\ x \text{ Perimeter} \end{matrix} \begin{matrix} \text{Design Temp. Diff.} \\ X \end{matrix} =$  \_\_\_\_\_

15. Total Sensible Heat Gain (Total Heat Gains from No. 1 through No. 14) \_\_\_\_\_

16. Latent Heat Gain (Multiply Line 15 by Heat Gain Factor from Table 8) \_\_\_\_\_

17. Total Heat Gain (Total Lines 15 and 16) \_\_\_\_\_

## 18. Outside Ambient Correction

(Multiply Line 17 by Correction Factor from Table 9)

Grand Total Heat Gain

TABLE 4

Design Temperature	90F	95F		100F		105F	110F
Daily Temperature Range	L or M	M	H	M	H	H	H
Wood Frame Walls	18.6	23.6	18.6	28.6	23.6	28.6	33.6
Solid Masonry, Block or Brick Walls	11.3	16.3	11.3	21.3	16.3	21.3	26.3
Partitions	10	15	10	20	15	20	25
Dark Colored Exterior roof	39	44	39	49	44	49	54
Light Colored Exterior roof	31	36	31	41	36	41	46
Floor over Unconditioned space	10	15	10	20	15	20	25
Floor over Conditioned space	0	0	0	0	0	0	0

\* Daily Temperature Range M=15° to 25°F swing in 24 hours

L=Less than 15°F swing in 24 hours H=Over 25°F swing in 24 hours

TABLE 5

Solar Heat Gain Factors (Btuh per square foot) Windows and Patio Glass Doors

Direction Glass Faces	North	South	East& West	NE & NW	SE & SW
Regular Single Glass	11	20	43	28	36
Regular Double Glass and Storm Windows	10	18	40	26	34
Heat-Absorbing Double Glass	7	13	28	18	23

TABLE 6

Air to Air Heat Gain Factors (Btuh per square foot)  
Windows and Patio Glass Doors

Outdoor Design Temperature	90°F	95°F	100°F	105°F	110°F
Single Glass	8	12	16	20	24
Double Glass and Storm Windows	4	7	9	11	13

TABLE 7

Heat gain factors (Btuh per square foot)  
Doors (Other than Patio Glass Doors)

Outdoor Design Temperature	90°F	95°F	100°F	105°F	110°F
Doors	11	14	16	18	19

TABLE 8  
Latent Heat Gain Multiplier

Design Wet Bulb Temperature	Percent Latent Load Multiplier
70°F W.B. or less	0.2
More than 70°F W.B. but less than 78°F W.B.	0.3
More than 78°F W.B.	0.4
Design Wet Bulb Temperature	Percent Latent Load Multiplier

TABLE 9  
Outside Ambient Correction Multipliers

Outside Design Conditions		For 3°F Indoor Temperature Swing, Air cooled Units.
Temperature °F	Daily Range	
90	Medium	1
90	Low	1.01
95	High	1.05
95	Medium	1.06
95	Low	1.07
100	High	1.11
100	Medium	1.12
105	High	1.19
105	Medium	1.2
110	High	1.25

## Heat Loss

In recent years, most manufactured homes have been built to the Federal Mobile Home Construction and Safety Standard (better known as the HUD Standard). Under these standards it was required that a certificate be placed in the home specifying the lowest outside temperature at which the heating appliance will maintain 70° F inside the home. By examining this certificate, it is quite easy to determine the heat loss of the home. In simple terms, the heat loss of the home is equal to the BTU output of the furnace at the temperature specified on the certificate. For example, let us assume that the home is equipped with a furnace that has an output of 55,300 BTU s per hour. In examining the certificate it is found that this furnace will maintain 70° F inside the home at an outside temperature of -15° F. In simple terms, the heat loss of the home is 55,300 BTU s per hour at 15° F.

In some cases, the temperature shown on the certificate will be considerably lower than the actual winter temperatures that are experienced at the actual location of the home. The reason for this is quite simple, since the manufacturer of the home has no control over the final destination, it is necessary to size the furnace to cover most winter conditions that are experienced in his marketing zone. Therefore, the installer may want to convert the heat loss as developed above, into a heat loss for the home as it sets at its final destination. This can be done by simply dividing the heat loss by the temperature difference to obtain a heat loss at a 1° F temperature difference. In the example above, the temperature difference would be the difference between 70°F (inside design temperature) and 15°F (outside design temperature). The total temperature difference is 70° F ( 15° F)= 85° F. Therefore: 55,300 BTU s divided by 85° F = 650.588. Now let s assume that the winter design temperature for the locale of the home is -5° F, this would give us a new temperature difference of 75° F. Our adjusted heat loss would be equal to the heat loss at 10° F temperature difference, multiplied by the new temperature difference. In this case, it would be 650.588 BTUH X 75° F = 49,794. In other words, the heat loss of the structure would be 48,794 BTU s per hour at -5° F outside temperature.

Since the heat loss of the home is linear, the above exercise will allow the installer to calculate the heat loss of any home, directly from the information given on the heating certificate. Plus he can then adjust the heat loss to better represent actual conditions at the final destination.

One note of caution, when dealing with electric furnaces, be sure to use the rated output of the furnace at 230 Volts instead of the output at 240 Volts as shown on the name plate of the furnace. Since the final destination of the home is generally not known at the time the furnace is installed, it is accepted engineering practice to size the furnace at its 230 Volt BTU per hour output. The reason for this is that line voltage vary from one locale to another.

If a heating certificate has not been placed in the home, it may be necessary to calculate the heat loss. Use an approved method, either ASHRAE 1993 Handbook of Fundamentals or ACCA manual J to calculate the heat loss.

## MANUFACTURED HOUSING DUCT SYSTEMS

## Existing Duct Systems

Most manufactured housing builders prefer to use one duct size as a standard system, varying only the number of registers installed in the duct. This means that there is no change in the duct system for various models of furnaces or air conditioners which may be installed. The duct is usually sized for the largest furnace or air conditioner which will be used.

If the home was built after July 15, 1976, then it would have been built to the requirements of the Federal Mobile Home Construction and Safety Standard which stipulated some strenuous regulations concerning duct systems as they relate to air conditioning sizes, as explained in the preceding section on heat gain.

As stated earlier, under this Standard the manufacturer is required to place a certificate inside the home regarding his design intention concerning the air conditioner of the home. In one instance, if an air conditioner was supplied with the home as original equipment, the certificate would specify the size of air conditioner to be used. In this instance, one can only assume that the duct system is of adequate size to supply sufficient air to meet the requirement of the air conditioner listed.

Under a second alternative, the certificate states that the air distribution system is sized for a specified BTU s per hour of air conditioning. This means that the ducts have been tested and will adequately handle the air requirements of the specified air conditioner size.

Under the third alternative, the manufacturer simply states that the air distribution system was designed without air conditioning in mind.

Should the manufacturer use one of the first two alternatives, the installer only needs to check the size of the heat pump or air conditioner that he intends to use against the size of heat pump or air conditioner stated on the certificate. As long as the specified cooling BTU per hour size is not exceeded, no further consideration to duct size is usually necessary, although additional registers may need to be added to obtain desired air distribution.

If the manufacturer chooses the third alternative, or if the home was built prior to the July 15 date, then it will be necessary for the installer himself to determine the air handling capabilities of the duct system.

Since manufactured home duct systems are designed somewhat differently than conventional residential systems, there are no really accurate tables or mathematical methods available to predict air deliveries for an existing duct system.

NOTES

NOTES

## Ventilation Systems

The blend air systems allow fresh air to be brought into the structure. The normal volume is in the range of 80-100 CFM. The system employs a blower assembly located outside or on the structure to force fresh air into the structure and also to ventilate the attic space. The system functions with the heating and air conditioning system thermostat. The amount of air that is required to ventilate or reduce the amount of moisture in an attic or in a structure is going to vary according to the life style of the occupants. In other words if there are a number of occupants and; they bath twice a day, continually operate a washing machine, clothes dryer, and prepare food, they will generate an amount of moisture indirectly, and also respire moisture directly into the living space.

Provisions must be made upon installation to allow the air to exit the blower assembly's plenum. Where a heavy insulation pack is used, compress a small area under the blower to allow the air an opportunity dissipate over a much larger surface area. Also do install the plenum flush up against the side of a roof rafter, direct transmission noise may result. The blower assembly is small and lightweight enough to be installed equidistant between rafters or trusses.

### SEQUENCE OF OPERATION

The standard blend air damper will open when the wall thermostat is set to ventilate, when the circulating fan of the furnace is on, when the thermostat calls for heating. This allows fresh air into the home whenever the furnace circulating blower is on. The standard blend air control has a switch that can be set to not ventilate in the peak of conditions that may cause a health threat. There is a mesh filter that is installed inside the blower compartment on the damper assembly that will need be cleaned on a regular basis.

The Deluxe blend air damper and blower assembly will operate on a signal from the wall thermostat. The blend air controls actually parallel those of the heating and cooling systems. When the thermostat fan switch is set to the on position or Vent position the furnace fan comes on, the damper opens, and the attic fan runs, and will continue to run. If neither heating or air conditioning systems come on in any 4 hour period then the attic fan will start up and run for four hours, the damper will be closed. If the Heating system comes on, the attic fan will come on and after about 1 min. the damper will open to allow the furnace to warm up. If the thermostat calls for cooling then the damper and attic fan both are energized.

### DELUXE BLEND AIR SYSTEM

Winter operation: Thermostat set to Heat and ventilation switch set to Auto .

The Deluxe Blend Air II operates on a four hour on and four hour off cycle. While in the four hour on cycle, the roof mounted unit will operate and ventilate the attic only.

If the furnace cycles on during the four hour on time, the damper motor, located on top of the furnace will drive the damper open and allow outside air (not air from the attic) to be drawn into the home. The damper motor is controlled by "W" terminal on the thermostat in the heating mode. A signal from W terminal will over-ride the timed off cycle. In the four hour off cycle, the Blend Air II (roof mounted unit) is off and the damper is closed.



However; If the furnace should come on during the four hour off cycle, the roof mounted unit will cycle on, venting the attic space. The damper motor will drive the damper open within one minute and allow outside air to be drawn into the home by the furnace blower.

Summer operation: Thermostat set to Cool and ventilation switch set to Auto.

The Deluxe Blend Air II operates in a four hour on and four hour off mode. During the four hour on cycle, the damper is closed. The roof mounted unit will ventilate the attic only.

If an air conditioning unit is installed, the roof mounted unit will continue to operate in a four hour on, four hour off cycle. In the four hour off cycle, the roof mounted unit is off and the damper is closed .

On a demand for cooling with the roof mounted unit in an off cycle, the air conditioning unit and Blend Air will cycle on. The damper motor is energized driving the damper to the open position. Fresh outside air will be drawn into the home. The roof mounted unit will ventilate the attic.

If the Blend Air II is in a four hour on cycle, when a call for cooling is received, the damper will open and supply outside air to the home. With the thermostat system switch set to cooling mode, the Blend Air is controlled by "G" terminal on thermostat. A signal from G terminal will over-ride the timed off cycle.

Ventilation: The thermostat is equipped with a switch marked **ventilation on - auto**. When set to the auto position, the roof mounted unit is in the four hour on and four hour off mode. When set to the on position, the blower motor is operating, the roof mounted unit is on and ventilating the attic. The damper is open, supplying fresh outside air to the home.

Pressure Balancing Damper: The home is equipped with a damper assembly designed to allow air to pass to the outside. This relieves the positive pressure introduced by the Blend Air.

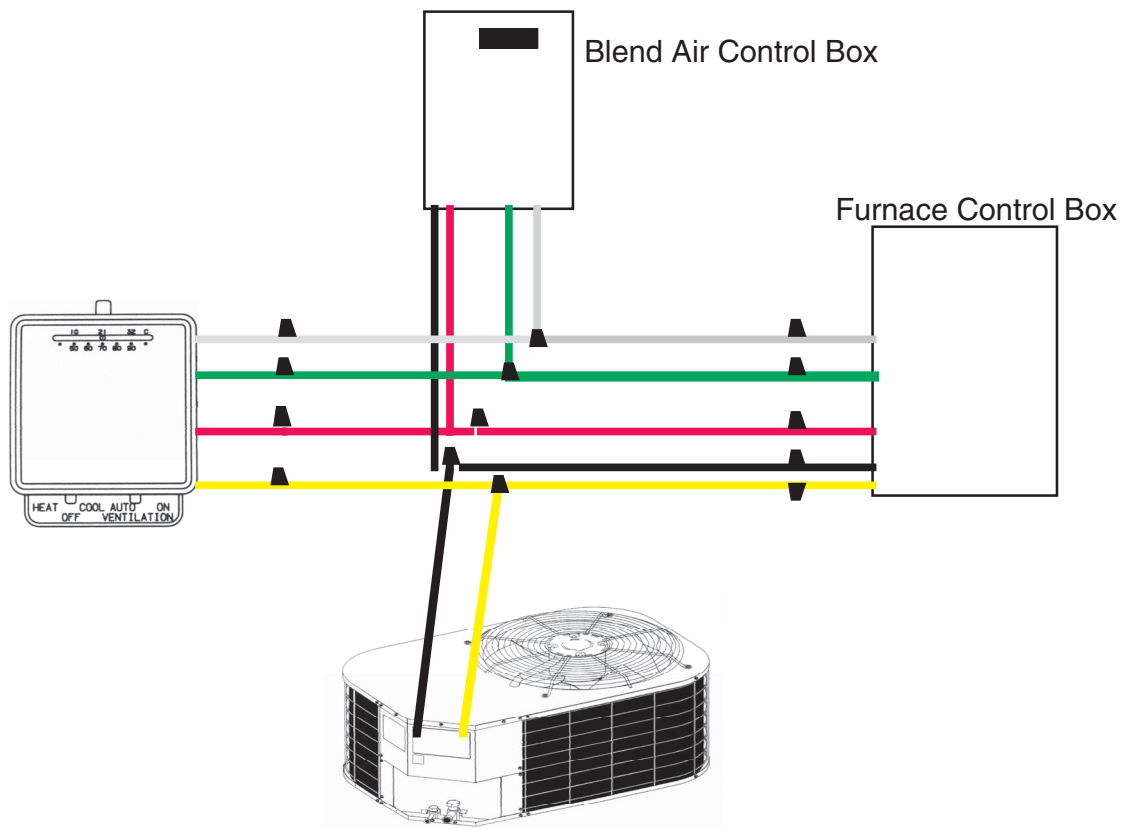
Alarm Signal: An alarm will sound when the motor in the roof mounted unit fails to respond to a ventilation demand.

The Deluxe blend air capacities for ventilation are:

Furnace	Standard	Large Capacity
DGAT-	94 CFM	143 CFM
COAT	94 CFM	143 CFM
EB	80 CFM	129 CFM
Package	96 CFM	

The Deluxe blend air attic ventilation capacities are:

Furnace	Standard	Large Capacity
DGAT	150 CFM	150 CFM
COAT	150 CFM	150 CFM
EB	150 CFM	150 CFM



**Figure 1:**

## Pictorial Wiring

## 7681-8171 Deluxe Blend Air II

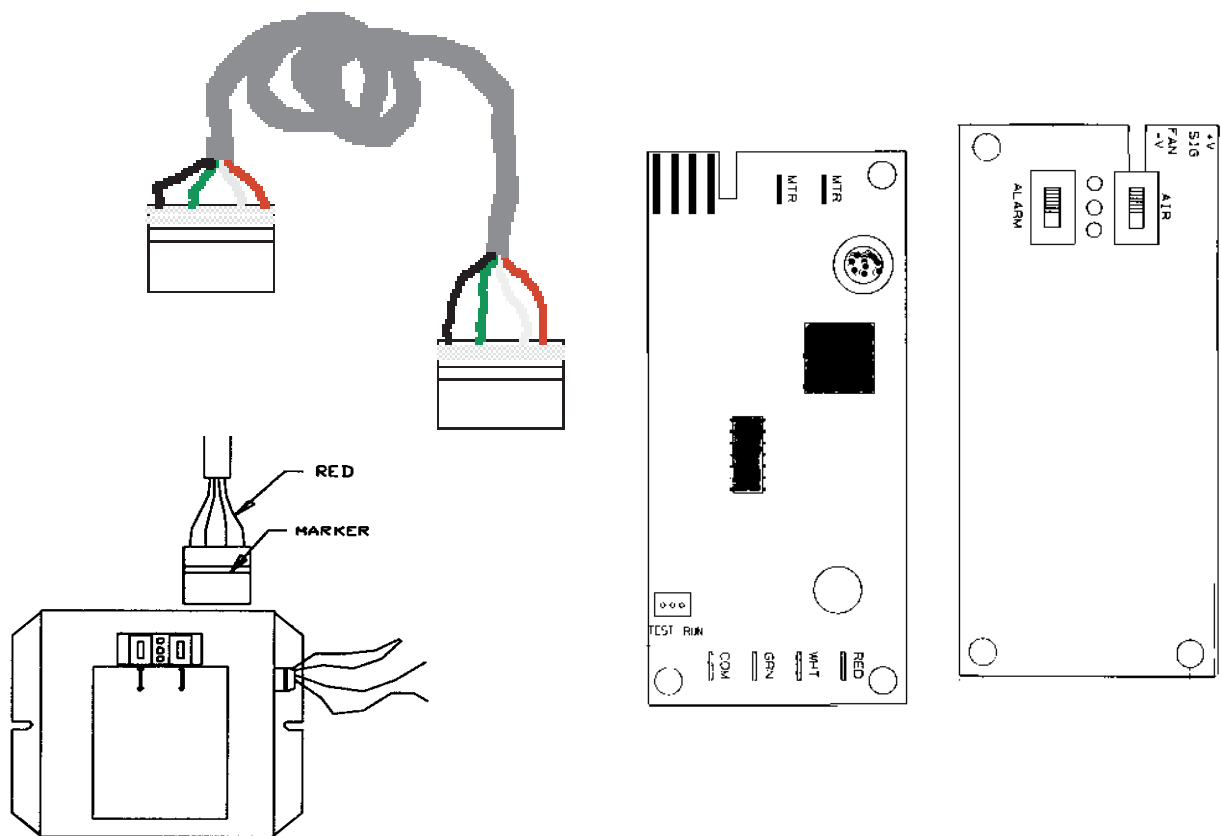


Figure 2:

### Trouble Shooting Chart

1. Check wiring:

**Blend Air II**

Red  
White  
Green  
Black

**Furnace**

Red  
White  
Green  
Black (or  
**Furnace Common**)

**Thermostat**

R Terminal  
W Terminal  
G Terminal  
Note: Y Terminal connects to  
A/C contactor. Other side of  
A/C Contactor connects to  
Black (common) on Furnace.

## 2. Check voltage:

1. With furnace power turned on: 24VAC will be at Red and Black
2. With thermostat fan switched to on: 24VAC will be at Green and Black.
3. With thermostat calling for heat: 24VAC will be at White and Black

The above checks will indicate that the Blend Air and Furnace are wired correctly.

## 3. Check Control Cable:

**NOTE: Do not short the following connections. If the connections are shorted, the transistors on the control boards will burn out.**

Check the four-wire connectors. On each connection, upper and lower board, make sure the connectors are not pushed out and are mated properly on both control boards. The ends of the control cable should have matching colors. EX: If Red is in Pin 1 at one end then Red should be in Pin 1 at the opposite end.)

NOTE: The cable is designed so that either end will work on the control board.

## 4. Check Lower Control Voltage: (System is fully hooked up)

With System operational	Black and Red	30-34VDC
With Attic Fan OFF	Black and Green	0 VDC
	Red and Green	30-34VDC
With Attic Fan ON	Black and Green	30-34VDC
	Red and Green	0 VDC
With Attic Fan ON	Black and White	0.5 VAC

The above test will indicate that the lower board is operating correctly.

## Deluxe Blend Air II Troubleshooting Guide

### 5. Motorized Damper Does Not Open:

Is the furnace system switch turned on (Powered Up)?

Yes

Turn the thermostat fan switch to ON. The furnace blower should run and the amber LED on the Blend Air Control Box will illuminate indicating that damper has opened.

No

Turn furnace on. NOTE: When the system switch is turned OFF, the attic fan will run constantly.

Has the damper opened?

Yes  
Damper OK.

No  
Verify that the Fresh Air switch and the Alarm switch are in the UP position.  
NOTE: Alarm switch will silence the alarm when there is trouble. It will also open and close the damper.

### Is the damper OPEN?

Yes  
Damper OK.

No  
With your hand, move the spring tension lever verifying that the damper blade is not stuck.

### Will damper now open?

Yes  
Damper OK.

No  
Verify 24VAC output on lower control board terminals marked MTR.

### Are 24VAC present?

Yes  
Replace damper motor.

No  
Replace control board.

### 6. Attic Motor Does Not Run:

Disconnect control cable at the lower box.

### Is the attic fan now running?

Yes  
This indicates that there is 110 V present and the attic motor and upper control board are OK.

No  
Check circuit breaker for Blend Air. If circuit breaker is OFF, switch to ON position.

## 7681-8171 Deluxe Blend Air II Trouble shooting Guide

### Is attic motor running?

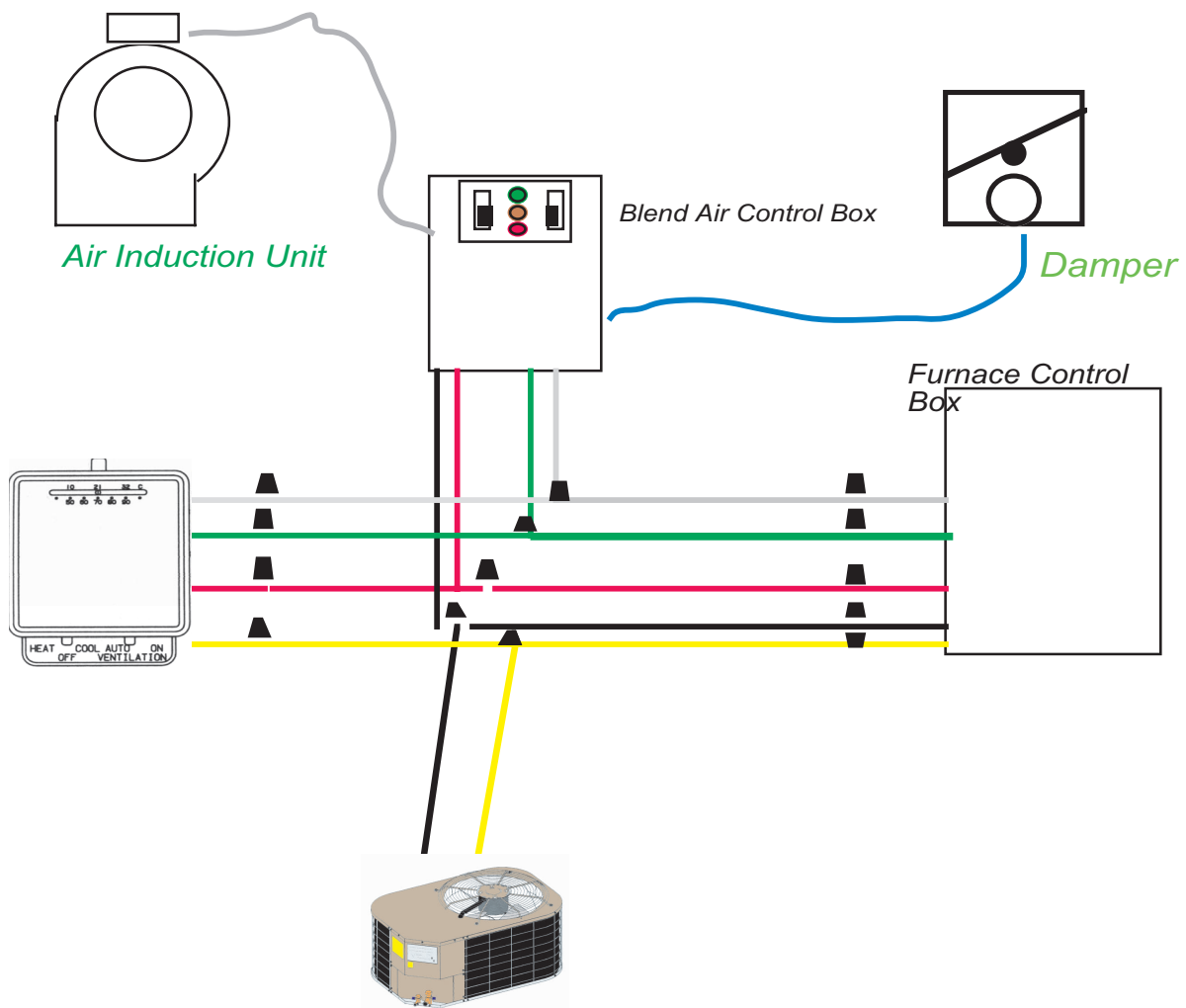
Yes  
Attic motor and upper control board are OK

No  
(This check requires going on top of the roof.) Use a voltmeter and check if 115 V

are on Black and White motor terminals.  
If 115 V present and motor still does not  
run, then motor has malfunctioned.  
Replace motor.

Caution: Disconnect power before  
replacing motor.

## 7. Upper and Lower Controls:



**Figure 3:**  
**Attic Motor Does Not Run:**

Functions: Attic fan responds to thermostat inputs  
(Heat, Cool, or Fan)  
4-hour "ON" cycle, attic fan comes on with or without thermostat inputs.  
4-hour "OFF" cycle is interruptible by thermostat inputs

and could return to "OFF" cycle if 4 hours has not elapsed.

Turn the thermostat ventilation switch to ON. Furnace blower should run. Amber LED, on Blend Air control box, will illuminate indicating that damper has opened and Green LED will illuminate indicating that the attic fan is on.

### **Is attic fan running?**

Yes

No

Upper and lower boards are good. Turn ventilation switch to auto. Did alarm sound and the Red LED flash?

Did alarm sound and the Red LED flash

Yes

No

Go to Steps 3 and 4. If no problem is found with Steps 3 and 4, replace UPPER control board.

Go to Steps 1 and 2. If no problem is found with Steps 1 and 2, replace LOWER control board.

Attic motor runs constantly:

NOTE: Make sure that there is no thermostat input.  
(NO HEAT, COOLING, OR VENTILATION)

IMPORTANT: Test pins, when shorted, cancel current cycle only. If jumper socket is permanently applied at "TEST", the attic fan will cycle ON/OFF every 30 seconds. When it is removed from the "TEST" pins, the normal cycle resumes. Normal cycle also resumes if jumper socket is not applied at "RUN" pins. (In other words, If you leave the jumper off the unit will return to the four hour cycle.)

## **7681-8171 Deluxe Blend Air II Troubleshooting Guide**

### **Is the Blend Air in the 4-hour "ON" cycle?**

Yes

No

Attic motor should cycle for 4 hours

NOTE: Check line voltage for power.



"OFF" and "ON".

Motor will run constantly if 24VAC isn't present. Be sure furnace system switch is on. Inside the lower control box, locate the jumper socket on the pins marked "RUN". Remove the jumper socket and temporarily slide it on to the pins marked "TEST". this should put the control in a 30 second on and 30 second off cycle.

### **Did the attic fan stop running?**

Yes

Return jumper socket to "RUN" pins and Go to Steps 3 and 4. If Steps 3 and 4 check good, then lower control board is good. Replace upper control board. If Step 4 does not check good, then lower board has malfunctioned. Replace lower control board.

No

Return jumper socket to "RUN" pins and Go to Steps 3 and 4. If Steps 3 and 4 check good, then lower control board is good. Replace upper control board. If Step 4 does not check good, then lower board has malfunctioned. Replace lower control board.

End of Blend Air Troubleshooting

## NOTES

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