

H/SERIES

Installation, Operation, and Service Manual



WARNING

ONLY FACTORY AUTHORIZED BURNER
SERVICE PERSONNEL SHOULD START- UP,
ADJUST, OR SERVICE THIS EQUIPMENT.

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OPERATING PRECAUTIONS

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Only trained and authorized personnel should be allowed to operate, adjust or repair this equipment.


If you are operating a burner(s), it is your responsibility to ensure that such operation is in full accordance with all applicable safety requirements and codes.

Placed on all Industrial Combustion burners are warning or caution labels designed to inform the operator of potential hazards and stress important information.

These symbols and their meanings are as follows:

	WARNING
FAILURE TO INSTALL AND OPERATE THIS EQUIPMENT IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDED INSTRUCTIONS AND INDUSTRY STANDARDS AND PRACTICES CAN RESULT IN FIRE, EXPLOSION, PROPERTY DAMAGE AND/OR PERSONAL INJURY !! READ THIS MANUAL IN IT'S ENTIRIETY PRIOR TO ANY ATTEMPT TO COMMISSION THIS EQUIPMENT. INSTALLATION, STARTUP, OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST BE PERFORMED ONLY BY FACTORY AUTHORIZED, EXPERIENCED AND QUALIFIED PERSONNEL.	

	WARNING
HAZARD OF ELECTRIC SHOCK !!! MORE THAN ONE DISCONNECT MAY BE REQUIRED TO DISCONNECT ALL POWER TO THIS PANEL. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.	

	WARNING
READ PRODUCT MANUAL AND FULLY UNDERSTAND ITS CONTENTS BEFORE- ATTEMPTING TO OPERATE THIS EQUIPMENT. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.	

	WARNING
TO AVOID PERSONAL INJURY FROM MOVING PARTS, SHUT OFF ALL ELECTRICAL POWER BEFORE SERVICING THIS EQUIPMENT.	

CAUTION	
PROVIDE SUPPORT FOR THIS PANEL TO PREVENT DAMAGE TO THE ELECTRICAL COMPONENTS.	

CAUTION	
ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD STARTUP, ADJUST, OR SERVICE THIS EQUIPMENT.	

CAUTION	
AFTER FINAL FUEL INPUT ADJUSTMENTS ARE MADE, VERIFY FUEL INPUT BY METER IF POSSIBLE.	

Further warning and caution references have been made in this manual and should be adhered to for smooth operation of the burner.



WARNING

This symbol precedes information which, if disregarded, may result in injury to the user of the burner or to others.

CAUTION

This symbol precedes information which, if disregarded, may result in damage to the burner.

NOTE

This symbol precedes information which is vital to the operation or maintenance of the burner.

Model designations are based on the type of fuel(s) to be fired and the amount of furnace pressure to be overcome. Burner size is based on firing rate (rated input in BTU/HR).

MODEL	FUEL	ATOMIZATION
HG	GAS	
HL	#2 OIL	PRESSURE
HLG	#2 GAS/OIL	PRESSURE

EXAMPLE: Model number on nameplate is HLG-45, indicating it is a combination No. 2 oil and Gas burner with input rated at 4,500 MBTU per hour, against furnace pressures up to 1.0" W.C.

BURNER SIZE AND RATED FURNACE PRESSURE - H/BURNER:

SIZE 1 - H10 to 25	0.75" W.C.
SIZE 2 - H30 to 45	1.0" W.C.
SIZE 3 - H50 to 90	2.0" W.C.
SIZE 4 - H100 to 120	3.0" W.C.

RATED BURNER INPUT		
SIZE	MBTU/HR	US GPH
10	1,000	7.1
13	1,250	9.0
15	1,500	10.7
17	1,680	12.0
20	2,000	14.3
21	2,100	15.0
25	2,500	17.8
30	3,000	21.4
34	3,360	24.0
35	3,500	25.0
40	4,000	28.6
42	4,200	30.0
45	4,500	32.1
50	5,000	35.7
54	5,250	37.5
55	5,500	39.3
60	6,000	42.9
63	6,300	45.0
70	7,000	50.0
80	8,000	57.1
84	8,400	60.0
90	9,000	64.3
100	10,000	71.4
105	10,500	75.0
110	11,000	78.6
120	12,000	85.7
125	12,600	90.0

* Gas input based on natural Gas at 1,000 Btu/cu.ft. and 0.60 specific gravity.

** Oil input based on 140,000 Btu/gal.

*** Refer to burner nameplate data for correct manifold pressures.

THE INSTALLATION OF A BURNER SHALL BE IN ACCORDANCE WITH THE REGULATIONS OF AUTHORITIES HAVING JURISDICTION. THE EQUIPMENT MUST BE INSTALLED IN ACCORDANCE WITH APPLICABLE LOCAL, STATE OR PROVINCIAL INSTALLATION REQUIREMENTS INCLUDING THE NATIONAL ELECTRICAL CODE (NEC) AND ASSOCIATED INSURANCE UNDERWRITERS.

OIL AND GAS BURNING EQUIPMENTS SHALL BE CONNECTED TO FLUES HAVING SUFFICIENT DRAFT AT ALL TIMES, TO ASSURE SAFE AND PROPER OPERATION OF THE BURNER.

THE H SERIES BURNERS ARE DESIGNED TO BURN EITHER GAS OR LIGHT OIL No.1 OR 2 AS DEFINED BY ASTM D396-1978 SPECIFICATIONS.

DO NOT USE GASOLINE, CRANKASE OIL, OR ANY OIL CONTAINING GASOLINE.

SECTION 1 INTRODUCTION

A. GENERAL INFORMATION

Industrial Combustion H/Series burners are assembled, wired and tested at the factory. They are listed by the Underwriters Laboratory, cUL, CSD-1, I.R.I., F.M., and other regulatory agency control options are available.

Optional controls and control systems are also available. The operator of this equipment must be familiar with the individual functioning of all controls to understand the operations and procedures described in this manual, and supplementary instructions provided with optional controls. Identify and locate each item in the illustrations as they are described in the following sections.

CAUTION

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B. DESCRIPTION

The Industrial Combustion H/Series burners are designed to operate with gas and light oil. H burners are specifically designed to operate in cast iron, firebox or commercial watertube boilers. The burners are designed for automatic, unattended operation except for periodic inspection and maintenance. The control panel components require little attention except for occasional cleaning.

The burners are available in the following configuration:

SIZE 1 - H10-25 On-Off
(Optional: Low-High-Off, Low-High-Low, Full Modulation)

SIZE 2 - H30-45 Low-High-Off
(Optional: Low-High-Low, Full Modulation)

SIZE 3 - H50-90 Full Modulation

SIZE 4 - H100-125 Full Modulation

C. OPERATING CONTROLS - PANEL

The control panel contains a flame safeguard programming control, motor relays (starters), and terminal strips mounted internally on a panel subbase. Lights, switches, and a control circuit breaker are mounted externally on the panel as indicated below.

1. ON-OFF BURNER SWITCH

2. FUEL SELECTOR SWITCH - Gas - Off - Oil

Gas position:	Selects gas as the firing fuel
Off position:	Burner off
Oil position:	Selects oil as the firing fuel

3. CONTROL CIRCUIT BREAKER

Supplementary low overcurrent protection only.
No larger than 15 amps.

4. AUTO-MANUAL MODULATION SELECTOR SWITCH

Auto Position: Selects boiler modulation control. In this position, the burner will operate automatically in response to load demand.
Manual Position: Selects 135 ohm potentiometer for manual modulating control.

5. MANUAL MODULATING CONTROL 135 ohm (For full modulation burners only) Increases or decreases the burner firing rate manually.

6. SIGNAL LAMPS.

- POWER ON (white) illuminates when the control circuit is energized (powered).
- IGNITION (amber) illuminates when the ignition transformer is powered, and pilot valve is energized (opened).
- MAIN FUEL (green) illuminates when the main fuel valve or valves are energized (open).
- FLAME FAILURE (red) illuminates when the flame safeguard system fails to detect pilot or main flame.

7. MODULATING MOTOR

Operates the air damper and fuel rate valves through a linkage system to adjust air-fuel ratios under all load conditions.

8. IGNITION TRANSFORMER

Provides high voltage spark for ignition of gas pilot or main flame direct spark models.

D. FLAME SAFEGUARD CONTROLS

The flame safeguard controls the operating sequence of the combustion system (prepurge, pilot, firing and shutdown). The flame safeguard programmer incorporates a flame sensing cell (scanner) to shut down the burner in the event of pilot flame or main flame failure. Other safety controls shut down the burner based on sequence of operation as shown in the manufacturers flame safeguard manual.

E. COMBUSTION AIR HANDLING SYSTEM

1. **MOTOR AND BLOWER** - The impeller is directly driven by the motor at 3450 rpm. Combustion air is supplied by a heavy duty balanced backward curved impeller. The impeller remains free from dirt accumulation.

2. **AIR VOLUME REGULATOR** - The air damper is located in the air inlet housing. The damper is mechanically linked and actuated by the hydraulic cylinder for on-off operation. Low-high-off, low-high-low or full modulation burners have the damper directly driven by the modulating motor.

3. **COMBUSTION AIR PROVING SWITCH** - A pressure sensitive switch actuated by air pressure created by the blower fan. Contacts close to prove combustion air flow.

4. **DIFFUSER** - An air flow diffuser stabilizes flame front.

OPERATION

Air from the impeller flows through the blast tube and diffuser to mix with fuel in the ignition zone. Combustion air flow rate is determined by the position of the air regulating blades at the inlet of the impeller. Linking the air flow with fuel flow provides efficient combustion at all firing rates.

F. OIL SYSTEM

Models HL - HLG are high pressure atomizing burners using fuel pressure for atomization. Atomized fuel is discharged from the nozzle as a fine conical spray.

1. **FUEL UNIT** - Direct driven from the blower motor with a flexible coupling at 3450 rpm, and set for 300 psi operation, fuel unit is two stage (two sets of gears) and must be installed for a two pipe installation, one suction and one return line. Separately driven oil pumps are available as option to the standard arrangement.

2. **NOZZLE** - The nozzle meters oil flow delivering a specified amount at a specific pressure. Fuel pressure (mechanical) atomizes oil in a fine conical spray pattern from the nozzle orifice. The burner is supplied with nozzle(s) to fire to its maximum rate unless a different firing rate was specified. Return flow nozzle(s) are used on the full modulation burners.

3. **NOZZLE ADAPTOR** - The nozzle adaptor provides the means for connecting fuel lines with the nozzle.

4. **OIL SOLENOID VALVES** - Two normally closed (N.C.) and one normally open (N.O.) solenoid valves are part of the oil system on LO-HI-OFF and LO-HI-LO burners. The two N.C. valves provide positive shut off of fuel oil while the one N.O. valve cycles the burner to high fire when closed.

5. **OIL METERING VALVE** - The firing rate is controlled by an adjustable metering valve in the return line. At low fire, the metering valve is open, and is closed at high fire.

6. **OIL FILTER** - Prevents foreign matter from entering the burner oil system. This item is provided optional and shipped loose with burner.

OPERATION

Fuel oil is delivered to the fuel unit, either by gravity, fuel unit suction, or by a circulating pump, through a fuel oil filter. Pressurized fuel returns to the storage tank until the two solenoid valves open. On direct spark ignited burners, (HL-10 to 45) ignition occurs when the oil valves open. Where gas pilots are provided (Models HG and HLG), the oil valves open after the pilot is proven. Oil input rate is controlled by the oil metering valve, which varies the flow to meet load demands. The low fire positions bypass oil back to the storage tank. At high fire, the metering valve is in the closed position. The modulating motor positions the metering valve and the air damper simultaneously.

G. IGNITION SYSTEM

Oil only models HL-10 to 45 are supplied with direct spark ignition. Models HL-50 to 125 are supplied with a gas pilot system. Gas and combination Gas-Oil models are supplied with a gas ignition system. The standard pilot gas train consists of a manual shutoff cock, a gas pressure regulator and a solenoid operated gas shutoff valve.

H. GAS HANDLING SYSTEM

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items:

MAIN GAS TRAIN COMPONENTS

1. **GAS VOLUME VALVE** - The butterfly type valve is positioned by linkage from the modulating motor and controls the rate of flow of gas.

2. **MAIN GAS VALVES** - Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard U.L. burners include:

- Models: 10-25; Diaphragm gas valve and one safety solenoid valve.

- Models: 30-50; One motorized gas valve w/proof of closure

- Models: 55-120; One motorized gas valve w/proof of closure and one safety solenoid valve

3. **MAIN GAS REGULATOR** - Regulates gas train pressure to specified pressure required at the burner manifold. Input is set by main gas pressure regulator adjustment.

4. **MAIN GAS COCKS** - Used for manual shutoff of the gas supply upstream of the pressure regulator. A second shutoff cock downstream of the main gas valve(s) provides a means of testing for leakage through the gas valve(s).

5. **HIGH GAS PRESSURE SWITCH.** (Models 30-125) A pressure actuated switch that remains closed when gas pressure is below a selected setting. Should the pressure

rise above the setting, the switch contacts will open causing main gas valve(s) to close. This switch requires manual reset after being tripped.

6. LOW GAS PRESSURE SWITCH. (Models 30-125)

A pressure actuated switch that remains closed when gas pressure is above a selected setting. Should the pressure drop below this setting, the switch contacts will open, causing main gas valve(s) to close. This switch requires manual reset after being tripped.

OPERATION

Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valves and butterfly valve to the gas manifold. The butterfly gas valve modulates flow to burner input demand. The butterfly valve is positioned through mechanical linkage by the modulating motor. The air control damper is positioned simultaneously by the modulating motor. The automatic gas valve(s) cannot be energized unless the combustion air proving switch is closed. The low and high gas pressure switches must be closed to prove proper gas pressure.

A normally open vent valve, if required, is located between the two automatic gas valves. This valve is shut when the automatic gas valves are open. When the automatic valves are closed, the vent valve is open for venting gas to the outside, should any be present.

NOTE

GAS TRAIN COMPONENTS UPSTREAM OF THE BUTTERFLY VALVE ARE SHIPPED LOOSE TO BE MOUNTED BY THE INSTALLER.

NOTE

PILOT GAS SUPPLY CONNECTION MUST BE UPSTREAM OF THE MAIN GAS PRESSURE REGULATOR

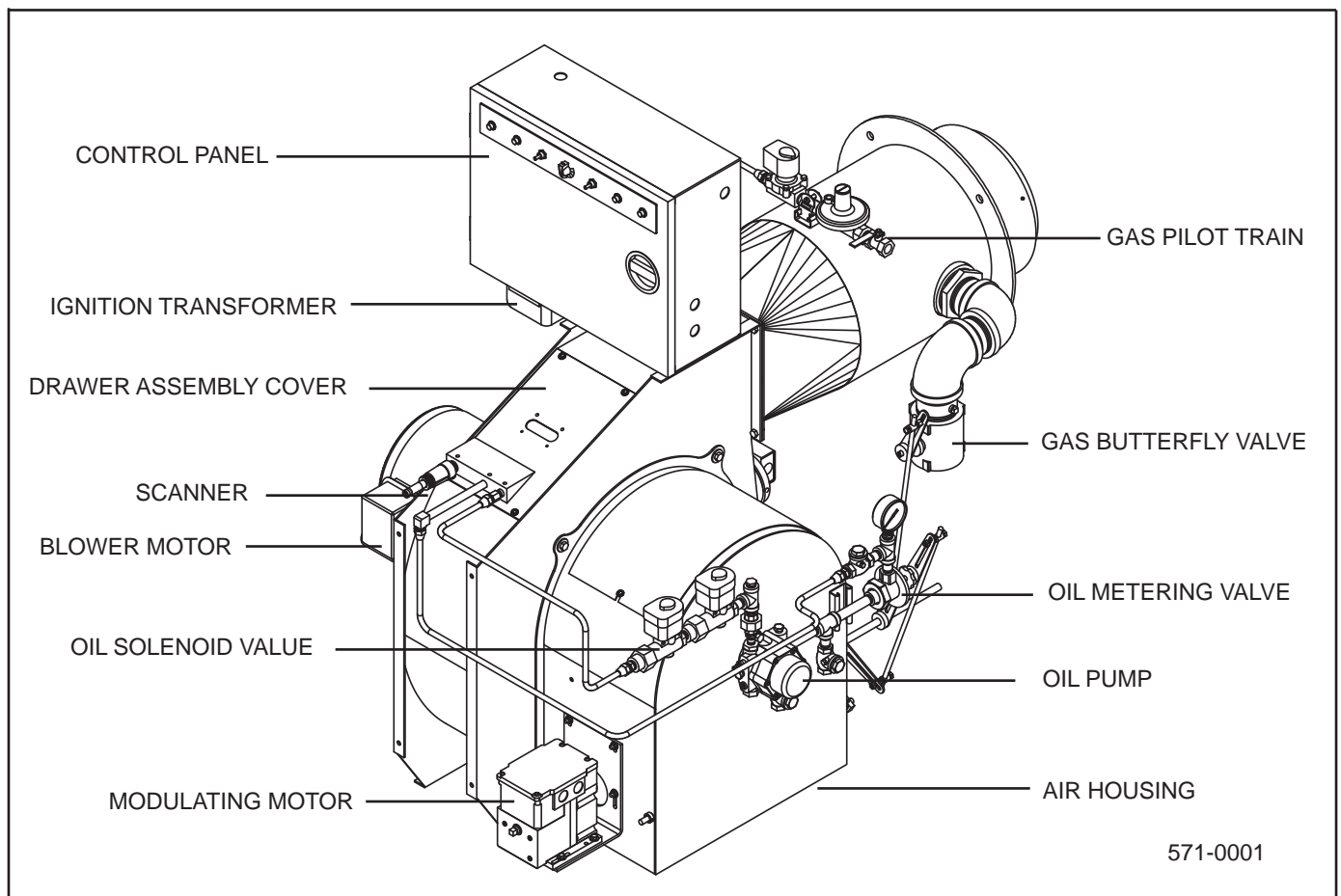


Figure 1-1

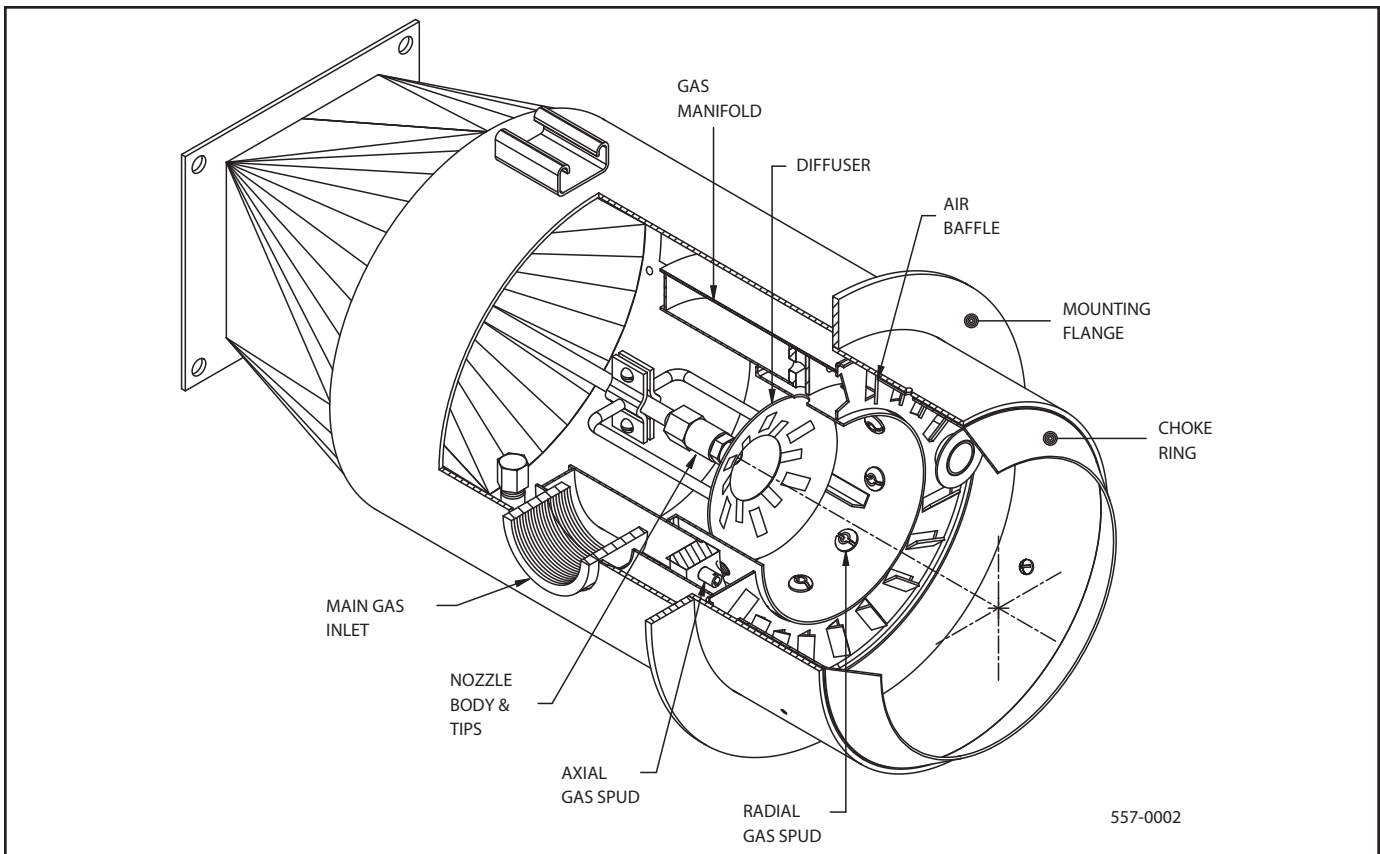


Figure 1-2

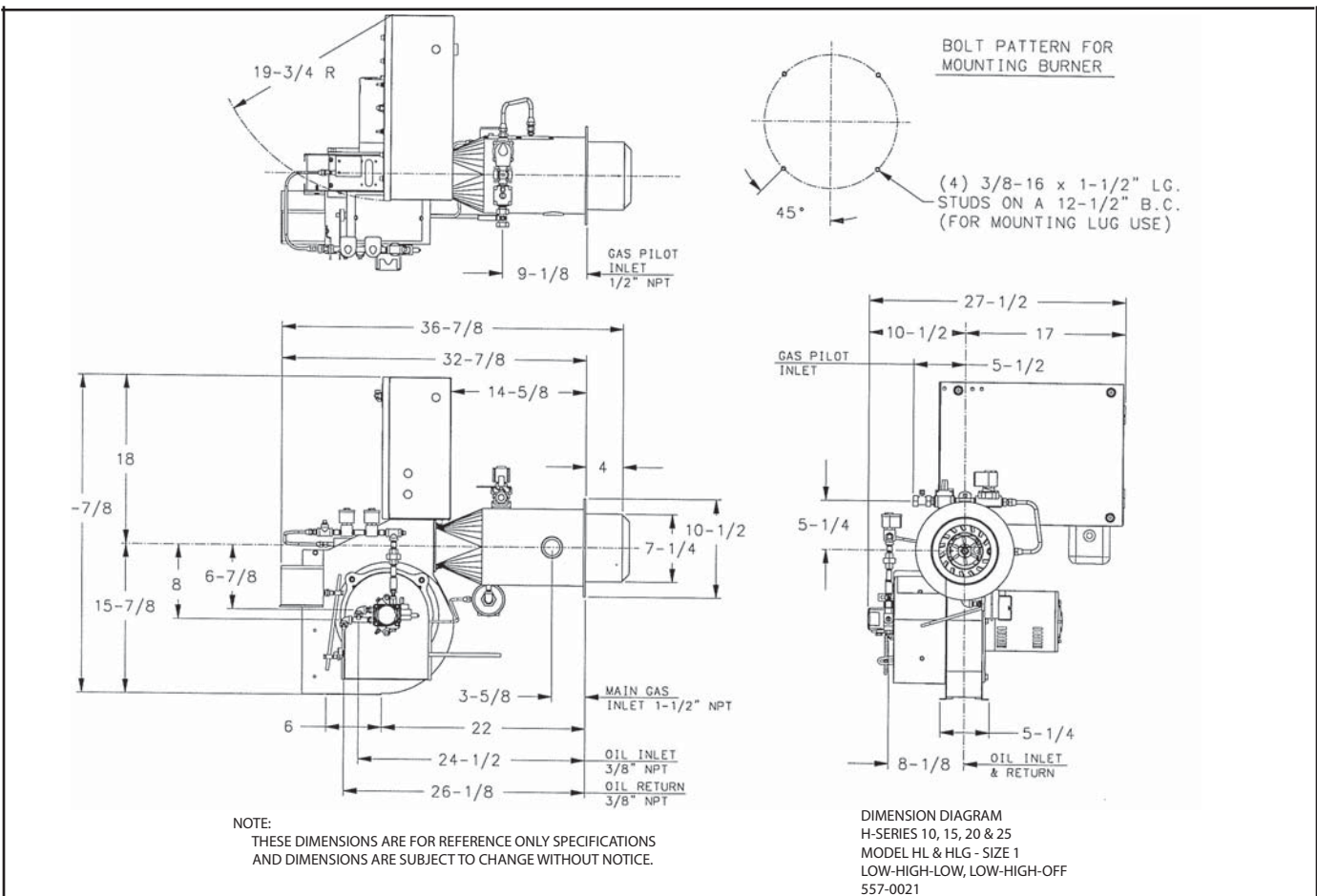


Figure 1-3

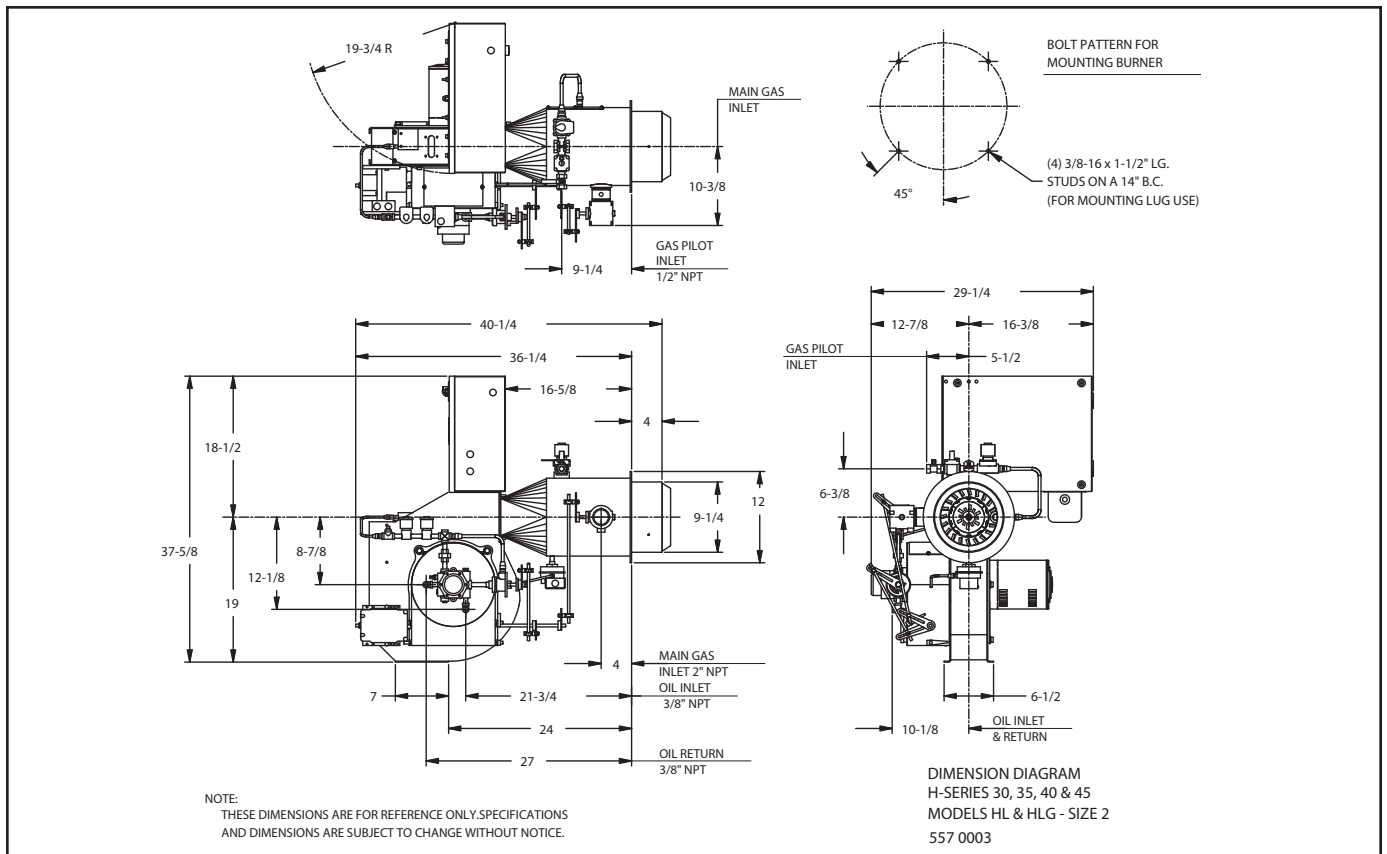


Figure 1-4

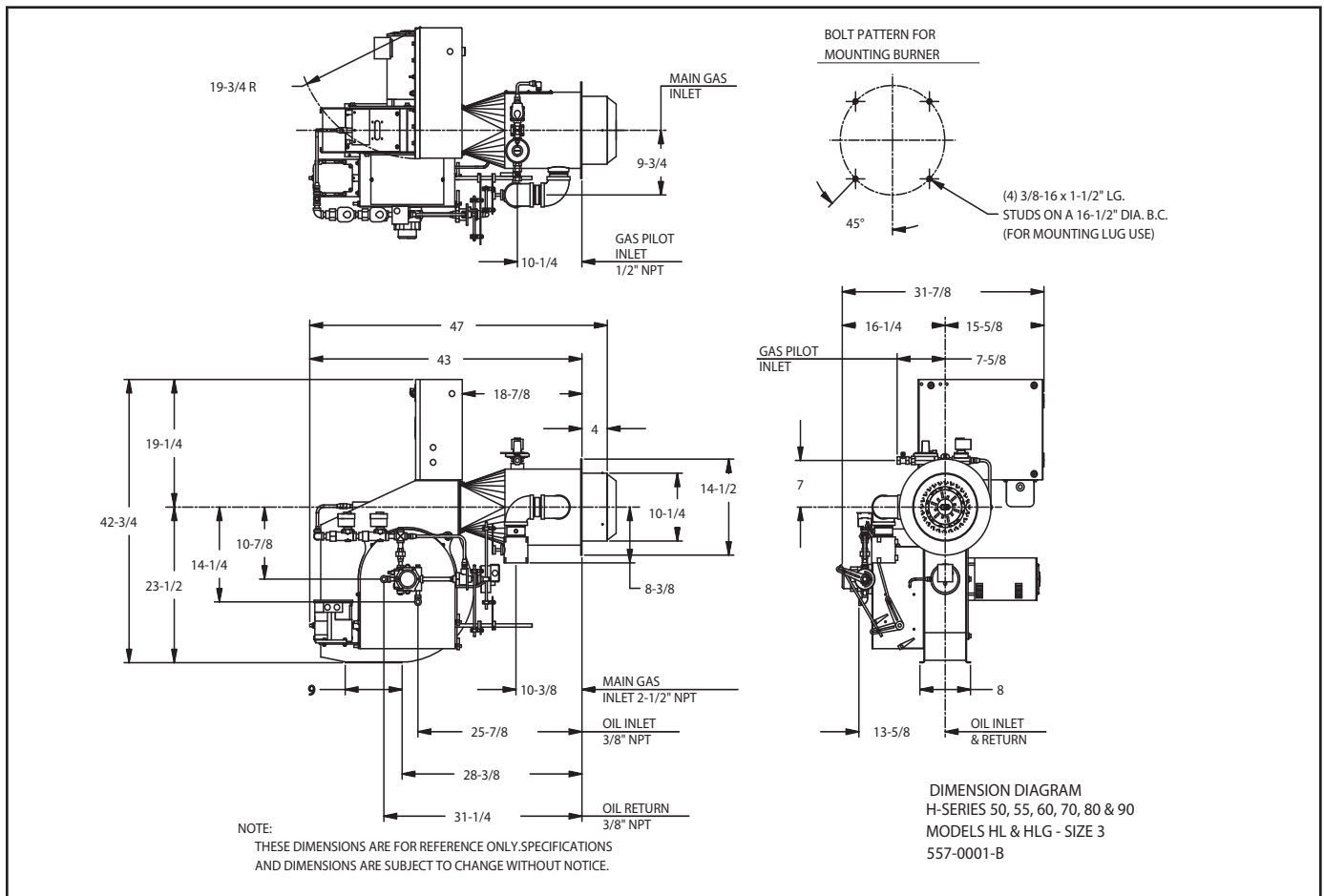


Figure 1-5

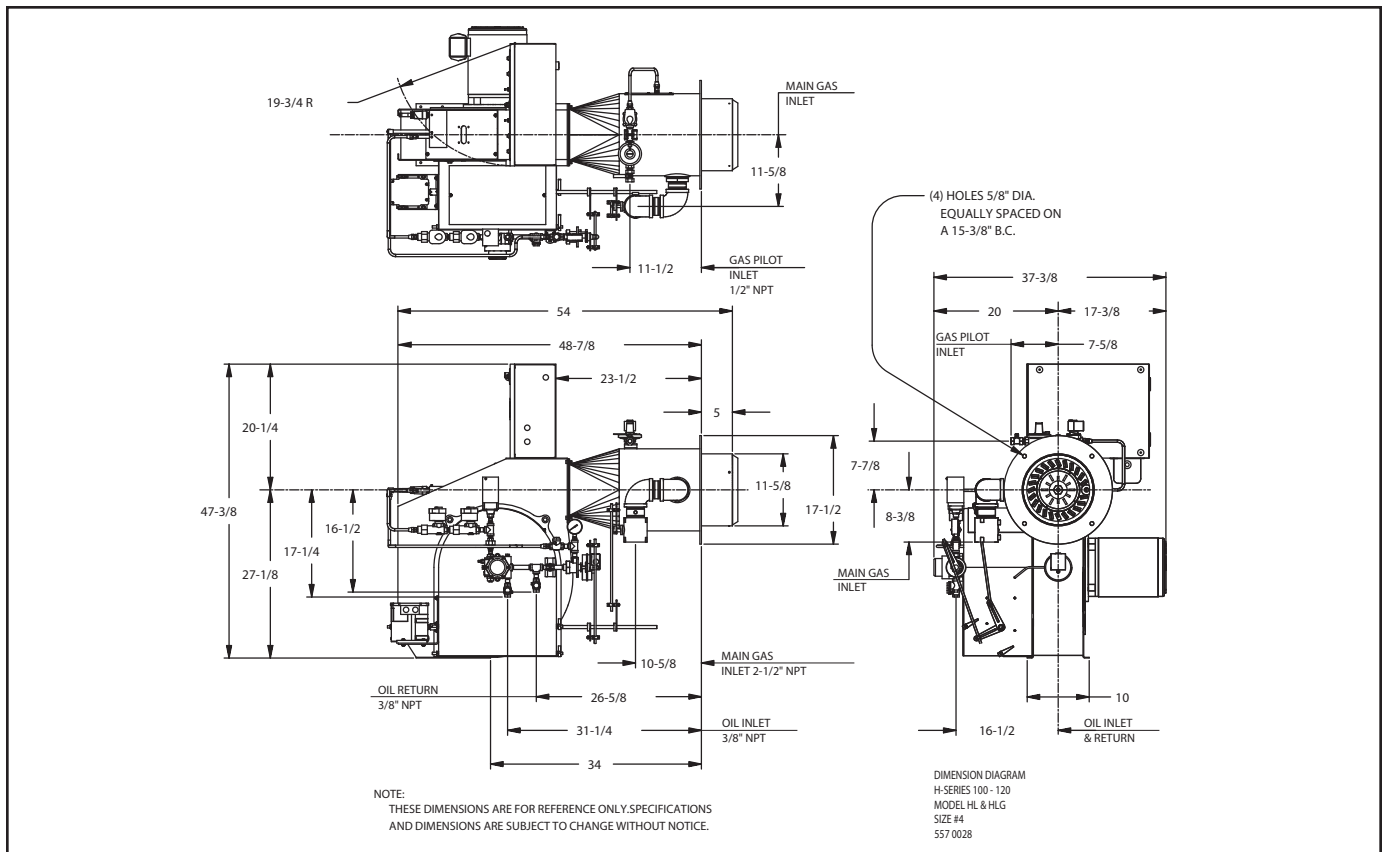


Figure 1-6

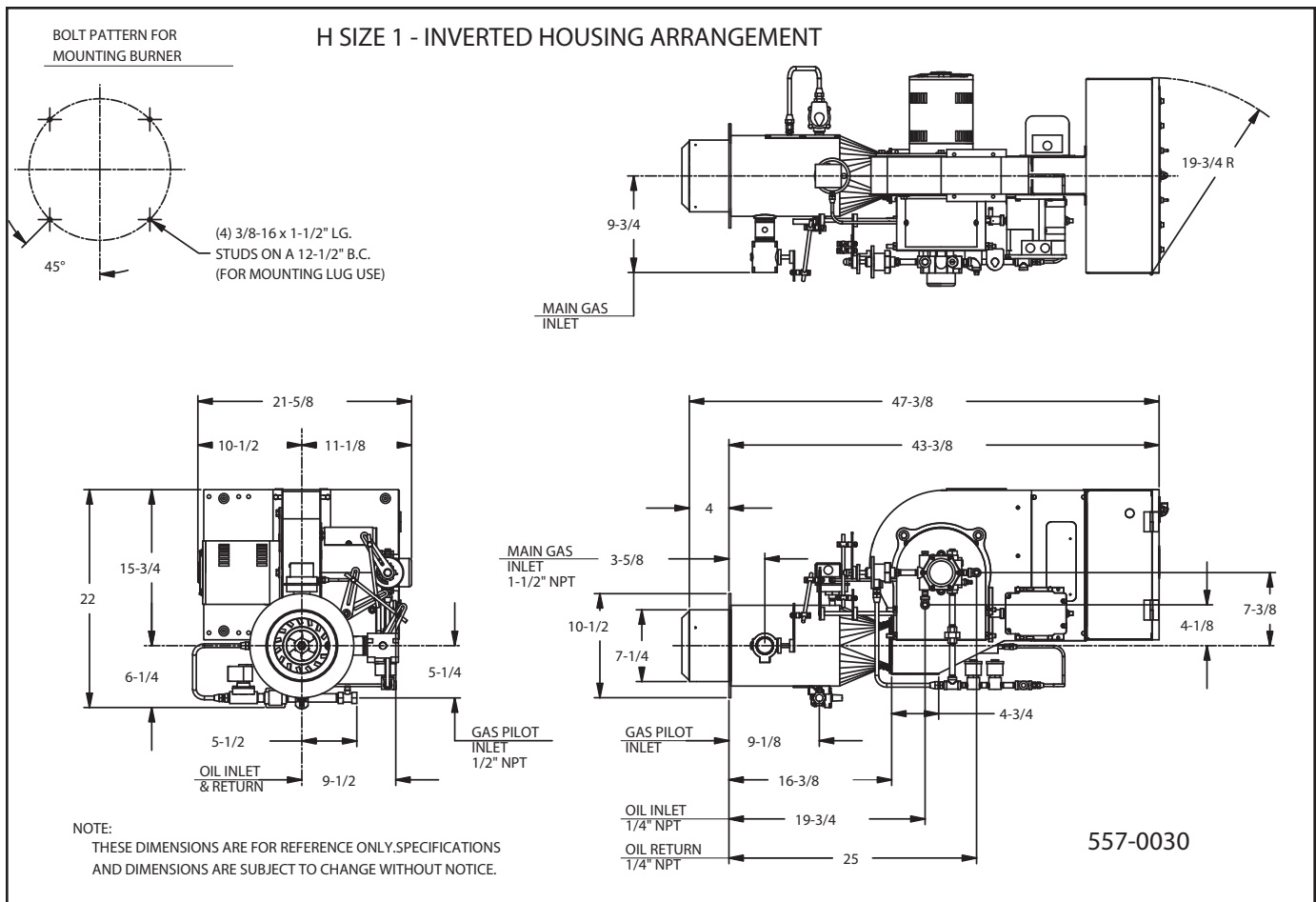


Figure 1-7

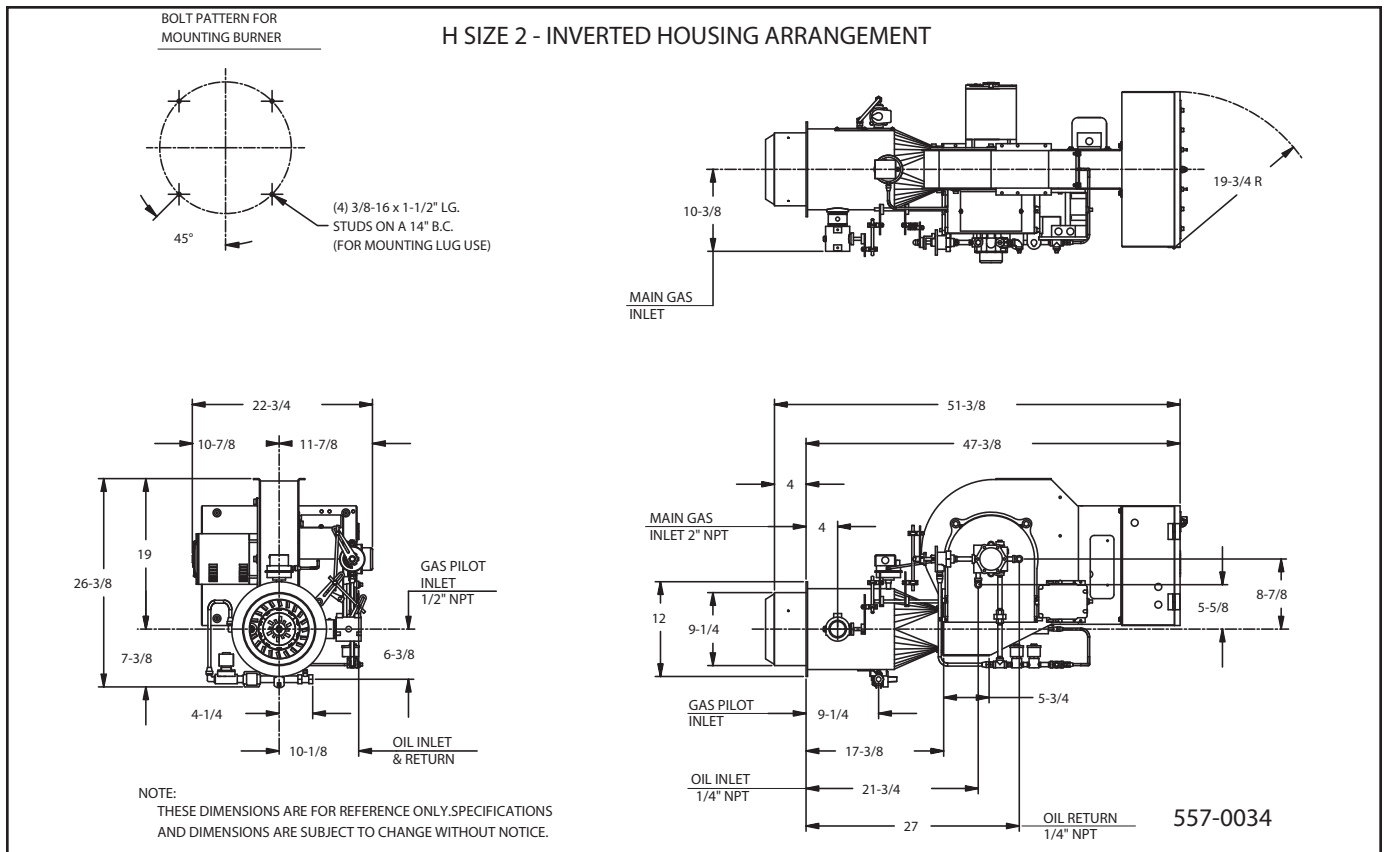


Figure 1-8

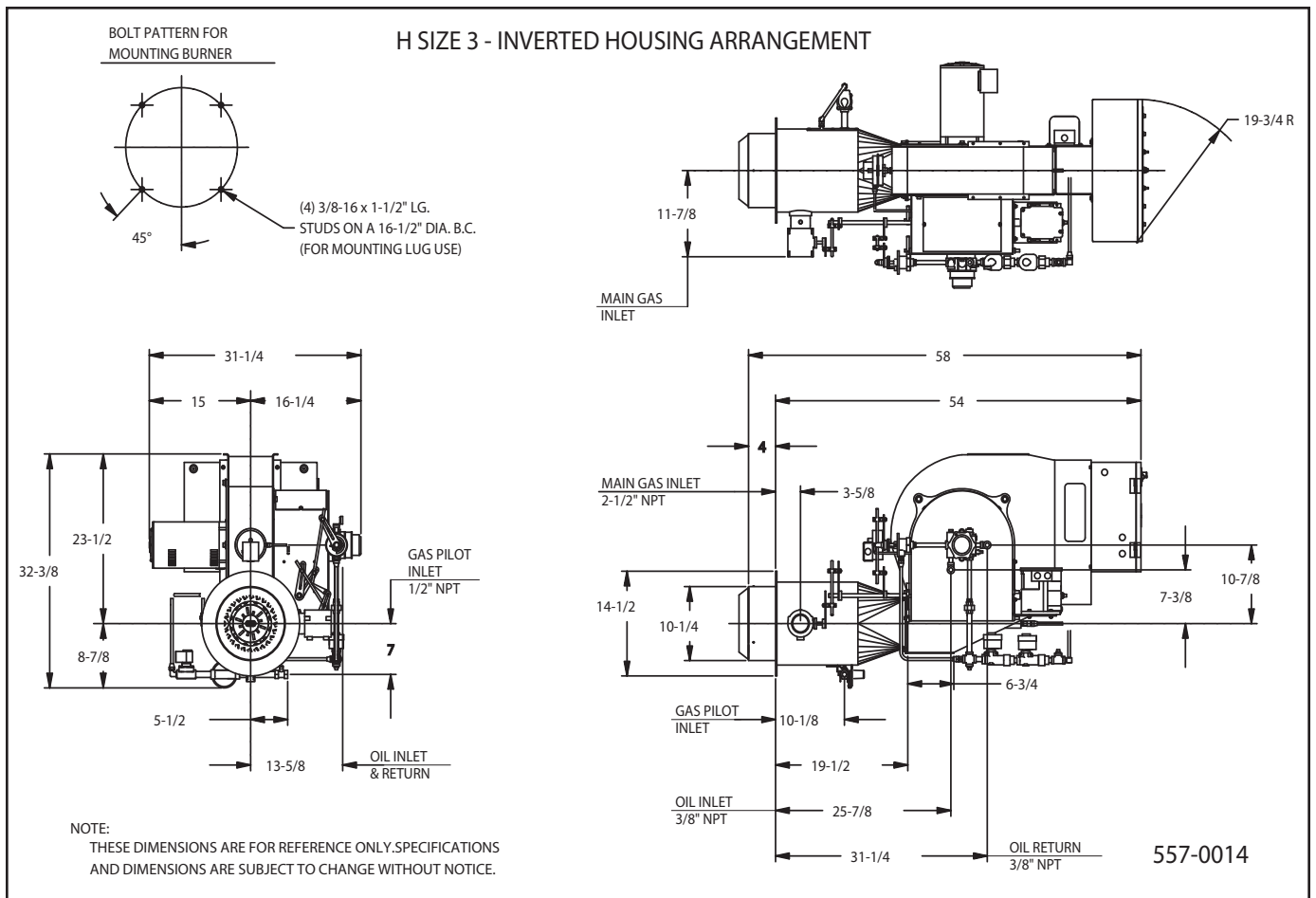


Figure 1-9

H SIZE 4 - INVERTED HOUSING ARRANGEMENT

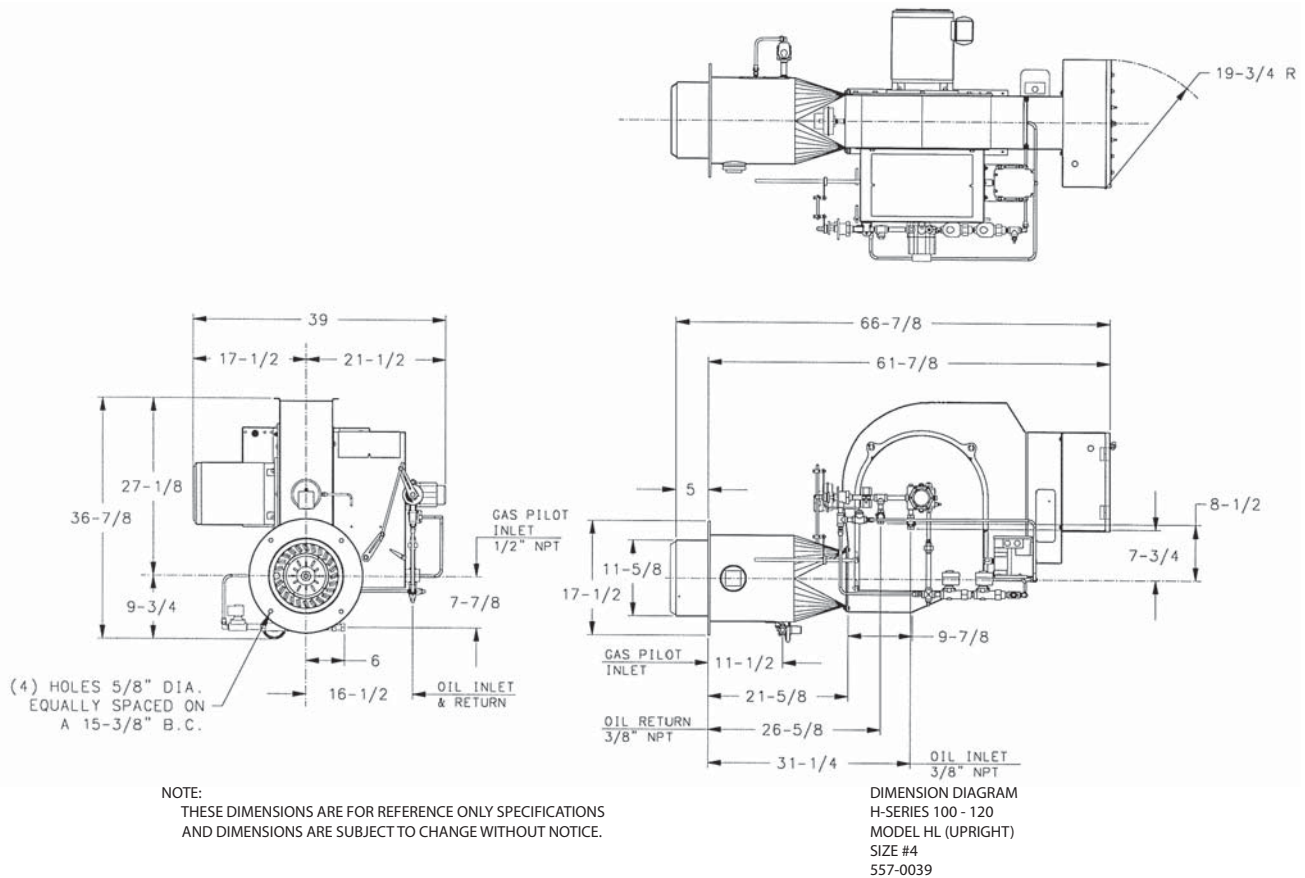


Figure 1-10

SECTION 2 INSTALLATION

A. DRAFT CONDITIONS

A boiler or other heating vessel fired with an H Series burner does not depend on chimney draft for proper combustion air. Combustion air is supplied by the burner forced draft blower providing adequate air for any normal combustion condition.

Since draft control is essential to maximum efficiency, a draft regulator may be required when the vessel is connected to a tall stack or where wind conditions may cause erratic draft. Excessive furnace draft contributes to inefficient burner operation.

Sealed boilers may be operated under positive firebox pressure within the capability of the burner.

B. COMBUSTION AIR SUPPLY

The space in which a burner operates must be supplied with adequate fresh air for combustion and ventilation purposes. Fresh air supply must meet or exceed all code requirements. Consult with insurance carrier and/or local authorities for specific regulations.



WARNING

THE BOILER ROOM PRESSURE MUST BE AT LEAST EQUAL TO THE OUTDOOR ATMOSPHERIC PRESSURE. WHERE FAN VENTILATION IS USED, AIR MUST BE FORCED INTO THE BOILER ROOM. NEVER EXHAUST AIR FROM THE BOILER ROOM. ADJOINING AREAS HAVING EXHAUST FANS MUST BE POSITIVELY ISOLATED FROM THE BOILER ROOM.

C. COMBUSTION CHAMBER DESIGN

It is not possible to include a complete design and construction combustion chamber manual in this section, but the following may be helpful in arranging burner applications in typical boilers. Combustion chambers are of four basic types:

1. Commercial "Flex tubes" watertube type boilers.
2. Conventional Cast Iron sectional boilers.
3. Conventional "dry bottom" firebox boilers having a refractory floor and full water walls.
4. Full refractory combustion chambers in "ash pit" type installations where a complete firebox is required below the level of the boiler water walls.

H burners are the forced draft flame retention type. Refractory is required only to protect surfaces not adequately protected by free circulating water. Four basic objectives:

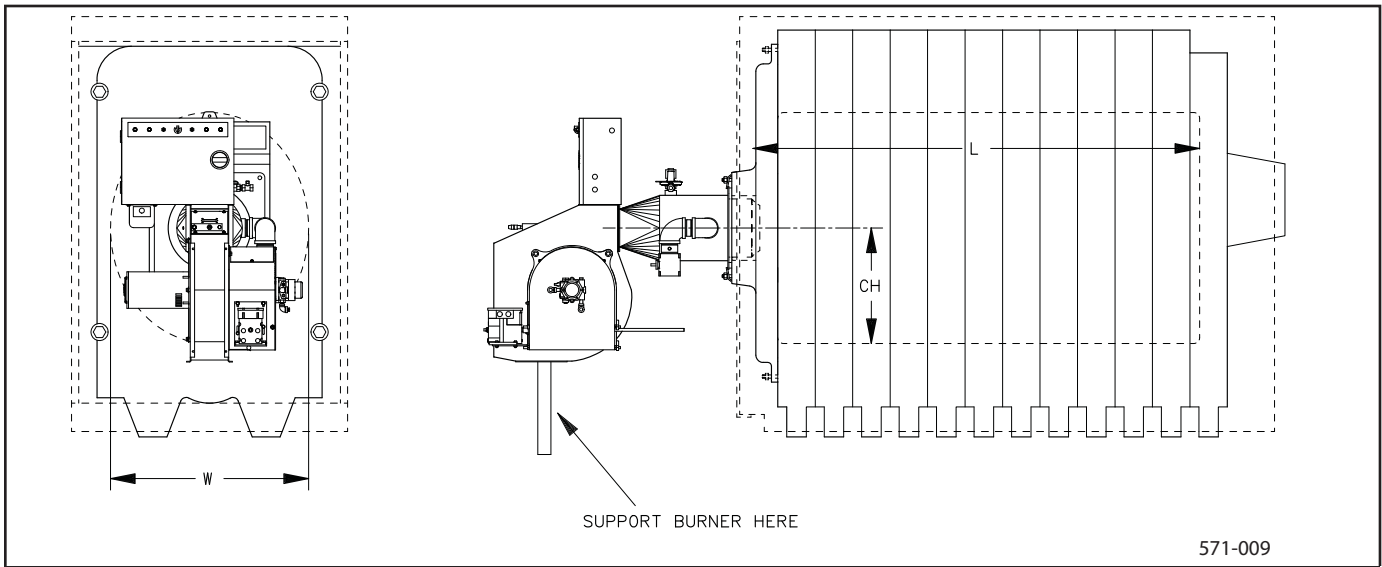
1. Provide adequate combustion space.
2. Avoid flame impingement.
3. Protect surfaces not adequately water cooled.
4. Seal openings

BURNER MODEL	COMBUSTION CHAMBER		
	LENGTH	WIDTH	CL HEIGHT
10	56	26	12
13	56	26	12
15	56	26	12
17	56	26	12
20	56	26	12
21	56	26	12
25	56	26	12
30	62	30	13.5
34	62	30	13.5
35	62	30	13.5
40	62	30	13.5
42	62	30	13.5
45	62	30	13.5
50	83	33	15
54	83	33	15
55	83	33	15
60	83	33	15
63	83	33	15
70	83	33	15
80	104	39	18.5
84	104	39	18.5
90	104	39	18.5
100	128	39	18.5
105	128	39	18.5
110	128	39	18.5
120	128	39	18.5
125	128	39	18.5

Figure 2-1

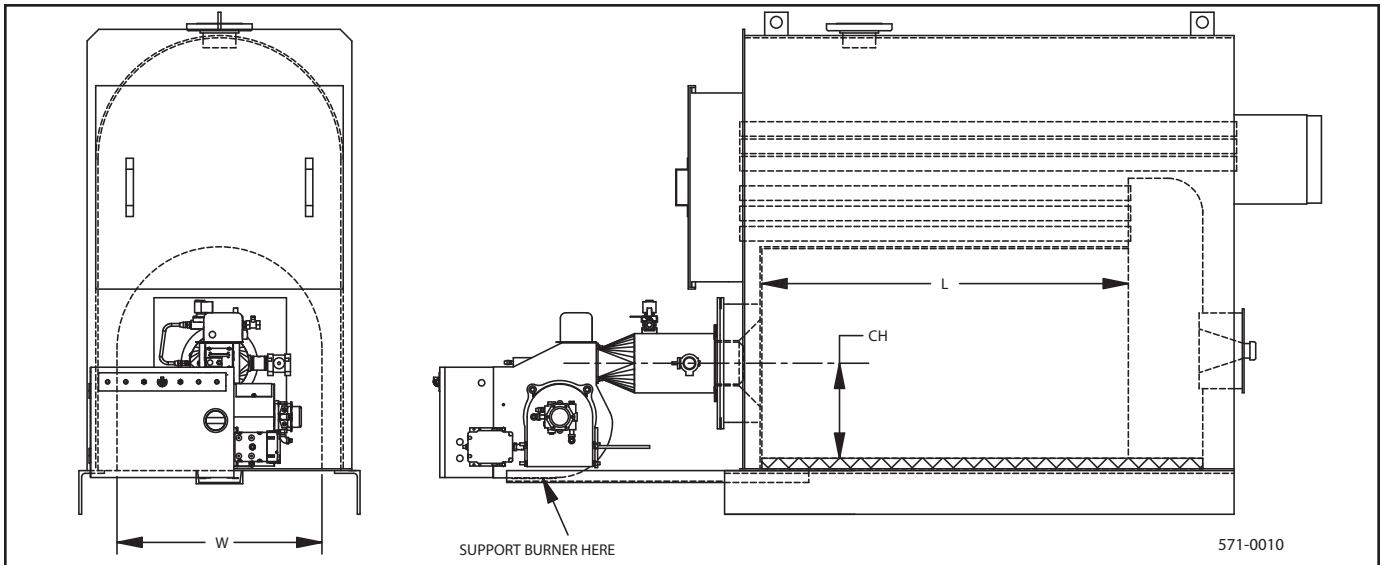
Suggested Minimum Combustion Chamber Dimensions in Figure 2-1 are based on the rated capacity of the burner.

While these dimensions are typical for good practice, satisfactory results may be achieved with modifications to suit some conditions. Factors such as fuel properties, total combustion volume, length of flame travel often make fixed requirements impractical. When in doubt, consult the factory. Insulation should be provided between the refractory and the boiler base. Mineral wool, or other material not likely to settle is preferred. The chamber front wall may be constructed of firebrick or insulating firebrick. Insulation should be used between refractory and front plate. Firebrick, or insulating firebrick should be set in high temperature bonding mortar with provision for expansion.



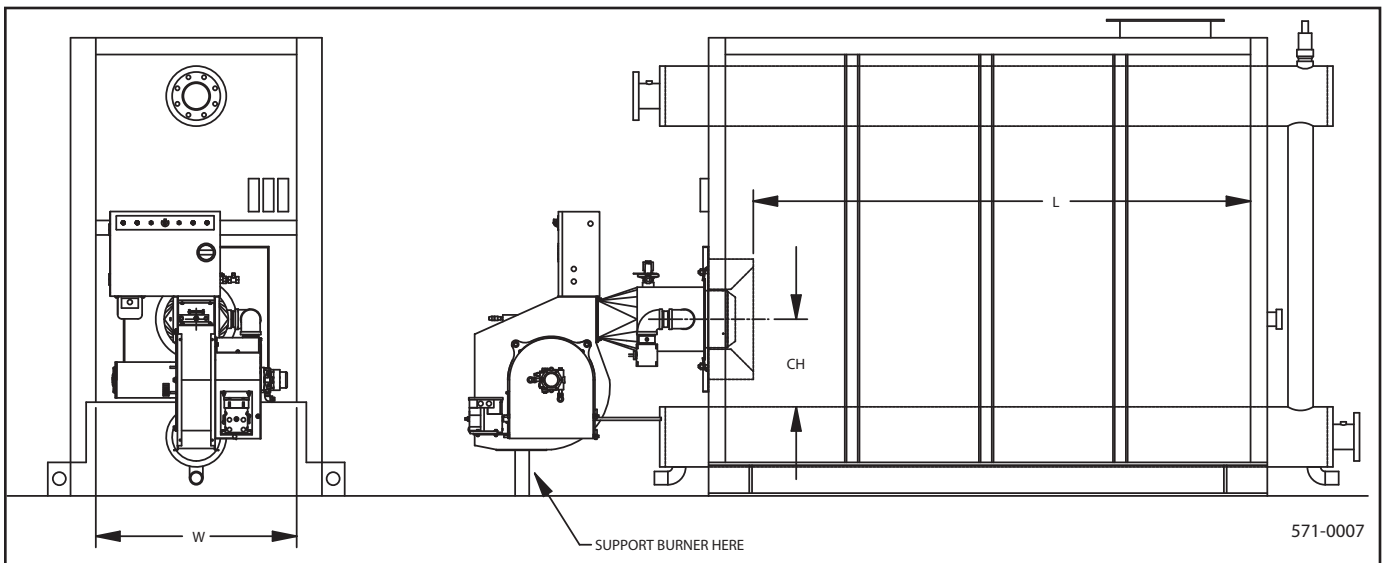
Cast Iron Boiler

FIGURE 2-2



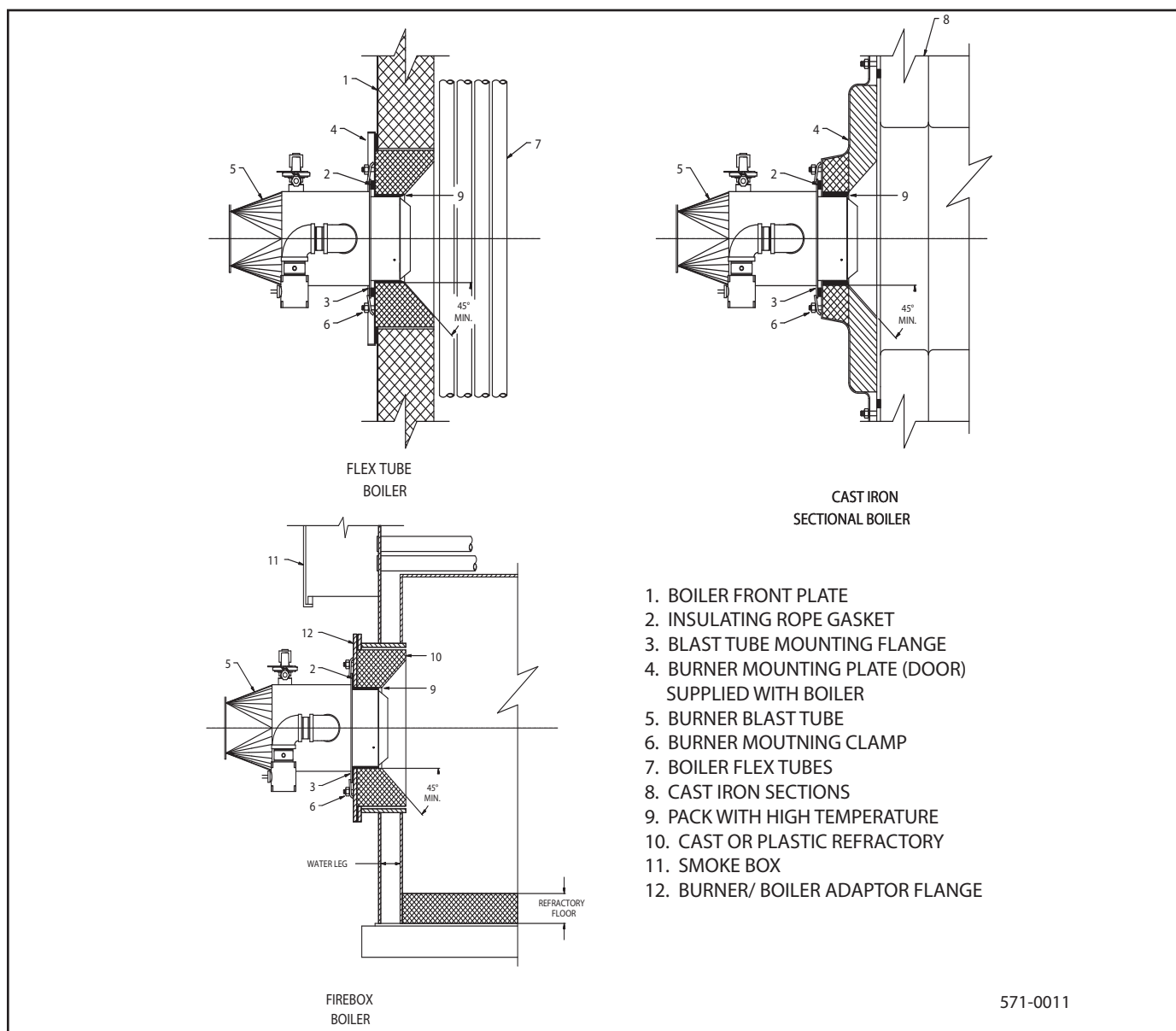
Firebox Boiler

FIGURE 2-3



Commercial Watertube

FIGURE 2-4



571-0011

FIGURE 2-5

CAUTION

GASKET MUST BE RESILIENT TO SEAL ANY UNEVEN AREAS BETWEEN THE BURNER FLANGE AND THE BOILER FRONT PLATE TO PREVENT LEAKAGE OF COMBUSTION GASES.

D. BURNER INSTALLATION

Prepare the boiler front plate as follows:

1. Determine burner mounting height. Locate and scribe a level horizontal centerline across the mounting face.
2. Locate and scribe vertical centerline. Be sure stud locations line up where studs will have full support. If they don't or if opening is too large, a steel adapter plate, 3/8" minimum may be welded or bolted in place. Suitable anchors should be provided to hold refractory in place. Adapter plate must be properly sealed (use insulating rope gasket to prevent leakage of combustion gases).

3. Using insulating rope gasket, wrap rope on the inside of the bolt circle, looping rope around the four mounting studs.

4. Set burner into position for mounting and tighten into place. All burners are equipped with a four-hole mounting flange. **Refer to the general arrangement drawings in the Introduction section of the manual.**

5. Permanently support the burner using the pipe support connections.

6. The space between the boiler refractory, water leg, or fire tube and outside diameter of the blast tube must be packed with plastic refractory, Kaiser Refractory Mono T-Air Set or equal. Ram plastic refractory from front to rear, parallel to outside surface of blast tube.

E. GAS PIPING

Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet.

All piping must be in strict accordance with applicable codes, ordinances and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with the following standards: "National Fuel Gas Code" NFPA No. 54, ANSI No. Z223-1.

Gas train components upstream of the butterfly valve are shipped loose. These components should be mounted by the installer as close to the butterfly valve as practical.

Normally, the control train is ordered to suit a particular code or insurance regulation - such as Underwriters Laboratories / Canadian Underwriter's Laboratories (UL / cUL) Factory Mutual, or Industrial Risk Insurance. See Figure 2-6 through 2-9 for component arrangement. Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly.

The pilot gas train is supplied with the burner, and is factory installed. The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shutoff valve.

The gas piping must be internally clean and free of foreign material. Before using in service, a leak test must be performed. (SEE SECTION 3-E)

F. FUEL OIL PIPING

PRESSURE ATOMIZATION OIL PIPING

The HL and HLG model burners use pressure atomization. Fuel oil is provided by a burner mounted fuel unit directly coupled to the blower motor via a flexible coupling. The suction and return line sizes (two-pipe system) are based on the suction rate of the fuel unit and not the burner firing rate. Pipe size must be selected so that suction vacuum is within suitable limits.

TWO PIPE - SINGLE BURNER OPERATION. A two-pipe system is essential. The suction and return between the storage tank or supply source and the burner must be sized to supply the required quantity of oil circulated, including excess oil returned to the storage tank.

SUCTION LINE SIZING. The Suction load is determined by:

1. The vertical lift from the oil level in the tank to the pump.
2. Pressure drop through valves, fittings, strainers, etc.
3. The friction loss due to oil flow. This loss varies with:
 - a. Quantity of oil pumped (gph).

- b. Length of suction line (feet).
- c. Diameter of the suction line.
- d. Number of fittings.

Although the gear type pumps used on the H series burners are capable of developing higher suction, it is not desirable to operate above 15 inches of mercury vacuum. If the vacuum is greater, flow may be erratic.

Refer to the manufacturers table for line sizing

1. Check suction capacity.
2. Measure total pipe length (horizontal and vertical).
3. Read up from line "total feet of copper tube" to the intersection line of the specific "suction capacity " in g.p.h.
4. Read left to column "inches of vacuum at fuel unit". This is vacuum required to draw oil through pipe listed at given length.
5. Add 1" of vacuum for every foot of lift.
6. Total inches of vacuum (frictional tube loss plus lift).
7. If total exceeds 15", check next larger pipe size.

RETURN LINE SIZING. Generally, the return line should be sized the same as the suction line.

TWO PIPE - MULTIPLE BURNER SYSTEM. Several options exist for a multiple burner installation. In Figure 2-14 a typical installation showing separate suction lines for each burner with a common return line.

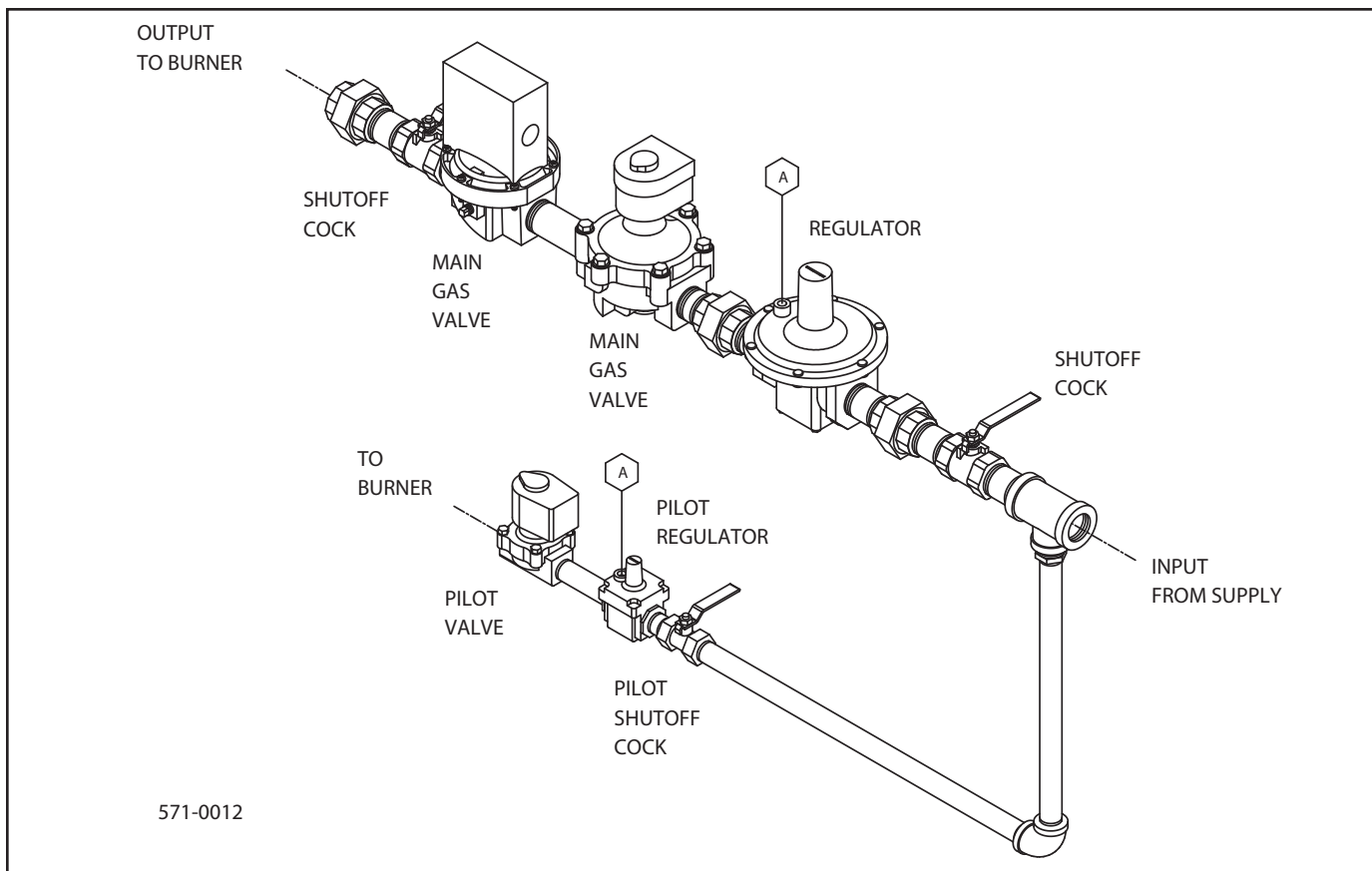
Figure 2-15 shows multiple burners with oil supplied by a transfer pump. The circulating pump is sized, in this case for the total suction capacity of all burners. Note that a special pressure regulating valve is required if the fuel unit inlet pressure is above 3 psi.

Figure 2-16 shows an installation using a day tank. A pump supplies oil to the day tank.

Figure 2-17 shows a flooded loop system. The circulating pump is sized according to the maximum burner firing rate for all burners plus a 30% service factor. The burner return lines feed into the common supply line.

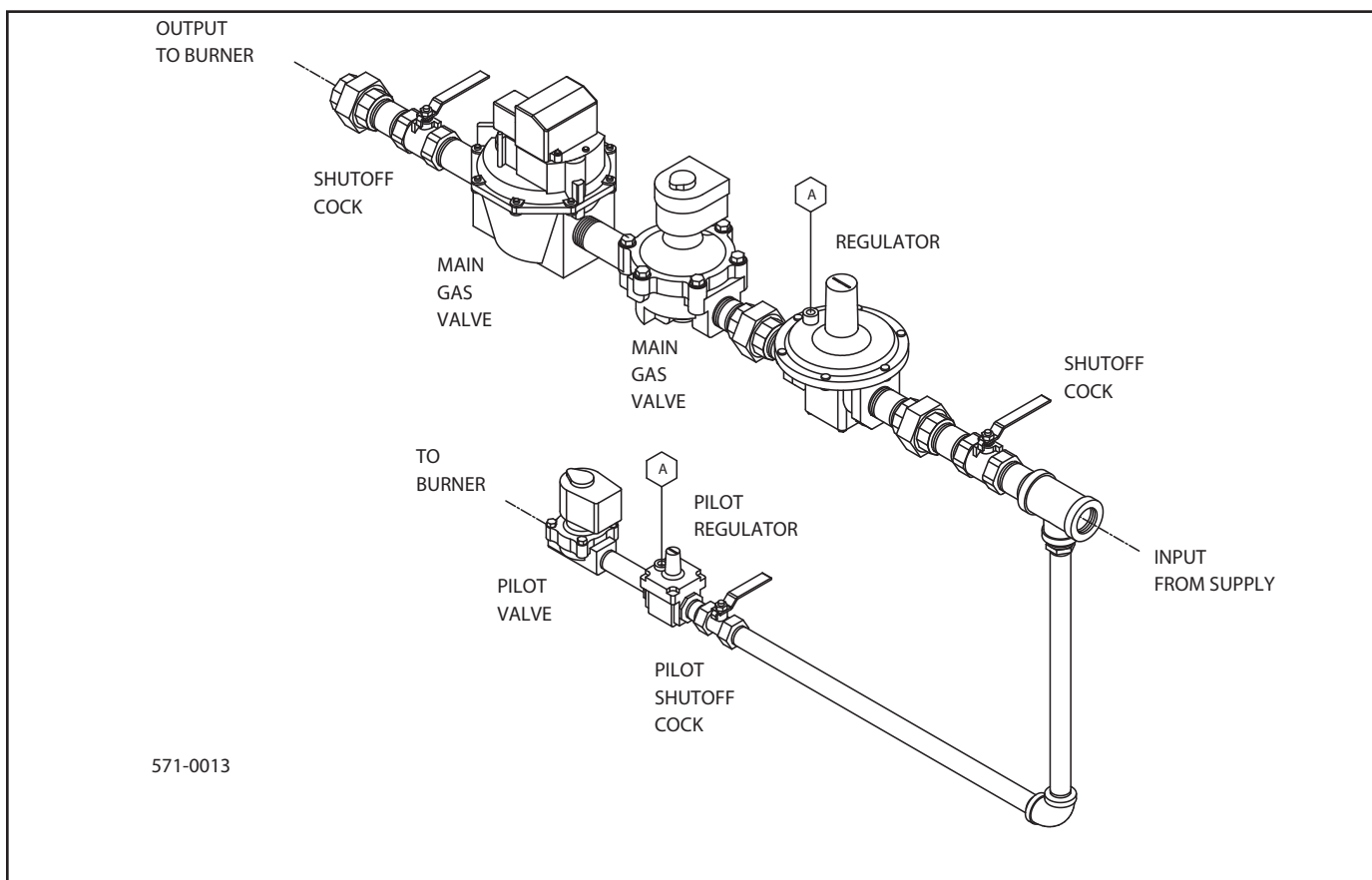
NOTE

INDUSTRIAL COMBUSTION RECOMMENDS THAT ALL OIL FIRING BURNERS BE EQUIPPED WITH AN OIL STRAINER (IF NOT INCLUDED WITH THE BURNER) TO PREVENT PARTICLES FROM CLOGGING THE NOZZLE. IT IS ESSENTIAL TO FOLLOW THE STRAINER MANUFACTURER'S MAINTENANCE SCHEDULE TO ENSURE PROPER FILTRATION.



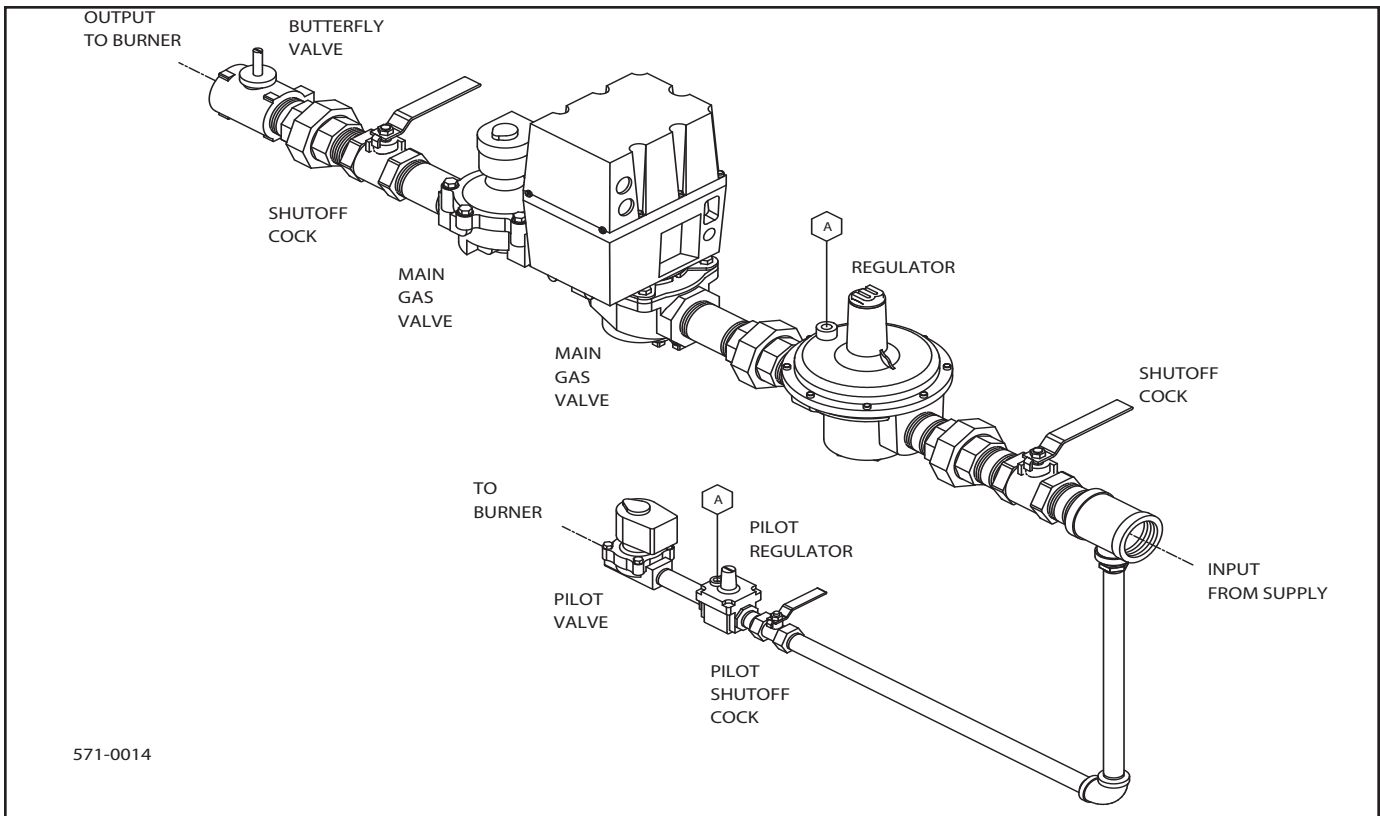
Typical U.L. Gas Train - On-Off System - Size 1 H10 to H25

FIGURE 2-6



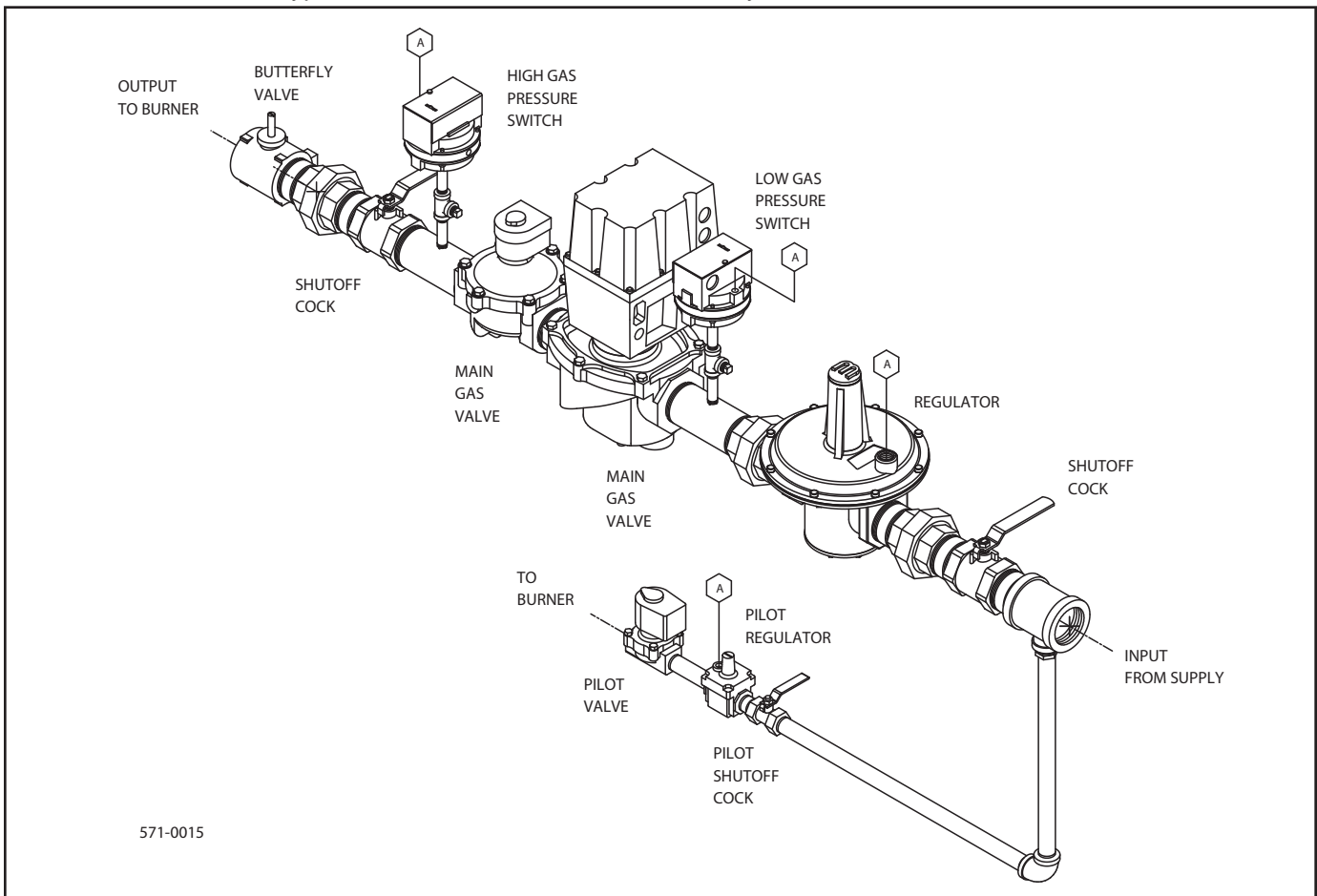
Typical U.L. Gas Train - Low-High-Off System - Size 1 H10 to H25

FIGURE 2-7



Typical U.L. Gas Train - Full Modulation System - Size 1 H10 to H25

FIGURE 2-8



Typical U.L. Gas Train - Low-High-Off, Low-High-Low, Size 2 H30 to H45
Full Modulation System - Size 2-3-4 H30 to H125

FIGURE 2-9

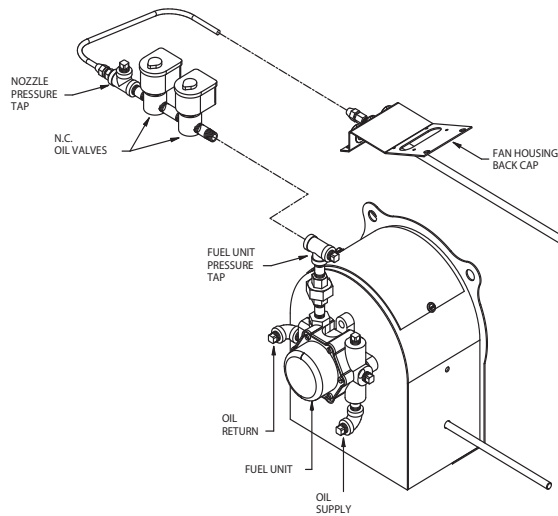


FIGURE 2-10
On-Off Oil System Size 1 - H10 to H25

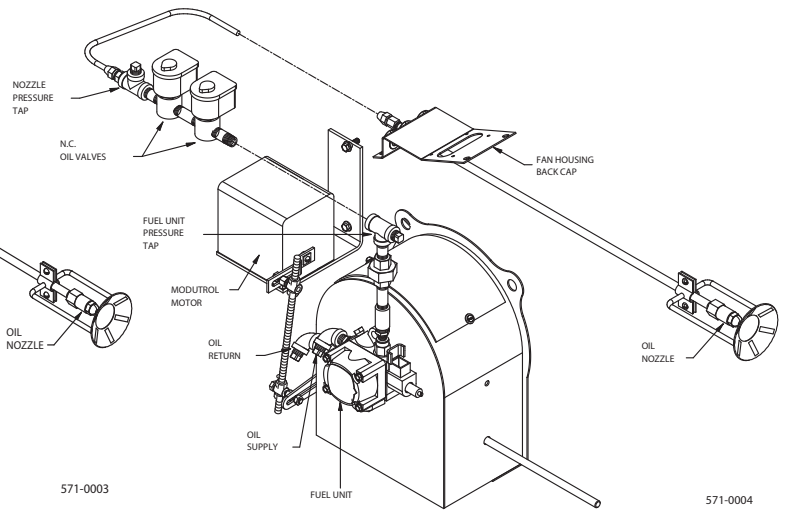


FIGURE 2-11
Low-High-Off, Low-High-Low Oil System
Size 2 - H30 to H45

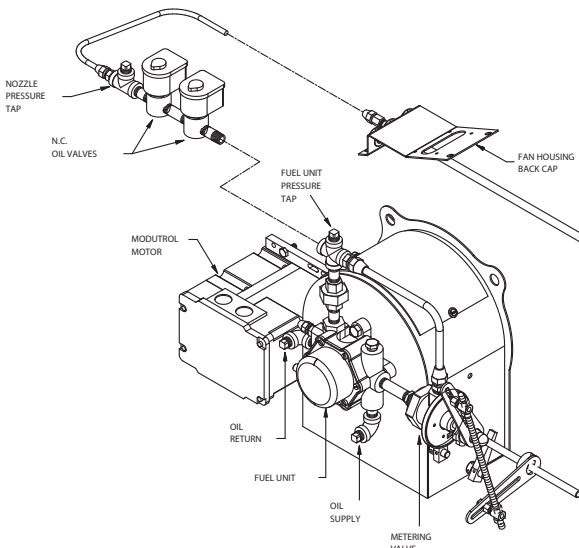


FIGURE 2-12
Full Modulation Oil System Size 1 - H10 to H25
Simplex Nozzle

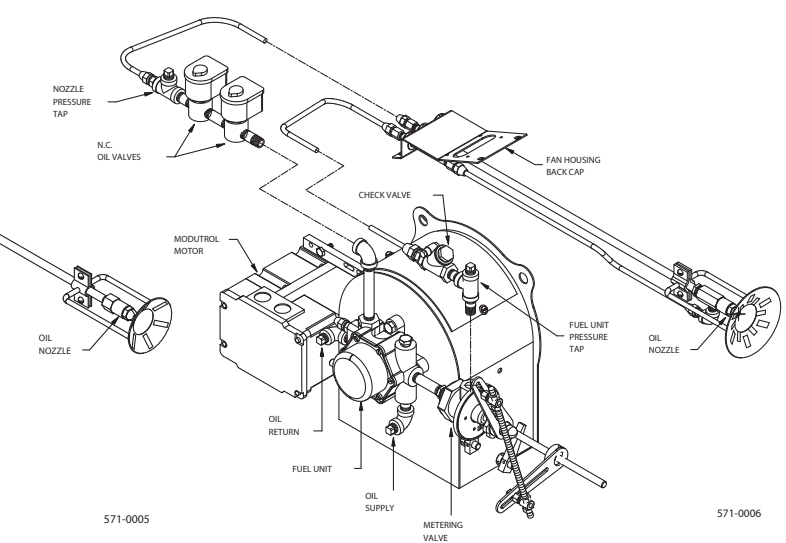
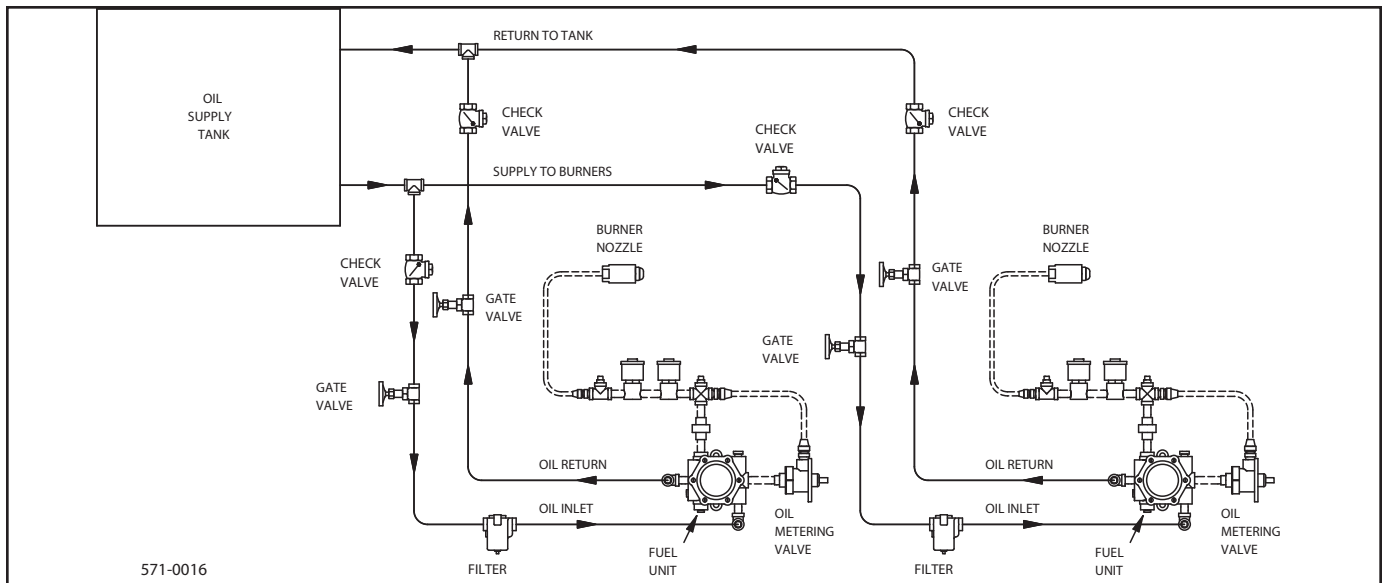
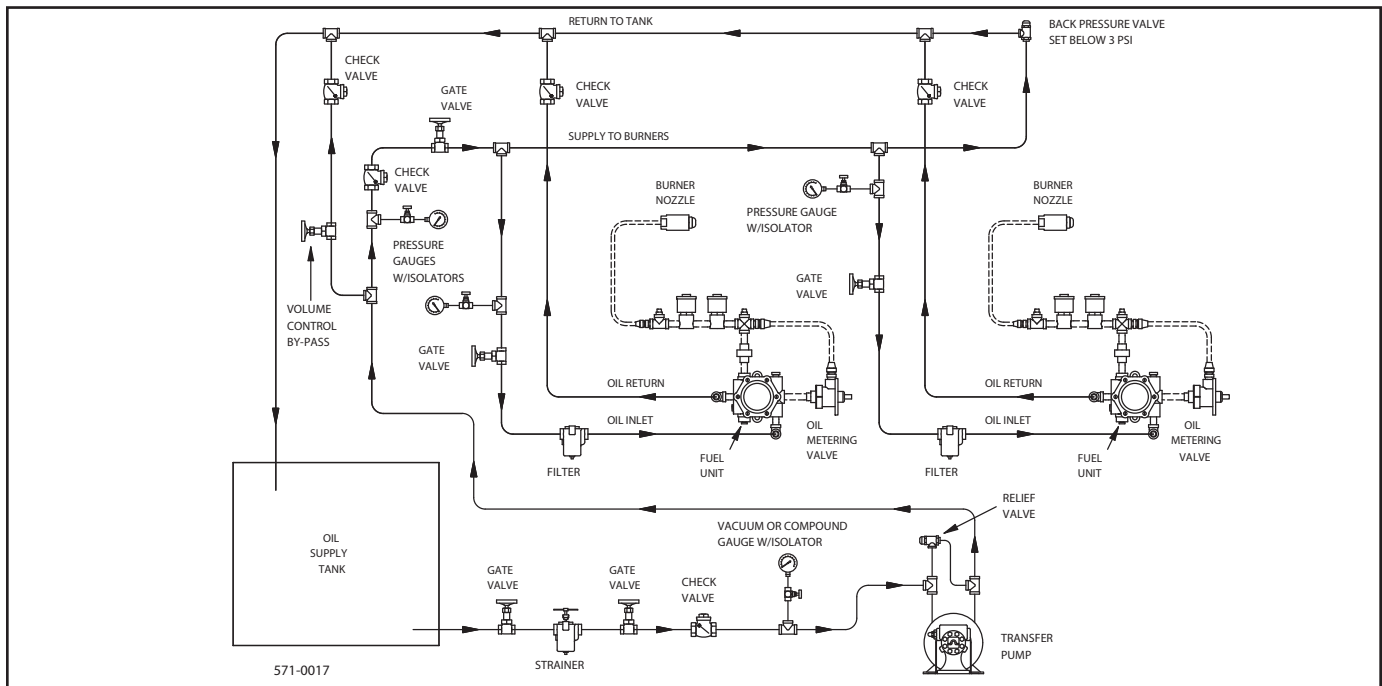


FIGURE 2-13
Full Modulation Oil System Size 2, 3, 4 H30 to H125
Return Flow Nozzle



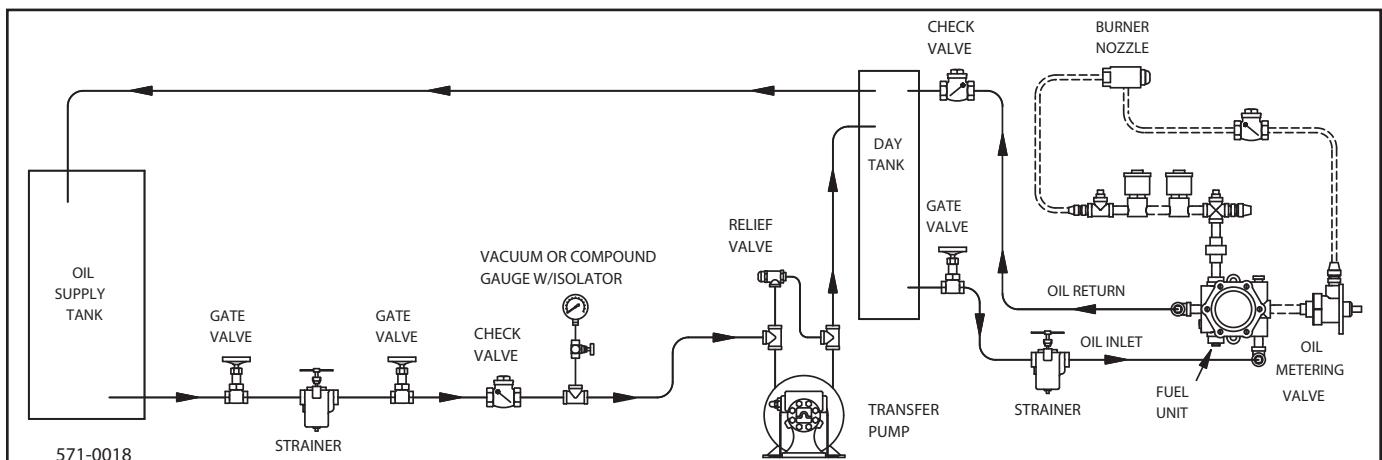
Multiple Burners with separate suction lines

FIGURE 2-14



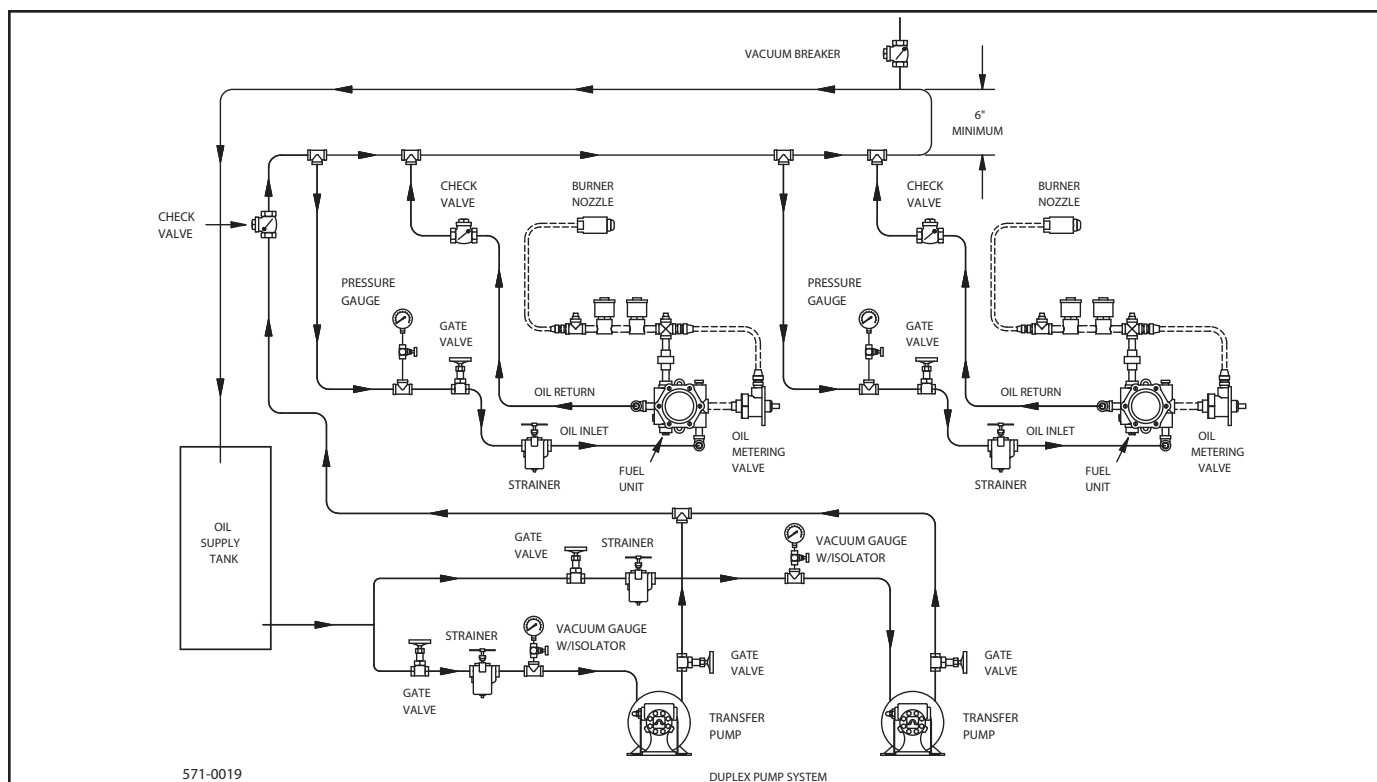
Typical Oil Loop for Multiple Burners with Transfer Pump

FIGURE 2-15



Typical Installation Using Day Tank

FIGURE 2-16



Typical Flooded Loop System

FIGURE 2-17

G. INSTALLATION CHECKLIST

1. All burners are carefully assembled and tested at the factory, but before being placed in service all connectors should again be checked for looseness caused during shipment.

Check:

- Electrical terminals in the control panel and on all electrical components.
- Pipe fittings and unions.
- Tubing connections.
- Nuts, bolts, screws.

2. Open all necessary oil shutoff valves. Do not run pumps or fuel unit without oil.

3. Before connecting electrical current to any component, be sure the voltage is the same as that specified on component nameplates.

4. Before burner operation, be sure all motors are rotating in the proper direction.

5. Before firing, make sure the burner firing head and dry areas of the boiler are protected with refractory. The burner mounting flange must be properly sealed against the vessel front plate.

6. Make certain that the operator in charge is properly instructed in operation and maintenance procedures.

CAUTION

BEFORE OPENING THE MANUAL GAS SHUT-OFF VALVES, READ THE REGULATOR INSTRUCTIONS CAREFULLY. THE INSTRUCTIONS ARE IN THE REGULATOR BOX. FOLLOW THE MANUFACTURER RECOMMENDATIONS. OPEN SHUT-OFF VALVE ON THE INLET SIDE OF THE REGULATOR SLOWLY AND CAREFULLY TO ALLOW INLET PRESSURE TO BUILDUP SLOWLY IN THE REGULATOR UNTIL IT IS FULLY PRESSURIZED. OPENING THE SHUT-OFF VALVE QUICKLY WILL DAMAGE THE REGULATOR. DO NOT EXCEED THE REGULATOR PRESSURE RATINGS.

SECTION 3 STARTING UP AND OPERATION

A. PREPARATION FOR INITIAL START-UP

When the installation is complete and all electrical, fuel, water and vent stack connections are made, make certain said connections are tight. The operator should become familiar with the burner, boiler controls and components. To identify controls and components refer to drawings and contents of Section 1. Adjustment procedures given in Section 4 should be reviewed prior to firing. The wiring diagram should also be studied along with the operating sequence of burner programmer. Check the electrical power supply for accordance with the nameplate specifications for all motors and controls.

Read and understand starting instructions before attempting to operate the burner. The following checks must be made:

BOILER.

Check boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the operating control. Set operating control at the desired temperature or pressure.

BURNER.

For protection in shipment, the flame safeguard control chassis is shipped unmounted. Check all screw connections before attaching flame safeguard chassis to base. Screw must be secure to assure low resistance connections. The relay chassis is mounted on the subbase with a screw which, when tightened, completes the connection between the subbase and chassis contacts. Press manual reset button to be sure safety switch contacts are closed.

Check fuses in main panel and in burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. The control cabinet components are 120 volt. If a control transformer is supplied, ensure that the supply voltage matches its primary voltage.

Check motor rotation by momentarily closing the starter or relay. Blower rotation is clockwise when viewed from the drive end.

Check the pilot electrode setting. Refer to the ADJUSTMENT section.

Check control linkage for proper movement of the air volume damper and fuel metering components. This can be done by loosening the linkage at the actuator lever and manipulating by hand.

Check the air shutter and adjust low fire setting. Refer to the ADJUSTMENT section.

B. FIRING PREPARATIONS

Check to make certain that all plugs, connections, linkages etc., are tight. Prior to initial firing, oil flow and pressure should be verified.

GAS BURNERS

A representative of the gas utility should turn on the gas. Determine by a test gauge upstream of the burner regulator that sufficient pressure exists at the entrance to the gas train. The gas pressure regulator must be adjusted to the pressure required and the pressure setting recorded.

On combination fuel models, set the selector switch to gas. On initial start-up it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequences to determine that the main gas valve opens. Turn the burner switch "OFF" and let programmer finish its cycle. Check to see that gas valve closes tightly.

On burners equipped with high and low gas pressure switches, set switch pressure actuating levels and record settings for future service reference.

See the burner specification nameplate inside the control panel door for minimum and maximum input rate and required manifold pressure.

When the conditions covered above and in Section 2 are assured, the burner is ready for firing. Refer to Section E for starting and operating information.

OIL BURNERS

Prior to initial firing, oil flow and pressure should be verified. If the burner is a dual fuel model, make certain that the main gas shut off cock is closed and the fuel selector switch set to "OIL".

OIL FLOW.

If the oil supply tank is below level of oil fuel unit, it is recommended that the suction line be primed with oil prior to starting the pump to avoid possibility of damage to pump through operation without lubrication.

To check for proper pump rotation, momentarily energize the starter. With rotation verified, operate the pump to determine that oil circulation exists. Observe the oil burner pressure gauge. If no pressure shows after a few moments, stop the oil pump and re-prime. If the supply tank is lower than the pump, it is possible that the initial priming of the suction line, followed by operation of the pump, will not establish oil flow. This might be caused by obstruction in the suction line, excessive lift, inadequate priming, suction line leaks, etc. Until oil flow is established, avoid prolonged operation of the pump. If oil flow is not established after a second priming, investigation is required.

A vacuum (or compound pressure-vacuum) gauge should be installed at the suction port of the pump. It is advisable that the reading be less than 15" Hg vacuum. Vacuum in excess of this may cause unstable firing.

OIL PRESSURE AND VACUUM.

If vacuum gauge reads higher than calculated, look for restriction in the suction line, a closed valve, kinked copper tubing, plugged filter, sticking check valve, frozen oil line, undersized oil line, or excessive lift.

When there is a positive head of oil at the fuel unit, either from a gravity or by pump circulation, the pressure must not exceed 3 psi at the fuel unit suction inlet. Special pressure regulating valves are available for suction pressure above 3 psi. The fuel unit discharge pressure should be set at 300 psi.

BURNER SETTINGS

To ensure reliable and safe burner performance, the location and gap setting of the electrode for direct-spark igniters, and the relative positions of the burner nozzle, diffuser, and air baffle components must be correctly set. The air damper blades must be adjusted, relative to the established flow rates, to provide the correct amount of air for complete efficient combustion.

These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

Refer to Section 4, ADJUSTMENTS, for the instructions.

COMBUSTION SETTINGS

Fuel and air flow rates are individually adjusted at low fire and at high fire to achieve rated heat input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (including air temperature, humidity, barometric pressure), and fuel property changes. Refer to the nameplate inside the control panel for minimum and maximum fuel input ratings.

Refer to Section 4, ADJUSTMENTS, for the instructions.

TEST EQUIPMENT

The following test equipment should be on site:

1. Combustion analyzer with O₂ indication.
2. U-Tube manometer, or pressure gauge, to measure gas pressures (Main and Pilot), pressure and vacuum gauge for the oil burners.
3. Inclined manometer to measure draft pressures.
4. Smoke spot tester for oil burners and CO analyzer for gas fired units.
5. Voltmeter / Ammeter
6. Stack Thermometer and Thermocouples.



WARNING

READ THE FLAME SAFEGUARD MANUAL AND FULLY UNDERSTAND ITS CONTENT BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT.. SERIOUS PERSONAL INJURY OR DEATH MAY RESULT.



WARNING

SHOULD A STARTING FAILURE OCCUR FOR ANY REASON, COMBUSTIBLE FUMES MAY FILL THE COMBUSTION CHAMBER. NEVER ATTEMPT TO RE-LIGHT THE BURNER UNDER THESE CONDITIONS WITHOUT FIRST PURGING

C. SEQUENCE OF OPERATION

The programming control sequences the operation of all controls and components through the starting, ignition, firing, and shutdown cycle. The burner and control system are in starting condition when: a. The operating and high limit control (temperature or pressure) are below their cutoff setting; b. All power supply switches are closed; c. Power is present at the control panel.

Refer to the manufacturer's literature on programming controls and burner wiring diagrams for detailed information.

D. ELECTRICAL INTERFERENCE TEST

Prior to putting the burner into service, conduct the following test to ascertain that ignition spark will not cause the flame relay to pull in.

GAS FIRED

Close the pilot and main line manual gas valves. Start the burner and at time of pilot trial with just the electrical ignition system energized. The flame relay should not pull in (i.e. should not be energized).

Upon completion of successful test, proceed with start-up procedures.

OIL FIRED

Disconnect the electrical power to the burner. Disconnect the electric oil safety shutoff valve. Reconnect electric power. Close the pilot line manual gas valve, if used.

Start burner and at the time of pilot trial, with just the electrical ignition system energized. The flame relay should not pull in.

Upon completion of successful test, disconnect power supply. Reconnect oil safety shutoff valve and turn on manual pilot gas valve. Reconnect power supply and proceed with start-up procedures.

E. START-UP AND OPERATING

GAS BURNERS:

Performing A Gas Valve Leak Test (Bubble Test)

A gas valve leak-test must also be performed on the automatic safety shutoff valves located in the main gas train prior to any initial commissioning or subsequent maintenance of the burner and gas train systems – where automatic valve proving systems interlocked with the main burner safety control are not provided. This test should be performed periodically to ensure no leakage of valves in their closed or de-energized position.

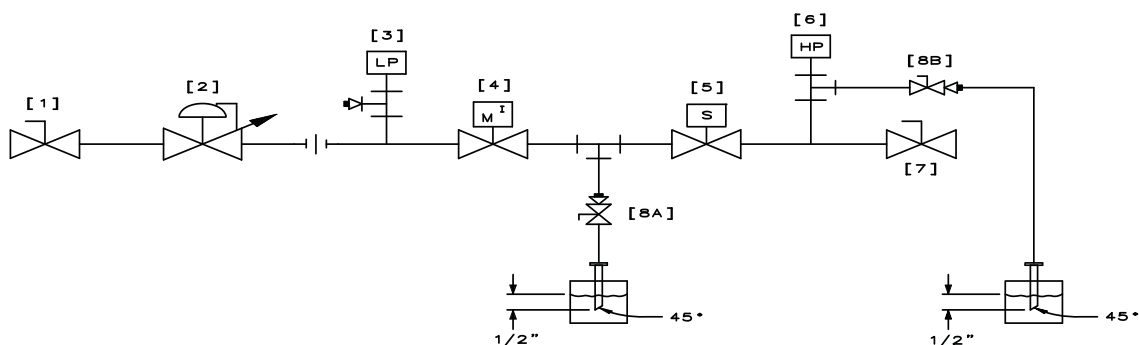
Refer to the diagram below when following this procedure. The unit should be taken out of service if the unit fails any of the following tests. Any defective part must be replaced prior to putting the equipment back into service.



WARNING

FAILURE TO FOLLOW THIS PROCEDURE MAY RESULT IN EXPLOSION, FIRE, PROPERTY DAMAGE AND PERSONAL INJURY. THIS PROCEDURE MUST BE PERFORMED ONLY BY AUTHORIZED AND QUALIFIED PERSONNEL.

- Close (or shut off) manual valve [7] downstream of the automatic safety shutoff valves, trapping gas pressure between the safety shutoff valves and manual valve and causing a flame failure. This should close the auxiliary safety shutoff valve [4] and main gas safety shutoff valve [5]. If both or either valve fails to close, do not proceed further until you correct the problem.
- Release gas pressure at the leak test cock [8B] between manual valve [7] and main gas safety shutoff valve [5], then conduct a bubble test for leak through blocking valve [5]. If no leak, close the test cock.
- Release gas pressure at test cock [8A] and bubble test for leak through auxiliary safety shutoff valve [4]. If you do not observe a leak, close test cock and go to next step. If either valve leaks, correct the problem and retest 10 times before proceeding.
- When there are no valve leaks, open manual valve [7] and relight the burners. Then close manual valve [1]. The safety shutoff and blocking valve should close due to low gas pressure.
- Relight the burners. Reduce the high gas pressure switch [6] setpoint setting until it reaches the operating gas pressure, which should cause the auxiliary and main gas safety shutoff valves to close from high gas pressure. Return the setpoint to its original position before proceeding.
- Shut off the combustion air blower. This should cause a failure due to low air pressure and cause the safety valves to close.
- Reset all manual valves to their normal setting for operation. Make sure all electric valves are operating normally. Make sure all test cocks are closed before resuming normal operation.



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Close the downstream main and pilot gas cocks. Make sure the "ON-OFF" switch is in the "OFF" position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.

For LOW-HIGH-OFF or LOW-HIGH-LOW and FULL MODULATION models set the "MANUAL-AUTO" switch to the "MANUAL" position.

Set the manual potentiometer to low fire position.

Open the gas pilot cock. check pressure. Normal setting is 3" to 6" WC when the pilot is burning.

Set the "ON-OFF" switch to "ON". The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized.

On initial start-up it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through prepurge and pilot sequence. Then determine that main gas valve opens. When this is confirmed, turn the burner switch "OFF" and let programmer finish its cycle. Check to see that gas valve has closed tightly. If ignition does not occur, turn the burner switch "OFF" and allow programmer to recycle for a new ignition trial.

Turn burner "ON" and after pilot ignition when the flame relay pulls in, the slow opening, motorized, main gas valve is energized. Slowly open the downstream manual shutoff gas cock. Main flame should ignite at this time. The gas valve and air damper continue advancing until high fire is reached.

Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting butterfly valve and air linkage. Referring to the adjustment section of this manual and using a combustion analyzer, adjust the low fire ratio (typical combustion analysis for low fire is 4 to 5% O₂). Verify the minimum input rate by measuring the gas meter.

When low fire is adjusted, shut down burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 2.0 to 3.5% O₂. Verify maximum input rate by measuring the gas meter.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings. CO levels should be less than 50 ppm on an air-free basis at all firing rates.

When conditions covered above are assured, refer to Sections F and G of this chapter.

OIL BURNERS

The fuel selector switch should be set to "OIL" and the "ON-OFF" switch is in the "OFF" position. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.

Set the "ON-OFF" switch to "ON". The burner will start and pre-purge. After pre-purge, the ignition transformer will direct spark. If the flame detector proves the presence of a satisfactory pilot, the programmer will proceed to main flame ignition.

Make initial air shutter settings for smooth ignition. Return line oil pressure should be set according to Section 4, ADJUSTMENTS. Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the oil low fire rate by adjusting the oil return pressure and air linkage. Refer to the adjustment section of this manual. Using combustion analysis instrument adjust the low fire. Typical combustion analysis for low fire is 4.0 to 6.5% O₂.

When low fire is adjusted, shut down burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

After the boiler has reached operating temperature or pressure, turn the potentiometer switch in small increments to the high fire position. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle. In high fire the oil metering valve should be in the fully closed position and the fuel oil pressure should be about 300 psi. Check high fire at this point using combustion instruments. High fire combustion analysis typically is 3.0 to 4.5% O₂. Verify maximum input rate by measuring the oil meter if available or by weighing the oil.

The burner should be set-up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot build-up in the boiler.

Do not disturb established low fire adjustment. Allow the burner to return to low fire position before adjusting high or intermediate settings.

When conditions covered above are assured, refer to letters F and G of this section.

COMBINATION GAS-OIL BURNERS

In general, the combination fueled system is to be started first using oil, because, as a fuel, oil has a greater combustion air requirement than natural gas.

Refer to the Gas burner or Oil burner adjustment procedures and to Section 4, ADJUSTMENTS.

Once the adjustments are set for oil, shut-down the burner and re-start and adjust the natural gas fuel. **DO NOT READJUST THE AIR SHUTTERS.** The adjustment is made by balancing the fuel input rate against the existing flow of combustion air.

When conditions covered above are assured, refer to letters F and G of this section.

NOTE

COMBINATION GAS/OIL UNITS USE A DIRECT COUPLING FROM THE BLOWER MOTOR TO THE OIL PUMP. WHEN FIRING GAS FOR AN EXTENDED PERIOD OF TIME, THE COUPLING SHOULD BE MANUALLY REMOVED AND REPLACED ONLY WHEN FIRING OIL. IF THE COUPLING IS LEFT CONNECTED TO THE BLOWER MOTOR, ENSURE THAT THERE IS PROPER OIL CIRCULATION AT ALL TIMES TO AVOID DAMAGE AND SEIZURE OF THE PUMP.

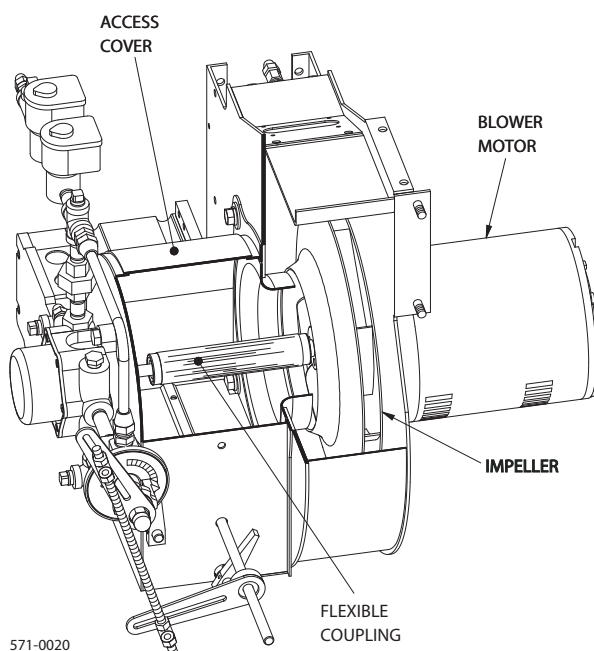


Figure 3-1

F. NORMAL OPERATION

Normal operation must be with the "MANUAL-AUTO" switch selector at "AUTO".

In automatic operation, the operating cycle always proceeds sequentially through pre-purge, pilot ignition, main flame ignition, run and post-purge. The length of purge and ignition trial vary according to the type of programmer used.

During the run cycle, burner input is regulated to the load demand by the modulating pressure or temperature control on the boiler. The burner will continue to modulate until the operating pressure or temperature is reached.

Programmer control operation should be tested when the burner is initially placed into service, when a control is replaced, and at scheduled intervals in the maintenance program.

Refer to adjustments procedures and maintenance instructions given in Sections 4 and 5.

G. SHUTDOWN

When the operating limit control setting is reached or the burner switch is turned "OFF", the following sequence occurs:

The fuel valve(s) de-energize and flame extinguishes. The blower motor continues running during post-purge (if so equipped with post-purge feature).

At the end of the post-purge the blower motor is de-energized. The programmer returns to its starting position and stops. Unit is ready to restart.

Abnormal shutdown might result from motor overload, flame outage, low water, current or fuel supply interruption, combustion or atomizing air pressure below minimum level, tripped circuit breakers, blown fuses, or other interlock devices. Check for cause and correct before restarting burner.

Safety shutdown caused by ignition or flame failure will actuate a red indicator light and energize an audible alarm (if so equipped). If the programmer has a non-recycling interlock circuit, any interruption in this circuit during the pre-purge or firing cycle will cause a safety shutdown. This type of shutdown requires manual reset of the programming control and must be corrected before operation can be resumed.

SECTION 4 ADJUSTMENTS

A. GENERAL

While each burner is tested at the factory for correct operation before shipment, variable conditions such as burning characteristics of the fuel used and operating load conditions may require further adjustment after installation to assure maximum operating efficiency.

Prior to placing the boiler into initial service, a complete inspection should be made of all controls, connecting piping, wiring, and all fastenings such as nuts, bolts and setscrews to be sure that no damage or misadjustments occurred during shipment and installation.

A combustion efficiency analysis made during the initial start-up will help to determine what additional adjustments are required in a particular installation.

B. COMBUSTION ADJUSTMENT ON OIL AND GAS

Efficient combustion cannot be properly judged by flame appearance, although it may help in making preliminary settings.

The proper settings of air-fuel ratios must be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide (CO₂), oxygen (O₂), and carbon monoxide (CO). At no time should CO₂ measurements alone be used to indicate proper excess air levels. Only O₂ measurement can definitively show whether sufficient air has been provided for combustion.

STACK TEMPERATURE

Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. Decreasing either the temperature or the volume of the flue gas, or both can reduce stack heat loss. Flue gas temperature is reduced by improving heat transfer or by reducing excess combustion air. A certain amount of excess air is necessary to complete combustion. More efficient burners require minimum excess air.

SMOKE MEASUREMENT

Smoke measurements can be made using a variety of different methods. The standards will vary somewhat according to the equipment used, and instructions accompanying the instrument should be followed.

Smoky combustion can result from: Improper air delivery, insufficient draft, improper fuel viscosity, improper fuel-air ratio, excessive air leaks in the combustion chamber, or improper fuel oil temperature.

TEST EQUIPMENT

The following test equipment should be used to set-up and adjust the burner correctly:

1. Combustion analyzer with O₂ indication.
2. U-Tube manometer, or pressure gauge, to measure gas pressures (Main and Pilot), Vacuum and pressure gauges for oil.
3. Inclined manometer to measure draft pressures.
4. Smoke spot tester for oil burners and CO analyzer for gas fired units.
5. Voltmeter / Ammeter
6. Stack Thermometer and Thermocouples.

AIR FLOW ADJUSTMENTS

The H-Series burners have a unique air shutter design that enables precise, independent air flow rate adjustments for both the high-fire and low-fire operating points. This design incorporates a variable main air shutter (mounted on a shaft and direct-coupled to the modulating motor), plus two adjustable, but non-modulating, air shutters.

NOTE

THE ON-OFF, LOW-HIGH-OFF, LOW-HIGH-LOW BURNERS ARE EQUIPPED WITH A SINGLE AIR DAMPER BLADE. THE SPECIAL AIR SHUTTER DESIGN IS APPLICABLE ONLY FOR THE FULL MODULATION SYSTEMS.

The modulating main air shutter regulates the flow of inlet air through the fan at flow rates between high-fire and low-fire conditions according to the modulating motor position. One non-modulating air shutter, for high-fire combustion air control, is adjusted to provide the correct amount of air while the system is operating at high-fire fuel input rate with the main air shutter fully open. The other non-modulating shutter, for low-fire combustion air control, is adjusted to provide the correct amount of air with the system operating at low-fire input rate with the main shutter completely closed.

COMBUSTION SETTINGS

Fuel and air flow rates are individually adjusted at low-fire and at high-fire to achieve rated input, firing rate turndown, optimum efficiency, safe operation, and the ability to cope with environmental changes (including air temperature, humidity, barometric pressure), and fuel property changes.

Turndown capability for oil is less than that for gas due to the excess air requirement of oil for clean combustion. Therefore, on combination fueled burners, gas turndown performance may be restricted (or determined) by the excess air levels set initially for oil combustion.

Two key components residing in flue gas are used to optimize combustion efficiency; excess air and unburned

fuel. The system should be adjusted to the minimum excess air quantity that provides low levels of unburned fuel with sufficient remaining oxygen to cope with normal atmospheric and fuel related changes. Unburned fuel is measured as carbon monoxide (CO) when burning natural gas, and smoke spots when burning oil.

GAS ADJUSTMENTS

Low fire combustion analysis typically is 6 to 9 percent CO₂ and less than .04 percent CO (400 ppm). High fire reading typically is 9 to 10.5 percent O₂ and less than .04 percent CO. The H/Series burners are capable of operating at low excess air and less than 50 ppm CO levels at all firing rates.

FUEL OIL ADJUSTMENTS

Adjust for a "clean fire". Typically for No. 2 oil, O₂ is 8 to 11 percent at low-fire and 10 to 13 percent at high-fire.

The burner should be set-up and maintained to yield smoke spot levels less than a #1 spot (ASTM D2156 Shell-Bacharach Scale) to minimize soot build-up in the boiler.

C. GAS PILOT FLAME ADJUSTMENT

Burner models HG-HLG and HL-50 to 125 are equipped with a gas pilot system. The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 3 to 6" WC when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame. Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal.

The flame safeguard amplifier has a meter jack for this purpose. At initial start-up and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout. Refer to the flame safeguard instruction manual.



WARNING

AN ULTRA-VIOLET FLAME SENSOR ELECTRICAL SPARK INTERFERENCE TEST MUST BE PERFORMED AFTER FINAL ADJUSTMENT. SEE SECTION 3 OF THIS MANUAL FOR ADDITIONAL INFORMATION.

Check the pilot electrode setting. The pilot is accessible by loosening the four screws on the side of the blast tube and disconnecting the gas line.

D. DIRECT SPARK OIL PILOT ADJUSTMENT

Burner models HL-10 to 45 are equipped with a direct spark ignition. Remove the oil drawer assembly and check electrode settings and nozzle size.

E. BURNER SETTINGS

To ensure reliable and safe burner performance, the location and gap setting of the electrodes, and the rela-

tive positions of the burner nozzle, diffuser and air baffle components must be set correctly. These items are preset at the factory, but must be checked prior to placing the burner into initial service, or after conducting any service work that may have altered their position.

The nozzle/diffuser assembly must be removed from inside the burner to enable measurement and adjustment.

Remove as follow:

1. Lock out and tag the electrical power supply to the burner to prevent inadvertent operation during check-out or maintenance activities.
2. Disconnect the high voltage power supply from the oil-spark-ignition electrodes (if installed).
3. Disconnect the flame scanner and oil piping from the end of the blast tube.
4. Remove the fasteners that secure the drawer to the side of the fan housing, and remove the complete assembly.
5. For burners with a gas pilot: Disconnect the pilot line and loosen the locking screws on the pilot access cover located on the side of the blast tube. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly. The pilot assembly will slide back and away from the diffuser. Turn the assembly and retract it through the access hole. Check the electrode position as illustrated in Figure 4-1. Reassemble in reverse order.

Measure the position and gap of the pilot electrodes and compare to the dimensions in Figure 4-2. Adjust as follows:

1. Loosen the locking screws on the spark ignition clamp

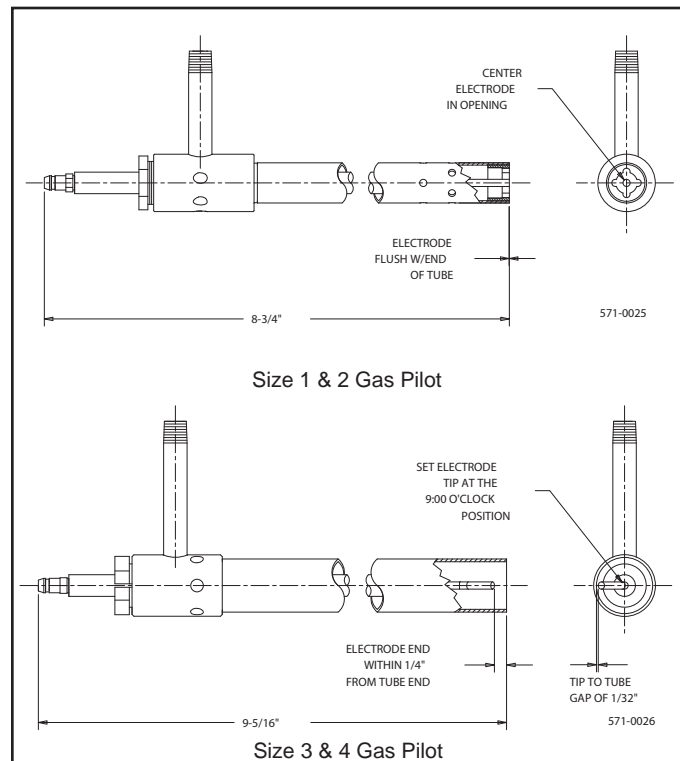
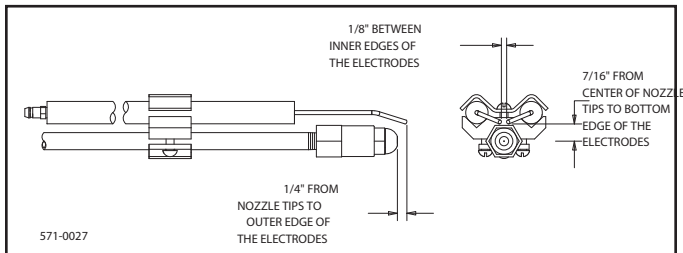


Figure 4-1

assembly.

2. Rotate and slide each electrode in the clamp, as necessary, to achieve the correct position relative to the burner tip.

3. Tighten the locking screws securely to lock the electrode in position. Apply a lock-tight type compound to the screws before tightening.



Direct spark ignition

Figure 4-2

Measure the position of the tip of the nozzle to the diffuser and compare to the following drawer assembly drawings. Adjust as follows:

1. Loosen the locking screws on the diffuser clamp.
2. Slide the diffuser clamp along the length of the burner pipe until the correct dimension is achieved.
3. Tighten the diffuser clamp securely to the burner pipe. Apply a lock-tight type compound to the screws before tightening.
4. Carefully install the drawer assembly into the burner. Reconnect the oil line, scanner, and high voltage power cable to the assembly.

Measure the position of the diffuser to air baffle and compare to the following drawer assembly drawings. Adjust as follows:

1. Measure the distance between the leading edge of the diffuser and the front face of the inner ring on the air baffle assembly.
2. If adjustment is required, loosen the burner pipe locking setscrew located on the rear cap at the top of the fan housing, and slide the burner pipe until the correct dimension is achieved.
3. Tighten the burner pipe locking setscrew securely.

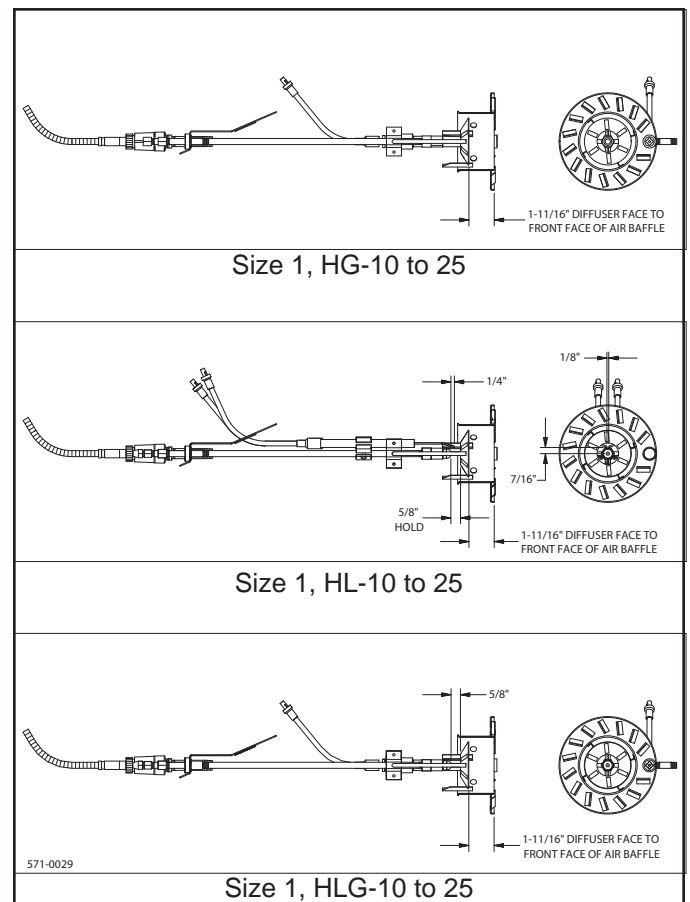


Figure 4-3

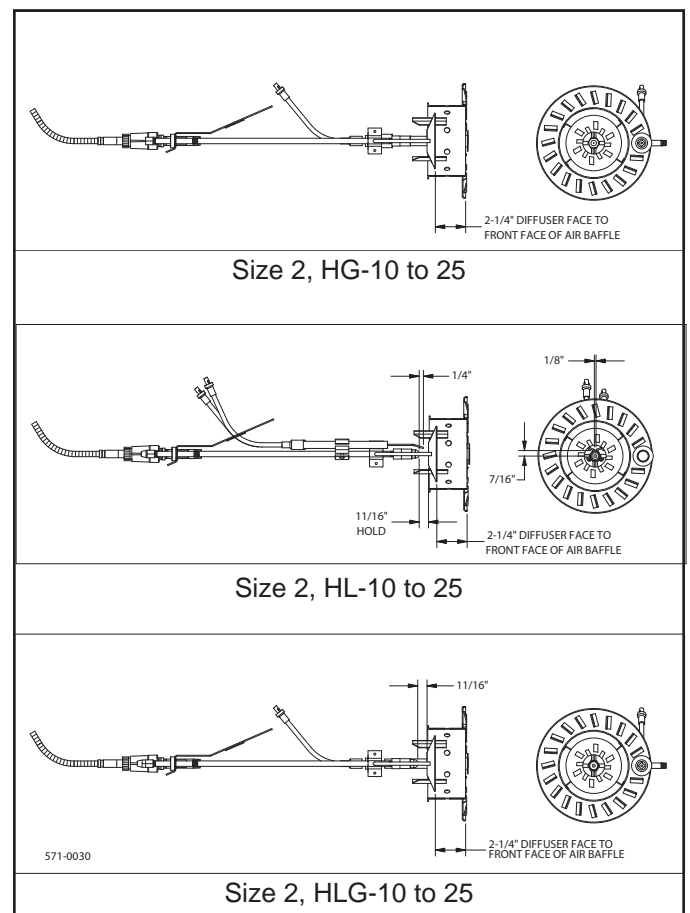


Figure 4-4

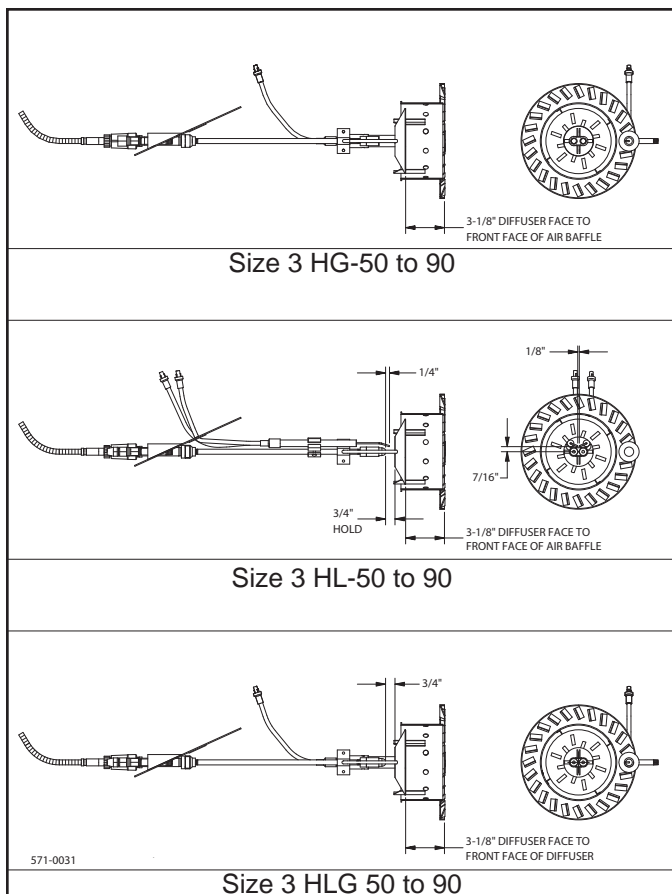


Figure 4-5

F. PILOT TURN DOWN TEST

For burners equipped with a gas pilot, conduct the following test:

1. Turn the burner switch on. This will start the blower motor and initiate the prepurge sequence. Make sure a pressure gauge 0-10" w.c. or manometer is installed in the pilot line to monitor the pilot gas pressure.
2. When the pilot comes on, put the programmer timer on pilot hold by placing the Run-Test switch of the flame safeguard to the "Test" position.

Refer to the flame safeguard control manual instructions.

3. Check the flame signal strength. Adjust the flame signal by increasing or decreasing pilot gas pressure with the regulator spring. Normal setting is 3" w.c. to 4" w.c.
4. Perform a pilot turndown test by reducing the pilot pressure very slowly until the scanner loses sight of the flame and give a flame lock-out, then reset the adjustment to normal level. Note the minimum pressure level.
5. After adjusting the pressure back to normal level, set the programmer to the "Run" position. Main flame will come on and the burner is in the low fire position.
6. Start and stop the burner several times to ensure proper pilot setting.

G.ON-OFF BURNER ADJUSTMENTS

Refer to the burner data plate located inside the control

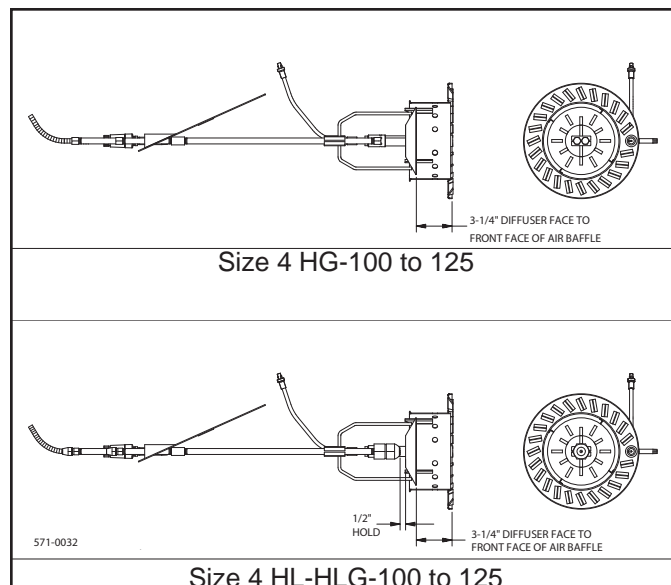


Figure 4-6

NOTE

Maximum valve inlet pressure for the V4944 is 0.5 PSI. If line pressure is greater, an over pressure device is to be installed down stream of main gas regulator. (CSD-1-CF160)

panel door. The nameplate will list the burner information: Burner and control voltage, phase, cycle, motor amperage, maximum and minimum fuel input settings, manifold pressure (at zero furnace pressure. Add the furnace pressure to get the correct manifold pressure at maximum firing rate.).

These procedures assume that the pre-start-up tasks, check list, electrical interference test, and pilot turn-down tests, have been performed in accordance with the instructions in this manual.

Allow boiler to fully warm up before making adjustments for most efficient combustion. Refer to the boiler instruction manual for the boiler controls settings.

GAS BURNERS

On-Off gas burners are typically equipped with a pressure regulator, and a solenoid operated diaphragm gas valve to control the on-off operation of the burner. Adjustments are made by matching the correct fuel/air ratios.

1. Open the manual gas shut-off cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on top and turn the adjustment screw clockwise to increase pressure, or counter-clockwise to decrease pressure.

3. Turn the burner switch to the ON position.

4. Adjust the burner for a smooth ignition of the main flame. The bleed valve adjustment controls the opening of the V48 valve. When the controller is not calling for heat, the coil is de-energized. The plunger in the 3-way actuator is in the DOWN position so the bleed port is closed and the supply port is open. Gas flows into the top part of the valve. The gas pressure on top of the diaphragm, the weight, and the spring hold the valve closed. On call for heat, the controller contacts close and the coil is energized. This pulls the plunger to the UP position, opening the bleed port and closing the supply port. The gas in the top of the valve flows out through the bleed port. This reduces the pressure on top of the diaphragm, allowing the gas pressure below to lift the diaphragm and open the valve.

5. Adjust the high fire gas input to match maximum rating. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record your readings and pressures. High fire is typically 2.0 to 3.5 % O₂ with a target value of less than 50 ppm CO.

The burner should be adjusted to provide correct fuel flow at a constant rate, as indicated on the burner data plate. This is achieved by clocking the gas flow at the gas meter. The gas utility or gas meter calibration data, should be consulted to determine the correction factors to be applied to the meter.

Use the following formula to determine actual flow:

$$\text{Gas Input} = \frac{(\text{HHV} \times \text{Patm} + \text{Pgas} \times 520 \times 3600 \text{ s} \times \text{RATE})}{29.92 \text{ Tgas} + 460 \text{ hr}} \text{ ft}^3 = \text{Btu} \text{ s hr}$$

Where:

HHV = The higher heating value of the gas in Btu/ft³ (contact your local gas company for an exact measurement).

Patm = Atmospheric pressure in inches of mercury.

Pgas = Gas pressure ahead of the volumetric flow meter in inches of mercury.

Tgas = Gas temperature at the volumetric flow meter in Deg.F

RATE = Natural gas rate taken with the volumetric flow meter in ft³ /second

6. After completing all adjustments, replace the regulator gaskets and slotted aluminum screw cap. Tighten all linkages and marked settings. Complete the Start-up report at the end of this section.

OIL BURNERS

On-Off burners use the Suntec B2TC-8931 oil pump model. High-fire pressure adjustment is 200-300 PSI

(solenoid energized), and low-fire pressure adjustment is 100-200 PSI (solenoid de-energized).

1. Briefly push in the starter contact and release to ensure that the blower motor and oil pump are rotating in the correct direction.

2. Turn the burner switch to the ON position.

3. Make sure a pressure gauge, 0-600 PSI range, is installed, downstream of the solenoid valves. Adjust the burner for a smooth ignition of the main flame. Disconnect the wiring to the solenoid on the Suntec B2TC-8931 oil pump. Loosen and remove knurled nut on the solenoid. Adjust the screw, clockwise to increase low fire oil pressure, and counterclockwise to decrease the low fire oil pressure, until a smooth ignition of the oil flame is obtained and a satisfactory low fire oil flame is established. Turn burner off and restart to ensure smooth ignition is obtained at the set low fire pressure. Replace knurled nut and tighten finger tight.

4. Adjust the high fire oil input to match the maximum rating. Turn the burner off and reconnect the wiring to the solenoid valve. Restart the burner and allow burner to go through ignition and low fire. When the solenoid energizes, the oil pump discharge pressure is at high fire pressure. The high fire pressure adjustment screw is located on the oil pump body. Adjust the screw, clockwise to increase the pressure and counterclockwise to decrease the pressure, until correct amount of oil pressure is obtained. The high fire oil pressure should be 300 PSI. High fire is typically 3.5% to 4.5% O₂, with less than a No.1 smoke. The burner should be adjusted to provide the correct amount of fuel flow at a constant rate at high fire position as indicated on the burner data plate, located inside the control panel.

COMBINATION GAS-OIL BURNERS

In general, the combination fueled system is to be started first using oil, because as a fuel, oil has a greater combustion air requirement than natural gas. After being completely adjusted for oil combustion, the burner is re-started and adjusted using natural gas as fuel. Combustion adjustment of the combination burner for natural gas involves balancing the input rate only against the existing flow of combustion air, as established initially for oil.

Do not readjust the air shutters when tuning the combination burner for combustion of natural gas.

1. Turn the fuel selector switch to the OIL position.

2. Turn the burner switch to the ON position.

3. Proceed with start-up and adjustments using the same procedures defined in the Oil Burners section.

4. After the system has been completely adjusted for oil firing, place the burner switch OFF, and position the fuel selector switch to GAS.

5. Proceed with start-up and adjustments using the same procedures defined in the Gas Burners section. Do not alter the air settings set for oil.

H. LOW-HIGH-OFF & LOW-HIGH-LOW BURNER ADJUSTMENTS

Refer to the burner data plate located inside the control panel door. The nameplate will list the burner information: Burner and control voltage, phase, cycle, motor amperage, maximum and minimum fuel input settings, manifold pressure (at zero furnace pressure. Add the furnace pressure to get the correct manifold pressure at maximum firing rate).

These procedures assume that the pre-start-up tasks, check list, electrical interference test, and pilot turn-down tests, have been performed in accordance with the instructions in this manual.

Allow boiler to fully warm up before making adjustments for most efficient combustion. Refer to the boiler instruction manual for the boiler controls settings.

GAS BURNERS

The gas burner adjustments on a Low-High-Off system consist of the gas pressure regulator, butterfly gas valve (Model H30-45), low and high gas pressure switches (Model H30-45), and air damper.

The auxiliary switch inside the M436 Mod motor makes or breaks the high-fire gas. See Fig.10 for switch adjustment. The Low-High-Low boiler control energizes the M436 motor, driving it to high-fire. When the boiler control deenergize the M436, a built in return spring drives it to the low-fire position.

The Size 1, HG-10 to 25, use a Honeywell V4944 two-stage solenoid operated diaphragm valve. No butterfly valve is used. This valve uses two pressure regulators (low-fire and high-fire) and two solenoids to provide two distinct stages of pressure regulation. High-fire is obtained when the 2nd style solenoid is energized by the auxiliary switch in the M346 Mod Motor.

1. Open the manual gas shut-off cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on top and turn the adjustment screw clockwise to increase pressure, or counter-clockwise to decrease pressure.
3. Turn the burner switch to the ON position.
4. Set the thermostat or control to energize the V4944 valve and check final outlet pressure. Allow enough time for the pressure to stabilize (valve outlet pressure measurements are made at a point approximately five pipe diameter downstream from the valve outlet). Low-fire outlet range is 0.85" wc to 2.0" wc for natural gas and high-fire outlet range is 3" wc to 4.5" wc.
5. To adjust the pressure, temporarily remove the slotted aluminum screw cap and gasket from the housing that contains the regulator adjustment setscrew. Turn the adjustment setscrew clockwise to increase the pressure or counterclockwise to decrease the pressure setting. Allow

enough time for the pressure to reach equilibrium between pressure adjustment.

6. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4 to 6 percent at low-fire, with less than 50 ppm CO. To obtain the proper readings, adjust the air shutter and low-fire regulator pressure.

7. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).

8. Bring the burner to the high-fire position and adjust the regulator pressure. Adjust the high-fire gas input to match maximum rating. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record your readings and pressures. High-fire is typically 2 to 4% O₂ with less than 50 ppm CO.

The burner should be adjusted to provide correct fuel flow at a constant rate, at the low fire and high fire position as indicated on the burner data plate. This is achieved by clocking the gas flow at the gas meter. The gas utility or gas meter calibration data, should be consulted to determine the correction factors to be applied to the meter.

Use the following formula to determine actual flow:

$$\text{Gas Input} = \frac{(\text{HHV} \times \text{Patm} + \text{Pgas} \times 520 \times 3600 \times \text{RATE})}{29.92 \times \text{Tgas} + 460} \times \frac{\text{ft}^3}{\text{s}} \times \frac{\text{hr}}{\text{hr}} = \text{Btu}$$

Where:

HHV = The higher heating value of the gas in Btu/ft³ (contact your local gas company for an exact measurement).

Patm = Atmospheric pressure in inches of mercury.

Pgas = Gas pressure ahead of the volumetric flow meter in inches of mercury.

Tgas = Gas temperature at the volumetric flow meter in Deg.F

RATE = Natural gas rate taken with the volumetric flow meter in ft³/second

9. After completing all adjustments, replace the regulators gaskets and slotted aluminum screw caps. Tighten all linkages and marked settings. Complete the Start-Up report at the end of this section.

The size 2, HG-30 to 45, use a butterfly gas valve to control the gas flow to the burner. The M436 Mod motor controls the position of the valve.

1. Open the manual gas shut-off cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on top and turn the adjustment screw clockwise to increase pressure,

or counterclockwise to decrease pressure.

3. Turn the burner switch to the ON position.
4. The burner will start and be in the low-fire position.
5. After a few seconds, the O₂ analyzer should have an accurate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4 to 6 percent at low-fire, with less than 50 ppm CO. To obtain the proper readings, adjust the gas butterfly opening and air shutter. Take note of the readings and pressures at the burner manifold and gas train.
6. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
7. Bring the burner to high-fire position. Adjust the high-fire gas input to match maximum rating. At high-fire, the butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record your readings and pressures. High-fire is typically 2 to 4% O₂ with less than 50 ppm CO.
8. Adjust the low and high gas pressure switches by turning the adjusting screw until indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 20% below and 20% higher than normal pressure).
9. Verify low-fire and high-fire rate by clocking the meter as previously explained.

OIL BURNERS

The Suntec B2TD-8842 oil pump is typically incorporated and is a two-stage, two step oil pump. The low-fire pressure adjustment is 100-200 PSI (solenoid de-energized). High-fire pressure adjustment is 200-300 PSI (solenoid energized).

1. Turn the burner switch to the ON position.
2. Adjust low fire with the oil pressure regulating valve to have approximately 100 to 200 PSI, and adjust the air shutter for a clean fire. Record your combustion reading from the flue gas analyzer, normally 8 to 11 percent O₂ and less than No.2 Smoke (Bacharach). To adjust the oil pressure regulating valve, remove lock screw and adjust pressure by turning the allen screw clockwise to increase pressure, and counterclockwise to reduce pressure.
3. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water).
4. Adjust the high-fire fuel input to match maximum oil pressure. At high-fire, the pressure should be 300 PSI. Verify and record your readings and pressures. High-fire is typically 11 to 13 CO₂ with less than No.2 smoke. The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate.
5. Tighten all linkages and marked settings. Complete the Start-up report at the end of this section.

COMBINATION GAS-OIL BURNERS

In general, the combination fueled system is to be started first using oil, because as a fuel, oil has a greater combustion

air requirement than natural gas. After being completely adjusted for oil combustion, the burner is re-started and adjusted using natural gas as fuel. Combustion adjustment of the combination burner for natural gas involves balancing the input rate only against the existing flow of combustion air, as established initially for oil.

Do not readjust the air shutter when tuning the combination burner for combustion of natural gas.

1. Turn the fuel selector switch to the OIL position.
2. Turn the burner switch to the ON position.
3. Proceed with start-up and adjustments using the same procedures defined in the Oil Burners section.
4. After the system has been completely adjusted for oil firing, place the burner switch OFF, and position the fuel selector switch to GAS.
5. Proceed with start-up and adjustments using the same procedures defined in the Gas Burners section. Do not alter the air settings set for oil. Correct your O₂ levels by adjusting the butterfly valve for Size 2 models, and the regulators low and high pressures for Size 1 models.

I. FULL MODULATION BURNER ADJUSTMENTS

Refer to the burner data plate located inside the control panel door. The nameplate will list the burner information: Burner and control voltage, phase, cycle, motor amperage, maximum and minimum fuel input settings, and manifold pressure (at zero furnace pressure. Add the furnace pressure to get the correct manifold pressure at maximum firing rate.).

These procedures assume that the pre-start-up tasks, check list, electrical interference test, and pilot turn-down tests, have been performed in accordance with the instructions in this manual.

Allow boiler to fully warm up before making adjustments for most efficient combustion. Refer to the boiler instruction manual for the boiler controls settings.

GAS BURNERS

The gas burners adjustments on a full modulation burner consist of the gas pressure regulator, butterfly gas valve, low and high gas pressure switches (Model H30-120), and air dampers.

1. Open the manual gas shut-off cocks.
2. Check the gas pressure at the inlet of the regulator and the pressure downstream of the regulator. Make sure they are in accordance with the regulator specifications. The gas pressure required at the manifold is the pressure that is required to fire the burner at its rated capacity. To adjust the regulator, unscrew the cap located on top and turn the adjustment screw clockwise to increase pressure, or counter-clockwise to decrease pressure.
3. Set the Manual-Auto switch on the "Manual" position.
4. Position the manual flame control potentiometer in the CLOSED (Low-Fire) position.
5. Turn the burner switch to the ON position.
6. The burner will start and be in the low-fire position.
7. After a few seconds, the O₂ analyzer should have an ac-

curate reading of the O₂ present in the flue gas. Normally, O₂ levels are set between 4 and 6 percent at low-fire, with less than 50 ppm CO. To obtain the proper readings, adjust the gas butterfly opening and low-fire air shutter. Take note of the readings and pressures at the burner manifold and gas train.

8. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards OPEN in small increments. This will cause the butterfly valve to open, allowing more gas into the burner.

9. At each point, allow the burner to operate for a few minutes before recording your O₂, CO and pressure readings. Observe that your O₂ and CO levels remain within an acceptable limit. Adjust the pressure regulator, as necessary, to correct this situation. For burners with the cam trim option, adjust the cam screws throughout the range to obtain correct O₂ and CO levels. Continue to do this until the burner reaches high fire (the potentiometer is at the OPEN position).

10. Adjust the high-fire gas input to match maximum rating. At high-fire, the butterfly valve should be near the full open position. Adjust the gas regulator so the manifold pressure matches the rating on the burner data plate. Verify and record your readings and pressures. High-fire is typically 2 to 4% O₂ with less than 50 ppm CO as a target value. Adjust the high-fire excess air rate using the high-fire shutter adjustment.

11. Modulate the burner to low-fire. Verify the readings once again.

The burner should be adjusted to provide correct fuel flow at a constant rate, at the low-fire and high-fire position as indicated on the burner data plate. This is achieved by clocking the gas flow at the gas meter. The gas utility or gas meter calibration data, should be consulted to determine the correction factors to be applied to the meter

Use the following formula to determine actual flow:

$$\text{Gas Input} = \left(\frac{\text{HHV} \times \text{Patm}}{29.92} + \frac{\text{Pgas} \times 520 \times 3600}{\text{Tgas} + 460} \times \frac{\text{s}}{\text{hr}} \times \text{RATE} \right) \frac{\text{ft}^3}{\text{hr}} = \text{Btu}$$

Where:

HHV = The higher heating value of the gas in Btu/ft³ (contact your local gas company for an exact measurement).

Patm = Atmospheric pressure in inches of mercury.

Pgas = Gas pressure ahead of the volumetric flow meter in inches of mercury.

Tgas = Gas temperature at the volumetric flow meter in Deg.F

RATE = Natural gas rate taken with the volumetric flow meter in ft³/second

12. Adjust the low and high gas pressure switches by turning the adjusting screw until indicator moves to a pressure slightly lower than normal operating pressure for the low gas pressure switch, and slightly higher for the high gas pressure switch (usually 20% below and 20% higher than normal pressure).

13. Tighten all linkages and marked settings. Complete the Start-up report at the end of this section.

14. Turn the Manual-Auto switch to AUTO. The burner will now modulate according to the load demand to the boiler.

OIL BURNERS

The oil burner adjustments consist of the oil metering valve and air shutters. The firing rate is regulated by a metering valve in the nozzle return line. At low-fire, the arrow on the valve points to approximately number 7, and at high-fire it is in the closed position (no return flow), approximately at number 2. The oil metering valve position will vary the oil pressure to the nozzle. An oil pressure gauge should be installed in the return line to monitor the oil pressure. Oil pressure at low-fire is approximately 80 to 100 PSI and 300 PSI at high-fire. Size 1 H10 to 25 uses a simplex nozzle; sizes 2, 3, and 4 use a return flow nozzle.

1. Set the Manual-Auto switch on the "Manual" position

2. Position the manual flame control potentiometer in the CLOSED (Low-Fire) position.

3. Turn the burner switch to the ON position.

4. The burner will start and be in the low-fire position.

5. Adjust low-fire with the metering valve position to have approximately 80 to 90 PSI, and adjust the low-fire air shutter for a clean fire. Record your combustion reading from the flue gas analyzer, normally 8 to 11 percent CO₂ and less than No.2 Smoke (Bacharach).

6. Operate the boiler at low-fire until it is up to operating pressure (steam) or temperature (hot water). Then increase the fuel input to the boiler by turning the manual flame control potentiometer towards OPEN in small increments. This will cause the metering valve to close, resulting in an increase in the oil pressure feeding the burner nozzle.

7. At each point, allow the burner to operate for a few minutes before recording your CO₂, CO, Smoke and pressure readings. Observe that your CO₂ and CO levels remain within an acceptable limit. Adjust the oil pressure as necessary, to correct this situation. For burners with the cam trim option, adjust the cam screws throughout the range to obtain correct CO₂ and CO levels. Continue to do this until the burner reaches high-fire (the potentiometer is at the OPEN position).

8. Adjust the high-fire fuel input to match maximum oil pressure. At high-fire, the metering valve should be in the fully closed position and the pressure should be 300 PSI. Verify and record your readings and pressures. High-fire is typically 11 to 13% CO₂ with less than No.2 smoke. Adjust the high-fire excess air rate using the high-fire shutter adjustment.

9. Modulate the burner to low-fire. Verify the readings once again. The burner should be adjusted to provide correct fuel

flow at a constant rate, at the low fire and high fire position as indicated on the burner data plate.

10. Tighten all linkages and marked settings. Complete the Start-up report at the end of this section.

11. Turn the Manual-Auto switch to AUTO. The burner will now modulate according to the load demand to the boiler.

COMBINATION GAS-OIL BURNERS

In general, the combination fueled system is to be started first using oil, because as a fuel, oil has a greater combustion air requirement than natural gas. After being completely adjusted for oil combustion, the burner is re-started and adjusted using natural gas as fuel. Combustion adjustment of the combination burner for natural gas involves balancing the input rate only against the existing flow of combustion air, as established initially for oil.

Do not readjust the air shutters when tuning the combination burner for combustion of natural gas.

1. Set the Manual-Auto switch on the "Manual" position.
2. Position the manual flame control potentiometer in the CLOSED (Low-Fire) position.
3. Turn the fuel selector switch to the OIL position.
4. Turn the burner switch to the ON position.
5. Proceed with start-up and adjustments using the same procedures defined in the Oil Burners section.
6. After the system has been completely adjusted for oil firing, place the burner switch OFF, and position the fuel selector switch to GAS.
7. Proceed with start-up and adjustments using the same procedures defined in the Gas Burners section. Do not alter the air settings set for oil. Correct your O_2 levels by adjusting the butterfly valve.

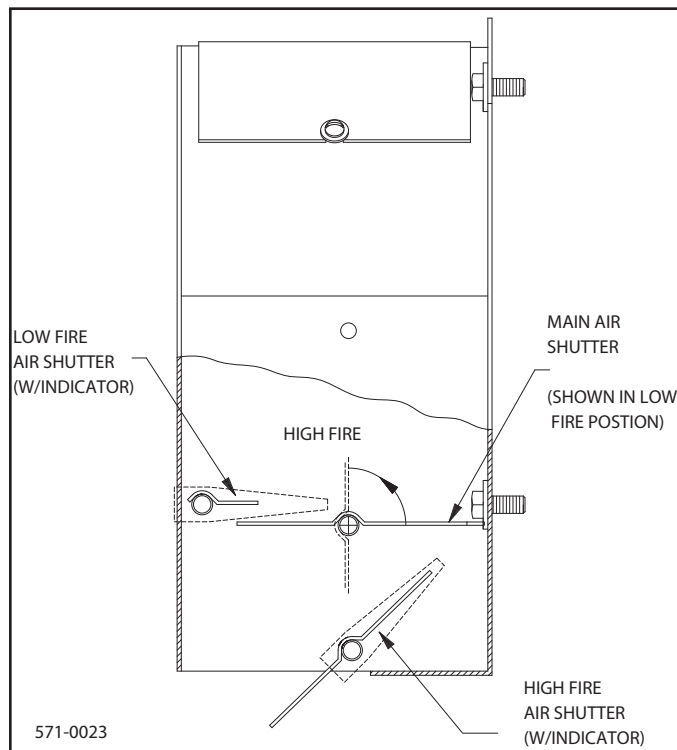


FIGURE 4-7

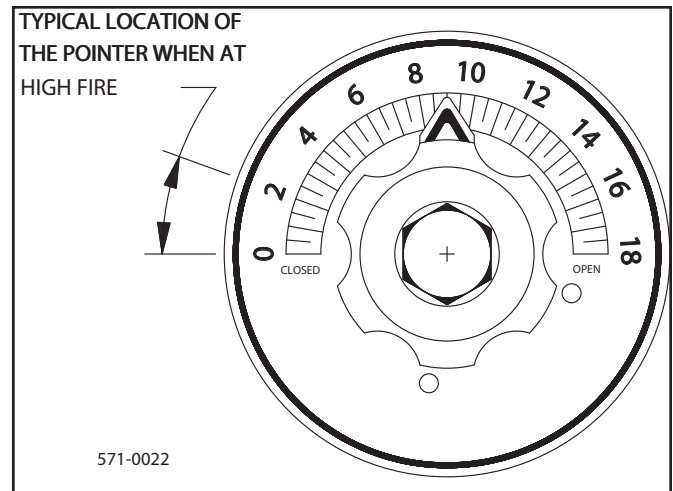


FIGURE 4-8

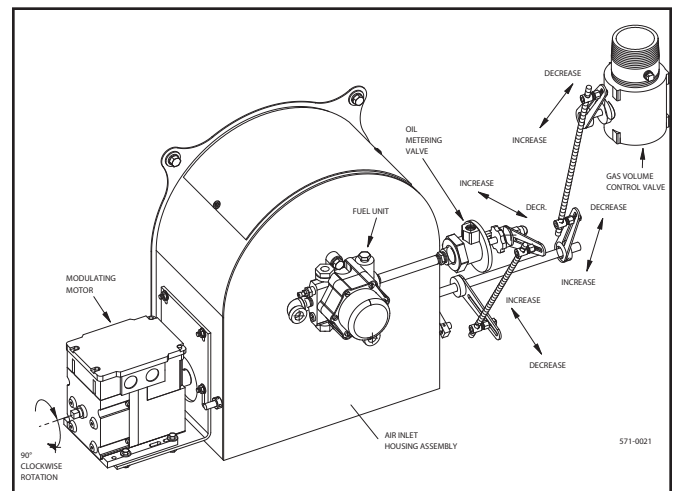


FIGURE 4-9

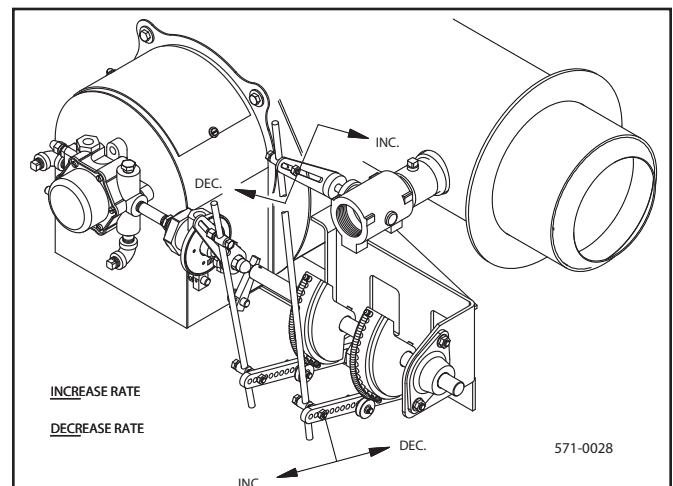


FIGURE 4-10

SECTION 5 MAINTENANCE

A. GENERAL

A maintenance program avoids unnecessary down time, costly repairs, and promotes safety. It is recommended that a record be maintained of daily, weekly, monthly, and yearly maintenance activities. See letter H.

Electrical and mechanical devices require systematic and periodic inspection and maintenance. Any "automatic" features do not relieve the operator from responsibility, but rather free him from certain repetitive chores, providing time for upkeep and maintenance.

Unusual noise, improper gauge reading, leak, sign of overheating, etc., can indicate a developing malfunction, requiring corrective action.



WARNING

ONLY FACTORY AUTHORIZED BURNER SERVICE PERSONNEL SHOULD START-UP, ADJUST, OR SERVICE THIS EQUIPMENT

CAUTION

Any cover plates, enclosures, or guards anchored to the burner, or any burner related equipment, must remain in position at all times. Only during maintenance and service shutdown can these cover plates, enclosures, or guards be allowed to be removed. They must be replaced, and securely anchored before testing, adjusting, or running the burner or burner related equipment.

B. CONTROL SYSTEM

Most operating controls require very little maintenance beyond regular inspection. Examine electrical connections. Keep the controls clean. Remove any dust from the interior of the control. Covers should be left on controls at all times. Keep the control cabinet doors closed. Dust and dirt can damage motor starters and relay contacts. Starter contacts are plated with silver and are not harmed by discoloration. Never use files or abrasive materials such as sandpaper on contact points.



WARNING

WHEN REPLACING A CONTROL OR CLEANING CONTACTS, BE SURE TO DISCONNECT THE MAIN POWER SUPPLY SINCE THE CONTROL IS ENERGIZED EVEN THOUGH THE BURNER SWITCH IS OFF. MORE THAN ONE DISCONNECT SWITCH MAY BE REQUIRED TO DISCONNECT ALL POWER.

PROGRAMMING CONTROL

This control requires no adjustment, nor should any attempt be made to alter contact settings or timing logic. Those programmers with contacts may require occasional cleaning. If so, follow instructions given in the manufacturer's bulletin. Never use abrasive materials. The manufacturer's bulletin also contains troubleshooting information. The flame detector lens should be cleaned as often as conditions demand.

A periodic safety check procedure should be established to test the complete safeguard system. Tests should verify safety shutdown with a safety lock out upon failure to ignite the pilot or the main flame, and upon loss of flame. Each of these conditions should be checked on a scheduled basis. The safety check procedures are contained in the manufacturer's bulletin.

MOTORS

Supply voltage to the motor must not vary more than 10 percent from nameplate ratings. At initial start-up and regularly thereafter, check the motor current with an ammeter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service factor, determine the cause and correct it. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

C. GAS SYSTEM

Check the gas train for leaks. Check the gas valves and verify the low and high gas pressure settings.

SOLENOID VALVES

A faint hum from the solenoid is normal when the coil is energized. Should the valve fail to operate, check that there is voltage at the valve coil. If there is no voltage at coil, check for loose wiring connections. If there is proper voltage at the valve coil and the valve still fails to open, replace the coil. Refer to manufacturer's bulletin for correct procedure in coil replacement.

Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the valve body.

Test for gas leaks and check valve action several times to ensure proper operation before attempting to relight burner.

CAUTION

All power must be disconnected before servicing valves.

MOTORIZED MAIN GAS VALVES

Should the valve fail to operate, check for voltage at valve. Make certain that the main shut-off cock is closed prior to

testing. The actuator is not field repairable nor should it be disassembled. Replace the actuator if valve fails to operate.

After replacement, cycle the valve with the fuel shut off to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

D. OIL SYSTEM

Little maintenance is required on the oil systems other than cleaning the oil filter. This procedure should be done at regular intervals. Increased inlet vacuum reading may indicate a clogged filter. Follow the strainer manufacturer's maintenance schedule.

Maintenance checks on the flexible coupling between the fuel unit and motor for alignment, tightness and wear and oil piping connection tightness should also be made at regular intervals. You access the coupling by removing the airbox cover and loosening the two setscrews on the flex coupling.

The oil nozzle should be checked. Inside the nozzle lies a small screen that keeps out any particle not caught by the strainer. These particles will interfere with the normal oil flow pattern exiting the nozzle. A distorted flame can indicate a clogged nozzle. Inspect and clean the nozzle and screen. To clean the screen, swirler, and tip, unscrew the tip from the nozzle body. Clean nozzle parts in solvent. Never use wire or sharp metal tools to clean the nozzle orifice. A metal tool will distort the orifice and ruin the nozzle. Reassemble the nozzle. The tailpiece must be screwed in with the swirler seating tight against the tip to ensure proper atomization. Reassemble the nozzle into the nozzle body. If a nozzle is replaced, it must be an identical nozzle (make, size and spray angle).

E. DRAWER ASSEMBLY

The drawer assembly may be removed for inspection and service.

1. Shut off burner, position switch in "OFF" position.
2. Shut off all electric power to the burner.
3. Disconnect the fuel lines from the drawer assembly access cover.
4. After making note of where the bolts are located in relationship to the access cover slots, remove the drawer assembly access cover bolts. Pull the drawer partially out of the housing. Reach inside to disconnect the ignition cables from the electrodes for direct spark applications. Pull the drawer assembly completely out of the housing.
5. To reinstall the drawer assembly, insert it part way into the housing, connect the ignition cables if applicable, and seat the assembly fully. Install the access cover bolts loosely. Slide the cover the original location, and tighten the bolts. Reconnect the fuel lines.

F. IGNITION ELECTRODE, CABLE AND PILOT

Failure to keep electrodes clean and set in the proper position accounts for much faulty burner operation. Not only must the gap be correct, but the electrode points must be carefully located with respect to the nozzle. Sometimes

difficulty in securing the electrodes in their clamps can be corrected by using light metal shims around the porcelain. Defective or cracked porcelains require replacement to prevent short circuiting of the spark. A gradual wearing away of the electrode tips may require respacing of the points or replacement of the electrode.

The pilot should be checked monthly for loosening of components and carbon buildup. Before removing the pilot, ensure that the fuel supply is shut off.

On direct spark oil units, once you have removed the drawer assembly, check the electrode to nozzle gap and adjust if necessary. Refer to the drawer assembly drawings in the ADJUSTMENT section.

For burners equipped with a gas pilot, the pilot is located on the side opposite to the main gas entrance. Close the gas pilot cock. Disconnect the pilot gas supply line. Remove the screws on the pilot access plate. Disconnect the high voltage ignition cable by pulling it straight back, away from the pilot assembly. The pilot gun assembly will slide back away from the flame side of the burner. Once the pilot assembly is clear of the burner head bracket, turn the pilot assembly and retract it through the access hole. Inspect the electrode and adjust the gap if necessary. Thoroughly clean and adjust the porcelain insulated electrodes. Correct all variations from the clearance dimensions. If the insulation on the high-voltage cables becomes cracked or charred, install new cables. Ignition cable should not be exposed to moisture, abrasion or rough handling. See that the connectors are in perfect contact with the cable ends. Unscrewing the snap portion of the connector will show whether this is true.

G. FLAME SCANNER

The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth. Check pilot and flame signal strength.

H. BURNER MOUNTING INSPECTION

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leaking occurs, refer to Section INSTALLATION for proper sealing procedure.

I. EXTENDED SHUTDOWN

When shutting down the burner for an extended period of time, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the operating life of the burner:

1. Turn the main electrical disconnect switch to the burner to OFF.
2. Close all main fuel valves.
3. If the burner operates in a damp environment, cover it with plastic to protect all electrical components from moisture.
4. Remove the flame safeguard and store in a dry atmosphere.

J. MAINTENANCE FLOW CHART RECOMMENDED TEST SCHEDULE

ITEM	SERVICE BY	REMARKS
DAILY		
Gauges, Monitors, and Indicators	Operator	Make visual inspection and record readings in log.
Instrument and Equipment Settings	Operator	Make visual check against recommended specifications.
Low water, Fuel cut-off and Alarms	Operator	Refer to instructions.
WEEKLY		
Firing rate control	Operator	Verify factory settings
Igniter	Operator	Make visual inspection. Check flame signal strength.
Pilot and Main Fuel Valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators, and check fuel meters.
Flame Failure Controls	Operator	Close manual fuel supply for (1) pilot and (2) main fuel cock and/or valve(s). Check safety shutdown timing. Record in log.
Flame Signal Strength Controls	Operator	Read and log the flame signal for both pilot and main flame. Notify Service if readings are very high, very low, or fluctuating.
Linkages	Operator	Check all burner linkages for tightness. Tighten if required.
MONTHLY		
Low Fan Pressure Interlock	Operator	Manually adjust until switch opens.
High and Low Gas Pressure Interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner and Diffuser	Operator	Check, inspect and clean for soot buildup.
Pilot Assembly	Operator	Check for loosening of components, erosion or carbon buildup.
ANNUALLY		
Strainer (Oil units)	Operator	Replace or clean the oil strainer element.
Impeller	Operator	Inspect and clean the combustion impeller.
Combustion Test	Service Technician	Perform a complete combustion test. Adjust burner if necessary. Read and Log data.
Pilot turndown Test	Service Technician	Required after any adjustment to flame, scanner, or pilot adjustment
Operating Controls	Service Technician	Refer to instructions.

SECTION 6 TROUBLE SHOOTING

PROBLEM	SOLUTION
BURNER DOES NOT START	1. No voltage at program relay power input terminals. <ul style="list-style-type: none"> a. Main disconnect switch open. b. Blown control circuit fuse. c. Loose or broken electrical connection.
	2. Program relay safety switch requires resetting.
	3. Limit circuit not completed - no voltage at end of limit circuit program relay terminal. <ul style="list-style-type: none"> a. Pressure or temperature is above setting of operation control. b. Water below required level. <ul style="list-style-type: none"> Low-water light (and alarm horn) should indicate this condition. Check manual reset button, if provided, on low -water control. c. Fuel pressure must be within settings of low pressure and high pressure switches. d. Check burner air proving switch and high fire limit switch.
	4. High or Low gas pressure - investigate and repair.
NO IGNITION	1. Lack of spark. <ul style="list-style-type: none"> a. Electrode grounded or porcelain cracked. b. Improper electrode setting. c. Loose terminal on ignition cable; cable shorted. d. Inoperative ignition transformer. e. Insufficient or no voltage at pilot ignition circuit terminal.
	2. Spark but no flame. <ul style="list-style-type: none"> a. Lack of fuel - no gas pressure, closed fuel valve, empty tank, broken line b. Too much air flow. c. No voltage to pilot solenoid. d. Defective pilot solenoid. e. Improperly positioned electrode (Direct spark models).
	3. Low fire switch open in low fire proving circuit. <ul style="list-style-type: none"> a. Damper motor not closed, slipped cam, defective switch. b. Damper jammed or linkage binding.
	4. Running interlock circuit not completed. <ul style="list-style-type: none"> a. Combustion proving switches defective or not properly set. b. Motor starter interlock contact not closed.
	5. Flame detector defective, sight tube obstructed, or lens dirty.

TROUBLE SHOOTING

PROBLEM	SOLUTION
PILOT FLAME, BUT NO MAIN FLAME	1. Insufficient pilot flame.
	2. Gas fired unit. <ul style="list-style-type: none"> a. Manual gas cock closed. b. Main gas valve inoperative. c. Gas pressure regulator inoperative.
	3. Oil fired unit. <ul style="list-style-type: none"> a. Oil supply cut off by obstruction, closed valve, or loss of suction. b. Supply pump inoperative. c. No fuel. Broken, loose or missing oil pump coupling. d. Main oil valve inoperative. e. Check oil nozzle, gun and lines.
	4. Flame detector defective, sight tube obstructed or lens dirty.
	5. Insufficient or no voltage at main fuel valve circuit terminal.

BURNER STAYS IN LOW FIRE	1. Pressure or temperature above modulating control setting.
	2. Manual-automatic switch in wrong position.
	3. Inoperative modulating motor.
	4. Defective modulating control.
	5. Binding or loose linkages, cams, setscrews etc.

SHUTDOWN OCCURS DURING FIRING	1. Loss or stoppage of fuel supply.
	2. Defective fuel valve; loose electrical connection.
	3. Flame detector weak or defective.
	4. Scanner lens dirty or sight tube obstructed.
	5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.

TROUBLE SHOOTING

PROBLEM	SOLUTION
SHUTDOWN OCCURS DURING FIRING (cont).	6. If the programmer lockout switch has tripped. <ul style="list-style-type: none"> a. Check fuel lines and valves. b. Check flame detector. c. Check for open circuit in running interlock circuit. d. The flame failure light is energized by ignition failure, main flame failure, inadequate flame signal, or open control in the running interlock circuit.
	7. Improper air/fuel ratio. <ul style="list-style-type: none"> a. Slipping linkage. b. Damper stuck open. c. Fluctuating fuel supply. <ul style="list-style-type: none"> Temporary obstruction in the fuel line. Temporary drop in gas pressure.
	8. Interlock device inoperative or defective.
	9. Air in the oil lines. Bleed lines.

MODULATING MOTOR DOES NOT OPERATE	1. Manual-automatic switch in wrong position.
	2. Linkage loose or jammed.
	3. Motor does not drive to open or close during pre-purge or close on burner shutdown. <ul style="list-style-type: none"> a. Motor defective. b. Loose electrical connection. c. Damper motor transformer defective.
	4. Motor does not operate on demand. <ul style="list-style-type: none"> a. Manual/automatic switch in wrong position. b. Modulating control improperly set or inoperative. c. Motor defective. d. Loose electrical connection. e. Damper motor transformer defective.

NOTES:



warranty policy

A. LIMITED WARRANTY

The Company warrants that at the time of shipment, the equipment manufactured by it shall be merchantable, free from defects in material and workmanship and shall possess the characteristics represented in writing by the Company. The Company's warranty is conditioned upon the equipment being properly installed and maintained and operated within the equipment's capacity under normal load conditions with competent supervised operators. Equipment, accessories and other parts and components not manufactured by the Company are warranted only to the extent of and by the original manufacturer's warranty to the Company; In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer than the Company's warranty covering equipment manufactured by the Company.

B. EXCLUSIONS FROM WARRANTY

(I) THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, ORAL OR EXPRESS OR IMPLIED, INCLUDING ANY WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION OF THE EQUIPMENT. THERE ARE NO EXPRESS WARRANTIES OTHER THAN THOSE CONTAINED HEREIN TO THE EXTENT PERMITTED BY THE LAW. THERE ARE NO IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. THE PROVISIONS AS TO DURATION, WARRANTY ADJUSTMENT AND LIMITATION OF LIABILITY SHALL BE THE SAME FOR BOTH IMPLIED WARRANTIES (IF ANY) AND EXPRESSED WARRANTIES.

(II) The Company's warranty is solely as stated in (a) above and does not apply or extend, for example, to: expendable item; ordinary wear and tear; altered units; units repaired by persons not expressly approved by the Company; materials not of the Company's manufacture; or damage caused by accident, the elements, abuse, misuse, temporary heat, overloading, or by erosive or corrosive substances or by the alien presence of oil, grease, scale, deposits or other contaminants in the equipment.

C. WARRANTY ADJUSTMENT

Buyer must make claim of any breach of any warranty by written notice to the Company's home office within thirty (30) days of the discovery of any defect. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts of the equipment which within twelve (12) months from the date of initial operation but no more than eighteen (18) months from date of shipment shall prove the Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within the above warranty. Any warranty adjustments made by the Company shall not extend the initial warranty period set forth above. Expenses incurred by Buyer in replacing or repairing or returning the equipment or any part or parts will not be reimbursed by the Company.

D. SPARE AND REPLACEMENT PARTS WARRANTY ADJUSTMENT

The Company sells spare and replacement parts. This subparagraph (d) is the warranty adjustment for such parts. Buyer must make claim of any breach of any spare or replacement parts by written notice to the Company's home office within thirty (30) days of the discovery of any alleged defect for all such parts manufactured by the company. The Company agrees at its option to repair or replace, BUT NOT INSTALL, F.O.B. Company's plant, any part or parts or material it manufacture which, within one (1) year from the date of shipment shall prove to Company's satisfaction (including return to the Company's plant, transportation prepaid, for inspection, if required by the Company) to be defective within this part warranty. The warranty and warranty period for spare and replacement parts not manufactured by the company (purchased by the Company, from third party suppliers) shall be limited to the warranty and warranty adjustment extended to the Company by the original manufacturer of such parts; In no event shall such other manufacturer's warranty create any more extensive warranty obligations of the Company to the Buyer for such parts than the Company's warranty adjustment covering part manufactured by the Company as set forth in this subparagraph (d). Expenses incurred by Buyer in replacing or repairing or returning the spare or replacement parts will not be reimbursed by the Company.

E. LIMITATION OF LIABILITY

The above warranty adjustment set forth Buyer's exclusive remedy and the extent of the Company's liability for breach of implied (if any) and express warranties, representations, instructions or defects from any cause in connection with the sale or use of the equipment. THE COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES OR FOR LOSS, DAMAGE OR EXPENSE, DIRECTLY OR INDIRECTLY ARISING FROM THE USE OF THE EQUIPMENT OR FROM ANY OTHER CAUSE WHETHER BASED ON WARRANTY (EXPRESS OR IMPLIED) OR TORT OR CONTRACT, and regardless of any advices or recommendations that may have been rendered concerning the purchase, installation, or use of the equipment.



START-UP / SERVICE REPORT

The following information should be filled in by the service technician at start-up or after any adjustment to the burner.

A copy of the start-up report MUST be returned to IC in order to validate the warranty of the burner.

Burner Model _____ Serial Number _____ Start-up Date _____

Test Conducted	GAS			OIL			Control Checks	Test	Set Point
	Low	50%	High	Low	50%	High			
Firing Rate MMBtu / gph							Low Water Cut Off		
Stack Temp (Gross) °F							Aux. LWCO		
Room Temp °F							High Water Cut Off		
O2%							Operating Limit		
CO2%							High Limit		
CO (PPM)							Operating Control		
NOx (PPM)							Stack Temp Interlock		
Smoke (Bacharach)							Flame Failure		
Combustion Eff. %							Combustion Air Switch		
Stack Draft "W.C.							High Purge Switch		
Furnace Pressure "W.C.							Low Fire Interlock		
Blast tube Pressure "W.C.							Oil Pressure Switch		
Steam Pressure PSIG							Oil Valve with P.O.C. Interlock		
Water Temperature °F							High Gas Pressure Switch		
Supply oil pressure PSIG							Low Gas Pressure Switch		
Return oil pressure PSIG							Gas Valve P.O.C. Interlock		
Vacuum oil pump "HG							Pilot Turndown Test		
Oil Temperature							Flame Signal Pilot		
Atom. air pressure									
Gas Pressure @ Burner	Inner Manifold								
Manifold "W.C.	Outer Manifold								
Center Gas pressure "W.C.									
Gas Pressure @ Regulator Inlet PSIG									
Gas Pressure @ Regulator Outlet PSIG									
Pilot Gas Pressure @ Regulator Outlet "W.C.									
Flame Signal Main	Low	50%	High						

(For Low NOx Burners)

Blast Tube Temp. Interlock		
FGR Line Purge Switch		
FGR Valve P.O.C. Switch		

Electric Motors	Voltage			Amperage		
	L1	L2	L3	L1	L2	L3
Control Voltage						
Blower Motor						
Air Compressor						
Air-Oil or Metering						

Adjusted by:

Date:

Accepted by:

(Signature Required)



Serial Number

Poor Good Excellent

Comments:[illegible]

By: _____