



# *Profire NTH*

## **Low Emission Burner**

*Operation, Installation, and Maintenance*



750-247  
11/07



**⚠ WARNING**

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

— Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

— WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier call the fire department.

— Installation and service must be performed by a qualified Cleaver-Brooks, service agency or the gas supplier.

**⚠ WARNING**

To minimize the possibility of serious personal injury, fire or damage to the equipment, never violate the following safety rules.

— Always keep the area around the boiler free of combustible materials, gasoline, and other flammable liquids and vapors

— Never cover the boiler, lean anything against it, stand on it or in any way block the flow of fresh air to the boiler.

**Notice**

Where required by the authority having jurisdiction, the installation must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1.

**⚠ WARNING**

Improper installation, adjustment, service, or maintenance can cause equipment damage, personal injury, or death. Refer to the Operation and Maintenance manual provided with the boiler. Installation and service must be performed by a qualified Cleaver-Brooks service provid-

**⚠ WARNING**

Be sure the fuel supply which the boiler was designed to operate on is the same type as specified on the boiler name plate.

**⚠ WARNING**

Should overheating occur or the gas supply valve fail to shut off, **do not** turn off or disconnect the electrical supply to the boiler. Instead turn off the gas supply at a location external to the boiler.

**⚠ WARNING**

Do not use this boiler if any part has been under water. Immediately call your Cleaver-Brooks service representative to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

**Notice**

This manual must be maintained in legible condition and kept adjacent to the boiler or in a safe place for future reference. Contact your local Cleaver-Brooks representative if additional manuals are required.

 **WARNING**

The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psi (3.5 kPa).

 **WARNING**

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to UL 795 Commercial-Industrial Gas Heating Equipment and/or the National Fuel Gas Code, ANSI Z223.1

## Notes

# SAFETY PRECAUTIONS AND ABBREVIATIONS

## Safety Precautions

It is essential to read and understand the following safety precautions before attempting to operate the equipment. Failure to follow these precautions may result in damage to equipment, serious personal injury, or death. A complete understanding of this manual is required before attempting to start-up, operate or maintain the equipment. The equipment should be operated only by personnel who have a working knowledge and understanding of the equipment.

The following symbols are used throughout this manual:



**WARNING**  
This symbol indicates a potentially hazardous situation which, if not avoided, could result in serious personal injury or death.



**CAUTION**  
*This symbol indicates a potentially hazardous situation which, if not avoided, could result in damage to the equipment.*

### Notice

**Notice**  
This symbol indicates information that is vital to the operation of this equipment.

## Abbreviations

Following is an explanation of the abbreviations, acronyms, and symbols used in this manual.

AC	Alternating Current
AR	Automatic Reset
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
BHP	Boiler Horsepower
BTU	British Thermal Unit
°C	Degrees Celsius
CFH	Cubic Feet per Hour
Cu Ft	Cubic Feet
DC	Direct Current
°F	Degrees Fahrenheit
FM	Factory Mutual
FS	Flame Safeguard
ft	Feet
GPM	Gallons per Minute
Hd	Head
HT	Height
HTB H	High Turndown Burner
HZ	Hertz
In H <sub>2</sub> O	Inches of Water
IRI	Industrial Risk Insurance
Lb	Pound
LWCO	Low-Water Cut-Off
M	Million
MFD	Micro-Farad
MR	Manual Reset
NEC	National Electric Code
No. Numbe	r
pH	Measure of the degree of acidity or alkalinity of a solution
P/N	Part Number
PPM	Parts Per Million
PR	Program Relay
psi	Pounds Per Square Inch
SAE	Society of Automotive Engineers
scfh	Standard Cubic Feet per Hour
T	Temperature
TC	Temperature Control
TI	Temperature Gauge
UL U	Underwriter's Laboratories
V	Volt
WC	Water Column
WSI	Watts Per Square Inch

# ***CLEAVER-BROOKS***

## ***Profire NTH***

### ***Low Emission Burner***

## **Operation, Service, and Parts Manual**



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Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative

** WARNING**

**DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.**

**DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.**

**FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.**

**TO: Owners, Operators and/or Maintenance Personnel**

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. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation. Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

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# Section 1

## Introduction

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## A. General



Figure 1-1 ProFire NTH

ProFire burners are assembled, wired and tested at the factory. They are constructed according to the Underwriters Laboratory code.

All burners in the ProFire series comply, when equipped with optional equipment, to CSD-1, Industrial Risk Insurers (IRI), Factory Mutual (FM), NFPA-85, including the National Electrical Code (NEC), or other insuring underwriters requirements. Where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail. Other regulatory agency control options are available. Installation should also conform to state and local codes governing such equipment. Prior to installation, the proper authorities having jurisdiction are to be consulted, permits obtained, etc.

The operator must be familiar with the individual functioning of all controls to understand the operations and procedures described in the manual. Identify and locate each item in the illustrations as they are described in the following sections.

## B. NT Firing Head Design

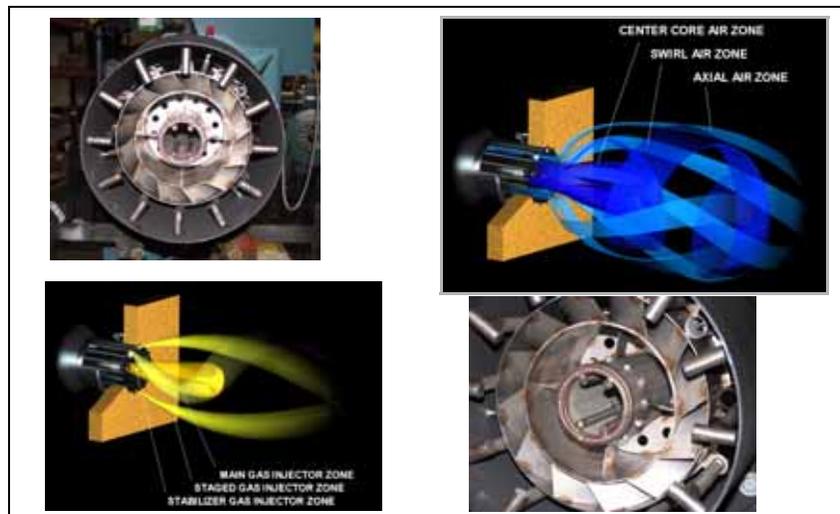


Figure 1-2 NT Firing Head Fuel and Air Flows

The H Series burners are available as standard gas or oil fired burners. The NT burner head's unique core and radially variable pitch swirl blades provide absolute flame stability at all loads for excess air from -20% to +400%.

The NT burner head is mounted inside the blast tube. Gas is directed to the various gas paths via connecting piping.

The high fuel-to-air mixing efficiency is obtained from the axial, radial and tangential turbulent air flow field generated at the burner outlet (see **Figure 1-2** & **Figure 1-3**). This is combined with high velocity fuel jets, resulting in an optimized and well defined mixing pattern for maximum local mixture uniformity.

Low NOx burners (<9 ppm) are more sensitive to atmospheric influences than standard burners, and have a tighter operating range. The HAWK ICS parallel positioning system gives the repeatability required for low NOx applications.

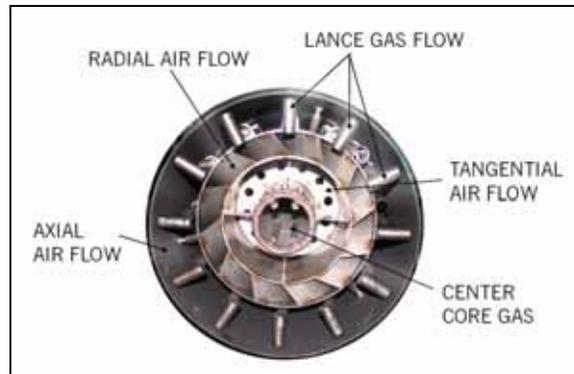


Figure 1-3 NT Fuel and Air Flows

ProFire gas burners are of the peripheral mix type. Oil burners are of the low pressure, air atomizing (nozzle) type. All burners feature ignition by spark-ignited gas pilot flame. The burner operates with full modulation whether burning gas or oil.

The HAWK ICS control system permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards assure that the burner always returns to minimum firing position for ignition.

The burners are designed for automatic, unattended operation except for periodic inspection and maintenance. After selecting the proper overload settings for the starter, the rest of the control panel components require little attention except for occasional cleaning.

Setting up a burner with an NT firing head is similar to standard burner setup procedures: precise adjustments and accurate monitoring equipment are essential to achieving operational efficiency potential and low emission level requirements.

Safety is paramount; be sure all boiler room personnel are aware of scheduled maintenance. Have the required maintenance tools, gaskets, and replacement items on hand. All service parts and expertise are available around the clock from your local Cleaver-Brooks representative. For the location of your closest Cleaver-Brooks representative log on to [www.cbboilers.com](http://www.cbboilers.com) and click <Find a Rep>.

Cleaver-Brooks highly recommends that the customer attain the services of a qualified technician. The cost of a qualified CB Service Technician will be more than offset by the savings in fuel costs resulting from a properly serviced boiler.

**Warning**

Before starting service on the boiler, be sure all fuel and power have been turned off and locked out for the duration of the service procedure.

## C. Operating Controls

The NTH burner is available for boilers using the Cleaver-Brooks HAWK ICS control system (Advanced package) with parallel positioning combustion control. Main control system features are described below; for additional information, see the HAWK ICS Intermediate/Advanced manual (CB Part Number 750-229) and the HAWK ICS Parallel Positioning manual (P/N 750-217).

The control panel (**Figure 1-4, Figure 1-5**) houses the HMI screen and other components of the HAWK ICS control system. Components include:

- Programmable Controller (PLC)
- Input and Output modules
- Power supplies for controller and I/O
- Flame Safety Control
- Panel circuit breaker

The Fuel Selector Switch (combination burners only) is normally located just below the Flame Safety unit (see **Figure 1-6**) and is used to select the type of fuel:

Gas position- Selects gas as the firing fuel.

Off position- Burner off.

Oil position- Selects oil as the firing fuel.



Figure 1-4 CB HAWK ICS Control Panel



Figure 1-5 Control Panel Interior



Figure 1-6 Fuel Selector Switch

Other controls included are motor starters to energize the motors and an ignition transformer to provide a high voltage spark for pilot ignition.

## D. Flame Safety Control

Automatically programs each starting, operating and shutdown cycle in conjunction with operating, limit, and interlock devices. Executes timed sequencing of the blower motor, ignition system, and fuel valves. The sequence includes air purge prior to ignition and after burner shutdown. The flame scanner monitors the pilot, both oil and gas flames, and instantly responds to loss of flame.

Status information and diagnostics for the Flame Safeguard are accessible through the HAWK ICS controls by pressing <Burner Control> from the HAWK ICS Screen Select Menu.

The control recycles automatically during normal operation, or following a power interruption. It must be manually reset following a safety shutdown. This can be done using the <Clear FSG Fault> button on the HAWK ICS Burner Control screen, or by using the RESET button on the CB780 unit. An internal checking circuit, effective on every start, will prevent burner operation in the event the flame relay is held in.

The CB780 LED display (duplicated graphically on the HAWK ICS Burner Control screen) shows the current burner sequence status:

### Burner Sequence Status

- **POWER** illuminates when the control circuit is energized (powered).
- **PILOT** illuminates when the ignition transformer is powered, and gas pilot valve is energized (opened).
- **FLAME** illuminates when flame is detected
- **MAIN** illuminates when the main fuel valve or valves (gas or oil) are energized (open).
- **ALARM** illuminates when the flame safeguard system fails to detect pilot or main flame.

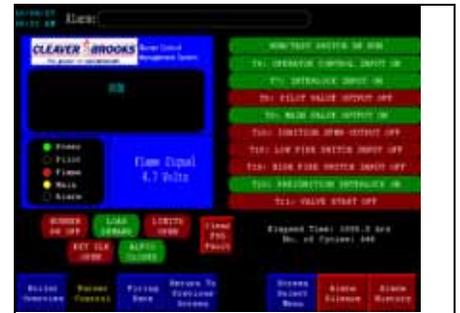


Figure 1-7 Top: HAWK ICS Burner Control/Diagnostic Screen  
Bottom: CB780 Flame Safety Unit

## E. Combustion Air Handling System

The combustion air handling system consists of several major components:

### 1. Rotary Air Damper (Figure 1-8, Figure 1-9).

A rotary air damper regulates the combustion air volume and is positioned by actuator. The damper blade is normally almost closed in the low fire position and opens as the burner drives toward a high fire position.

### 2. Motor Driven Impeller (Figure 1-10).

The heart of the burner is a backward curved aluminum impeller. The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Backward curve of the impeller prevents buildup on the blades, maintaining impeller balance.

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 to provide efficient combustion at all firing rates.

Alternate motor-impeller combinations are available for 50 cycle or 60 cycle power and for firing against either moderate or high furnace pressure. For higher altitudes and higher furnace pressures, motor and impeller combinations are determined at the factory. The impeller is directly driven by a 3450 rpm motor.

### 3. Combustion Air Proving Switch (Figure 1-11)

Combustion air is detected by a pressure sensitive switch actuated by air pressure created by the impeller. Contacts close to prove combustion air flow.

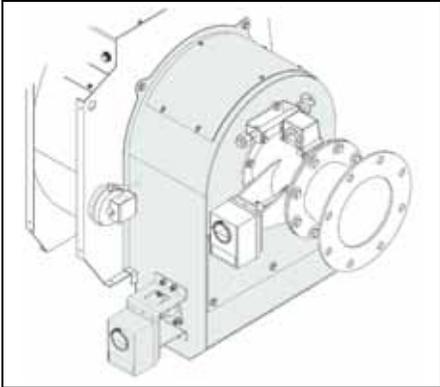


Figure 1-8 Rotary Damper Box

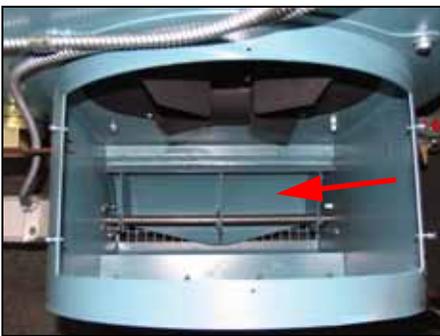


Figure 1-9 Rotary Damper Blade

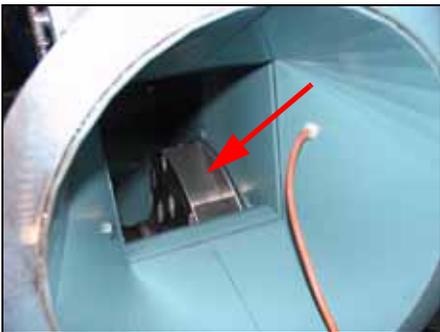


Figure 1-10 Impeller

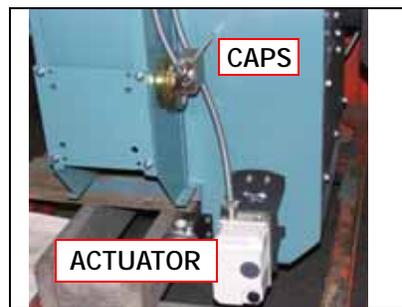


Figure 1-11 Combustion Air Proving Switch and Air Damper Actuator

## F. Firing Rate Controls

Regardless of the fuel used, burner input is fully modulated between low fire and high fire on boiler demand. Complete firing rate control is allowed through the HAWK ICS system. The Firing Rate screen (Figure 1-12) monitors critical values and allows access to major control functions.

Flow rate through each component is adjusted during commissioning of the HAWK ICS combustion controls. During this time the actuator type is selected and the stroke set for each actuator (fuel, air, and FGR). For additional information see the HAWK ICS Parallel Positioning manual (CB P/N 750-217).

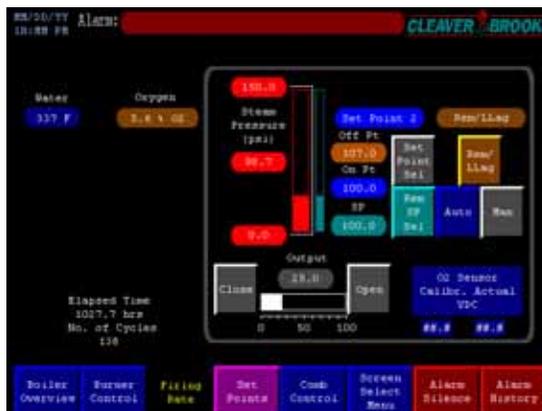


Figure 1-12 HAWK ICS Firing Rate Screen

## G. Firing Head

The burner head is straight and cylindrical with no divergent. Access to the firing head is provided by swinging open the impeller housing. First, disconnect any wiring that might interfere with opening the housing and release the housing latch. Swing the housing to open position. An internal gas pilot is standard on all burners. Pilot gas pressure is adjusted at the pilot pressure regulator. The internal components are removable for cleaning and adjustments.

The head MUST extend past the refractory wall a minimum of 6" to ensure proper flame recirculation.



Figure 1-13 Burner Door open for service

## H. Gas System

Gas is introduced into the combustion zone from a manifold through a center core zone and multiple lances in the blast tube. Firing rate is determined by the size and number of lances, by manifold pressure and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly type throttling valve at the manifold inlet. The valve actuator is positioned by signal from the PLC. Depending upon specific requirements, one or two safety shutoff, motorized main gas valves are provided for installation in the gas train upstream of the butterfly valves. Safety shutoff gas valves are wired into the control system to automatically open and close at the proper time in the operating sequence.

### Main Gas Components

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. A typical gas train is shown schematically in **Figure 1-14**.

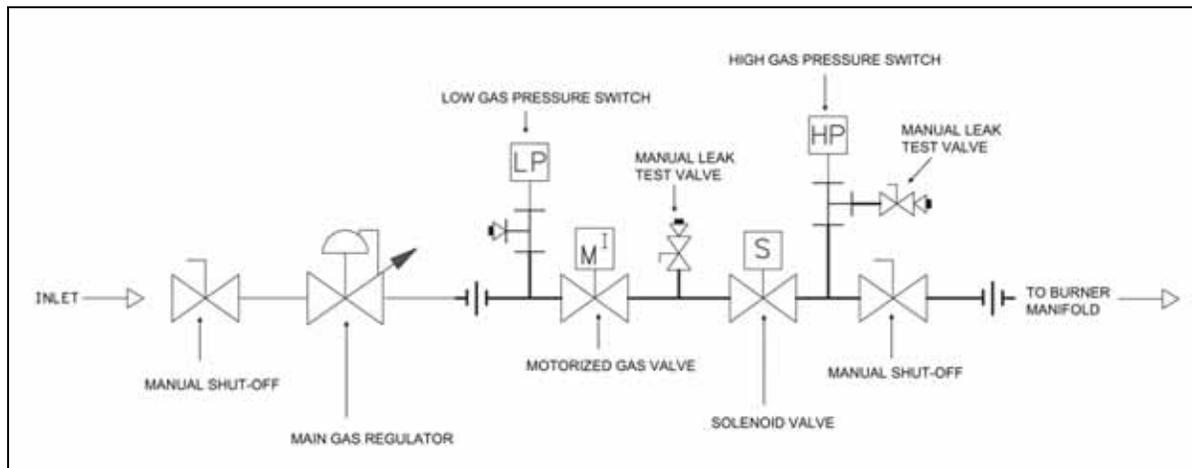


Figure 1-14 Main Gas Train

### Gas Control Valves

Two butterfly type valves are positioned by signal from the PLC and control the rate of flow of gas.

### Main Gas Valves

Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard U.L. burners include:

One motorized gas valve w/closure interlock and one standard motorized valve.

### Main Gas Regulator

Regulates gas train pressure to specified pressure required at inlet to gas train. Input is set by main gas pressure regulator adjustment.

### Main Gas Cocks

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).

### High Gas Pressure Switch

A pressure actuated switch that remains closed when gas pressure is below a preselected 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.

### Low Gas Pressure Switch

A pressure actuated switch that remains closed when gas pressure is above a preselected 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.

## PILOT GAS TRAIN

### Gas Pilot Valve

A solenoid valve that opens during the ignition period to admit fuel to the pilot. It closes after main flame is established.

### Gas Pressure Regulator

Reduces gas pressure to that required by the pilot.

### Gas Pilot Shut-off Cock

For manually closing the pilot gas supply.

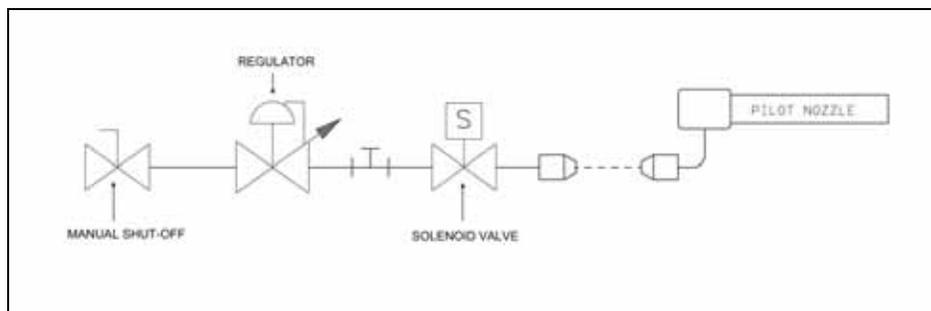


Figure 1-15 Pilot Gas Train

## OPERATION

Metered gas flows through the main gas shutoff cock, through the pressure regulator to the automatic gas valves and butterfly valves, and into the gas manifold.

The butterfly gas valves modulate flow according to burner input demand. The butterfly valves are positioned by actuators on signal

from the PLC. The air control damper is positioned independently by its own actuator. 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.

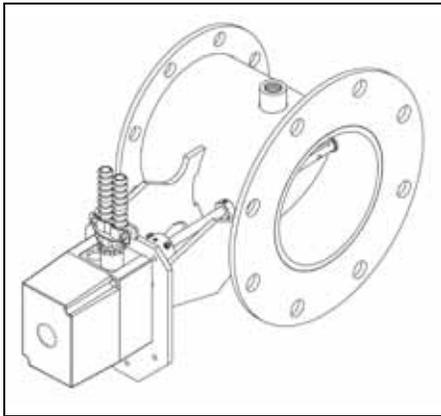
## I. NT Series Low NOx System

The NTH burner is designed to guarantee low emissions of < 30 ppm NOx @ 3% O2 (when firing natural gas) throughout the firing range.

CO emissions are estimated at < 50 ppm when firing gas.

The burner features an induced Flue Gas Recirculation system (F.G.R.). The flue gases of the boiler are re-circulated through the burner using the combustion air impeller to draw the exhaust gases and mix them with incoming fresh air. A top or bottom flanged F.G.R. connection is available on the air damper box. A modulating damper controls F.G.R. flow. Control system allows fine tuning of the F.G.R./fresh air ratio throughout the burner's firing range.

Ducting from the stack or boiler to the burner is by others. A F.G.R. shutoff valve is provided, and is installed near the flue gas outlet. The F.G.R. shutoff valve is closed during pre and post purge to prevent re-circulating combustibles through the combustion zone, and fully open when the burner is operating. A modutrol motor opens and closes the valve and proof of closure is provided by an auxiliary switch in the modutrol motor. The valve is equipped with ANSI flanges, to allow easy connection to the F.G.R. piping. The F.G.R. valve is shipped loose.



**Figure 1-16 F.G.R. Valve and Actuator**

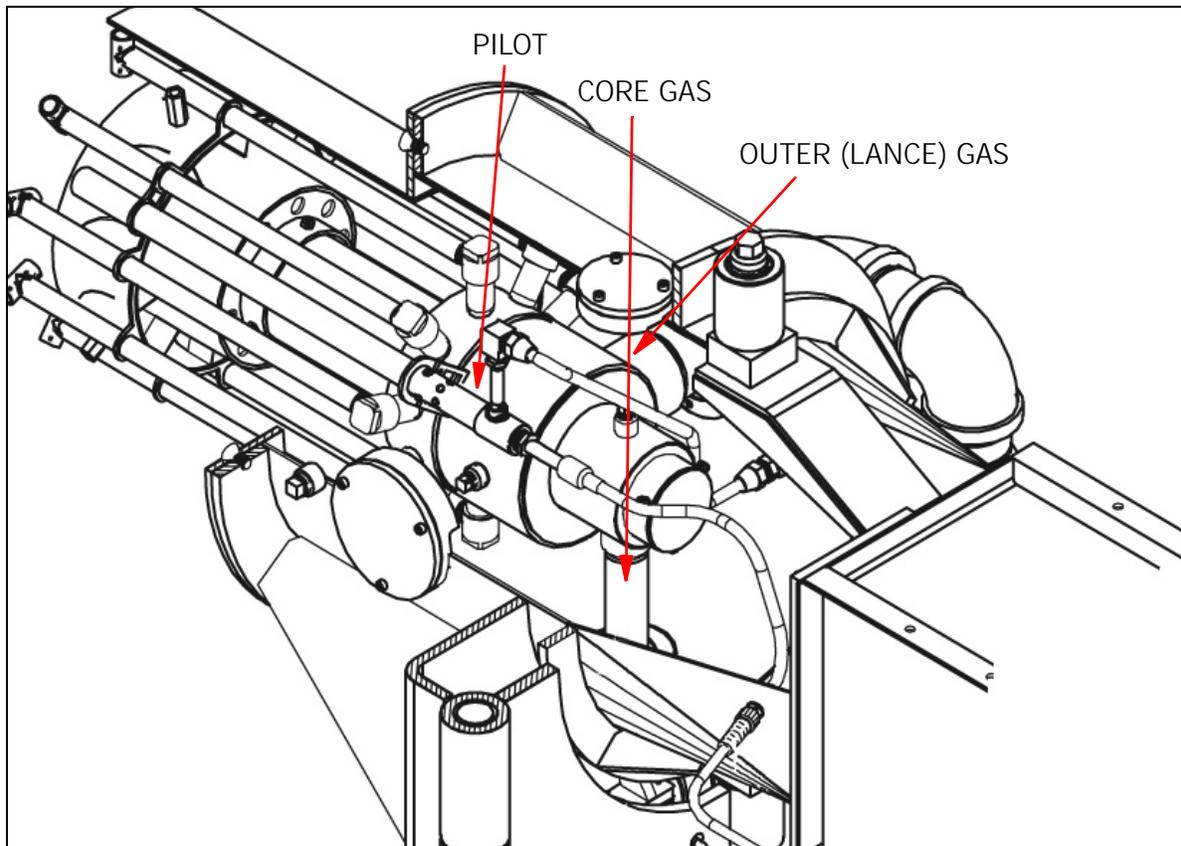


Figure 1-17 Firing Head (gas)

## J. Oil System

### 3-Way Solenoid Valve

Metered oil enters the common port of the 3-way solenoid valve. During shutdown, pre and post purge the valve is de-energized (normally closed port closed) and all metered fuel oil returns to the storage tank. When the valve is energized, metered oil is directed to the nozzle through the normally closed port.

### Nozzle Assembly

The nozzle assembly consists of the **oil nozzle**, the **oil nozzle body**, and the **oil nozzle piping**. **When firing oil, visually inspect and clean the oil nozzle every week. Please refer to Section 6, Inspection and Maintenance. If continual operation is required, a spare oil gun will allow oil gun replacement during service.**

 **Caution**

The oil gun must be allowed to cool before disassembling. Failure to follow this caution could result in equipment damage.

**Atomizing Air Proving Switch** - Pressure actuated switch contacts close when sufficient atomizing air pressure is present. The oil valve will not open unless switch contacts are closed.

**Oil Metering Unit**- All burners are equipped with a burner mounted oil metering unit.

**Atomizing Air** - When burning oil, the NTH uses compressed air for atomization. Atomizing air is independent of combustion air. Atomizing air is from a compressor module mounted near the burner, or alternatively from shop air supply. Shop air should be regulated to 80-90 psig and 500 ACFM. Air pressure should be initially set to 10 psig over the oil pressure. As oil pressure increases the air pressure should maintain a 10 psig differential.

### OPERATION

Fuel is delivered to the metering system at 50 to 70 psi. Metered oil is delivered to the common port of a 3-way solenoid valve for transfer to the burner nozzle through the normally closed port or back to the storage tank through the normally open port. During pre - and post purge, metered oil is returned to the tank. During normal firing, all metered oil is delivered to the nozzle. Air enters a rotary vane compressor through an air cleaner where it is compressed to atomizing pressure. Air flows from the compressor to an air-oil tank which serves the multiple purpose of dampening air pulsation, lube oil mist recovery, and storage for lube oil and atomizing air.

The compressor rotor is cooled and lubricated continuously by oil under pressure from the air-oil tank. Oil vapor is extracted by a mist eliminator in the upper section of the tank. Atomizing air from the upper tank section is delivered to the nozzle at a constant volume. Air pressure increases as the burner firing rate increases. Atomizing pressure may be adjusted by the valve located on the compressor air breather. The valve allows air to be bled from the tank to the compressor inlet. Delivery rate of the fuel oil metering system is controlled by the metering valve actuator.

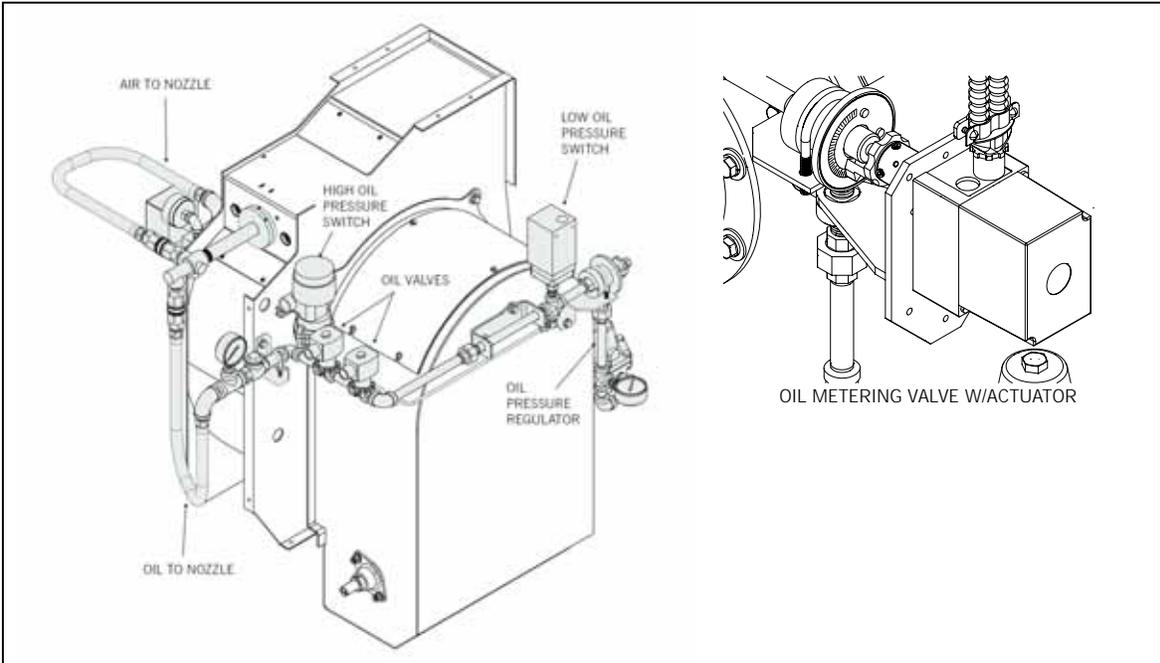


Figure 1-18 Oil System

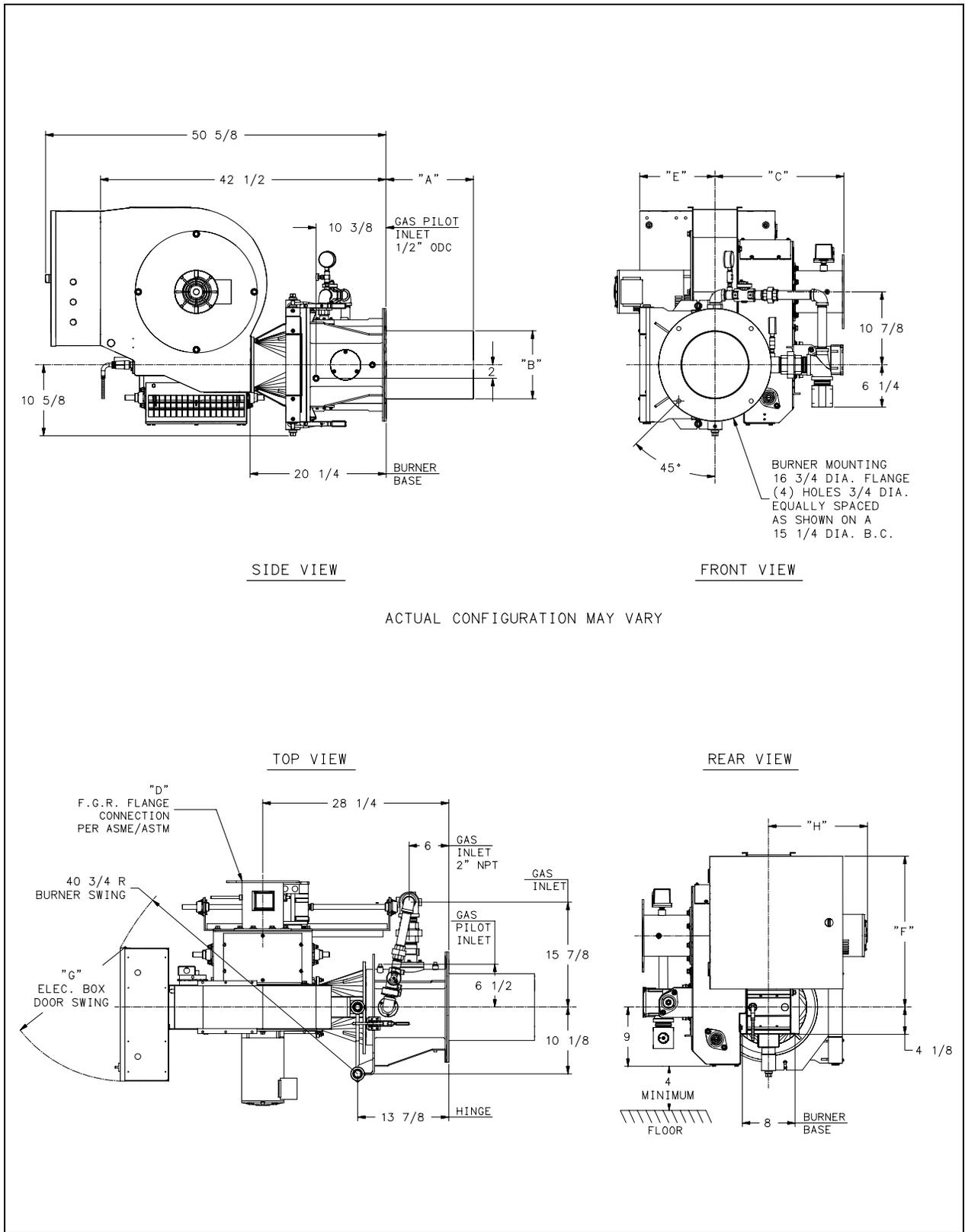


Figure 1-1 Dimension Diagram - Size 3

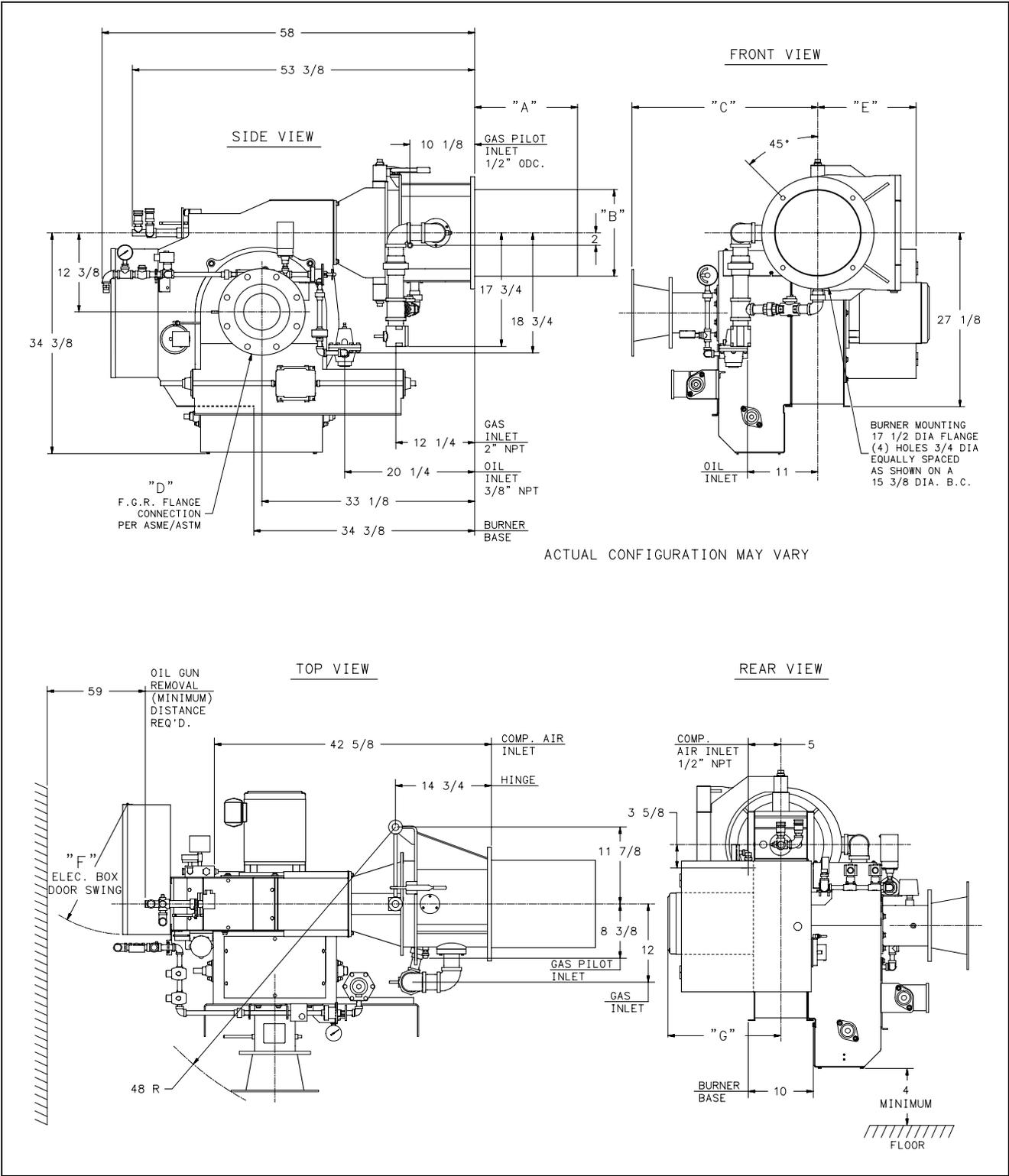


Figure 1-18 Dimension Diagram - Size 4

## Variable Dimensions

### Size 3

Burner Model	A*	B	C		D**		E***			F***			G***			H****			
			15 ppm	12 ppm	15 ppm	12 ppm	J-Box	Std.	Oversized	J-Box	Std.	Oversized	J-Box	Std.	Oversized	1.5 hp	2 hp	3 hp	5 hp
NTH-040	12	8.5	n/a	19.25	n/a	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	13.25	13.5	n/a	n/a
NTH-045	12	8.5	18	19.25	4	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	n/a	13.5	13.5	n/a
NTH-050	12	9.38	18	19.25	4	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	n/a	n/a	13.5	15
NTH-055	12	9.38	18	19.25	4	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	n/a	n/a	13.5	15
NTH-060	12	10.13	18	19.25	4	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	n/a	n/a	13.5	15
NTH-070	12	10.13	19.25	19.25	6	6	8.07	11.20	14.70	22.91	22.91	22.91	16.25	20.25	26.25	n/a	n/a	13.5	15

\* Based upon 6" furnace wall thickness  
 \*\* ASME/ASTM Flange connection (Pipe size shown) A same size F.G.R. Shut-off Valve will be supplied w/the burner (not shown).  
 \*\*\* J-Box 14" x 16", Standard panel 20" x 20", Oversized panel 20" x 26"  
 \*\*\*\* Fan motor sizing depends on furnace pressure, altitude and F.G.R. Temp. (ODP shown)

All values shown in inches.

### Size 4

Burner Model	A*	B	C		D**		E***			F***			G****		
			15 ppm	9 ppm	15 ppm	9 ppm	J-Box	Std.	Oversized	J-Box	Std.	Oversized	5 hp	7.5 hp	10 hp
NTH-084	16	11.25	23	29	6	8	12	15.5	21.5	16.25	20.25	26.25	15.75	15.75	16.25
NTH-105	16	12.5	23	29	6	8	12	15.5	21.5	16.25	20.25	26.25	15.75	16.25	16.25

\* Based upon 10" refractory cone thickness  
 \*\* ASME/ASTM Flange connection (Pipe size shown) A same size F.G.R. Shut-off Valve will be supplied w/the burner (not shown).  
 \*\*\* J-Box 14" x 16", Standard panel 20" x 20", Oversized panel 20" x 26"  
 \*\*\*\* Fan motor sizing depends on furnace pressure, altitude and F.G.R. Temp. (ODP shown)

All values shown in inches.

## Section 2 Installation

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## A. Electrical Connection

Electrical power available is usually 230/460 volt, 3 phase, 60 cycle or 380 volt, 3 phase, 50 cycle. Control circuit is 115 volt, single phase, 60 cycle or 115 volt, single phase, 50 cycle. Refer to the electrical schematic diagram shipped with the burner. Power connections are made at the control panel. The burner is furnished with a burner mounted junction box and remote control panel. Wiring from the burner junction box to remote panel, panel to boiler controls, low water controls, remote compressor motor and remotely located fuel valves is furnished by the installer.

## B. Installation

Locate the burner properly. The burner is designed for operation with the blast tube level. Do not tilt burner up or excessively downward. Installation of the refractory oven, or combustion cone, shipped with the burner is shown in **Figure 2-2**. Securely support the burner pedestal on the floor or foundation. Allow enough clearance at the rear of the burner to allow the housing to swing open for service and maintenance.

The face of the boiler and burner flange must be sealed with the gasket provided with the burner. Carefully place the gasket over the dry oven bolts before it is mounted onto the burner flange. The I.D. of the dry oven is slightly larger than the blast tube I.D. Make sure the dry oven and burner blast tube are concentric. Due to bolt hole tolerances, the dry oven may have to be shifted to accomplish this. After the dry oven nuts are properly tightened, the burner and dry oven assembly can then be mounted into the boiler.

## C. Refractory

The area between the outside circumference of the dry oven and existing refractory should be packed with Kaiser Refractory Mono T-9 Air Set or equal within two hours after coating the dry oven with Trowleze. Ram plastic refractory from the front to the rear parallel to outside surface of the dry oven.

## D. Atomizing Air

For oil burners without a separate air compressor module, shop air must be provided at 80-100 psig and 500 ACFM.

## E. Typical Oil Supply Loop

Continuous oil circulation must be supplied to the burner at a rate of 50 percent greater than the high fire burning rate. The oil circulating pump should be located as close as possible to the storage tank to keep suction lines short and minimize to prevent suction loss. Note that the supply line is higher above the burner metering pump inlet to help eliminate air problems. The return line to the tank is connected at the discharge port of the three-way valve. Note that the return line should be a minimum of 20 inches higher than the supply line. Since air rises to the highest point, it will rise from the supply entrance and pass through the return line and on to the tank. Metered oil flow to the common port of a 3-way valve. With the 3-way valve de-energized, the metered oil returns to

### Caution

The burner refractory cone is air-cured only. Heat-curing must be initiated at initial start-up. Run the burner at low fire for a period of 6 to 8 hours before starting to gradually increase the firing rate. Failure to do so will result in damage and cracks in the refractory.

the tank through the return line. When the 3-way valve is energized, metered oil is passed on to the burner oil nozzle and atomized by air from the compressor. The proper strainers, check valves, vacuum and pressure gauges, etc. should be installed as indicated. An oil strainer is shipped loose with the burner. All lines should be pressure tested after installation.

## F. Circulating Oil Pump

An circulating oil pump is required to deliver fuel oil from the storage tank to the burner at a minimum of 150% of the maximum burner firing rate. The excess oil allows a margin for piping error, viscosity changes in the fuel oil, and circulating pump wear. Correct pipe sizing is determined by circulating rate, not burner capacity. Install the pump as close to the supply tanks as possible. Suction lift should be as low as possible. Maximum suction of 15" Hg vacuum is good practice for either light or heated heavy oil. The strainer should be installed in the suction line just ahead of the circulating pump to prevent foreign material from entering the pump. Locate the strainer so it may be easily cleaned.

## G. Oil Pressure Regulator

An oil pressure regulator should be installed in the supply line, close to the burner to regulate oil pressure. Oil pressure is 50 to 70 PSI to the metering valve. One is shipped loose with the burner.

## H. 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. Z 223.1. (for Canada: the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail).

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, Inc., CGA, Factory Mutual, or Industrial Risk Insurance.

Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly.

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 shut-off valve. The gas piping must be internally clean and free of foreign material. Before placing into service, a leak test must be performed.

### **Caution**

Before opening the gas shut-off valves, read the regulator instructions carefully. Open shut-off valve slowly to allow inlet pressure to build up slowly in the regulator until it is fully pressurized. Opening the shut-off valve too quickly will damage the regulator.

## I. Installation Checklist

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.

Before operating pumps, and compressors, make certain that reservoirs are properly filled with the specific lubricant. Open all necessary oil shut-off valves. **Do not** run compressors, pumps, without oil.

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

Before burner operation, be sure all motors are rotating in the correct direction. See Motor Rotation Reference Figure 2-1.

Before firing, make sure that the refractory flame cone is properly sealed to the burner mounting flange and the boiler front plate.

## J. Low NOx System

The Profire NT burners are equipped with a flue gas recirculation system (F.G.R.) with either a top or bottom flanged connection. The flue gases are ducted to the air housing, and the burner combustion air fan is used to draw the exhaust gases to mix with intake air before reaching the combustion zone.

The F.G.R. system consists of the following components:

### F.G.R. Control Damper Assembly

The F.G.R. rate is controlled via a damper on the burner air damper box. Damper is positioned by actuator on signal from the PLC. The HAWK ICS controls provide proper fuel/air/FGR ratios throughout the burner firing range.

Refer to Section 4, Commissioning, for setup and adjustment information.

### F.G.R. Shutoff Valve

The F.G.R. shutoff valve is shipped loose and should be installed as close to the stack as possible. A modutrol motor with a 90 degree stroke opens and closes the F.G.R. shutoff valve in 15 seconds. Proof of closure for the shutoff valve is provided by an auxiliary switch in the modutrol motor.

The modutrol motor has a maximum temperature rating of 150 degrees F. During pre-purge and post-purge, the F.G.R. shut-off valve is closed to prevent any unused gas fumes from returning to the combustion zone.

### Notice

F.G.R. piping from the stack to the burner is not supplied with the burner and is installed by the contractor.



### Important

It is suggested that all F.G.R. piping be sch.#40, 14 I.D. and be covered with a minimum of 2 inches of insulation

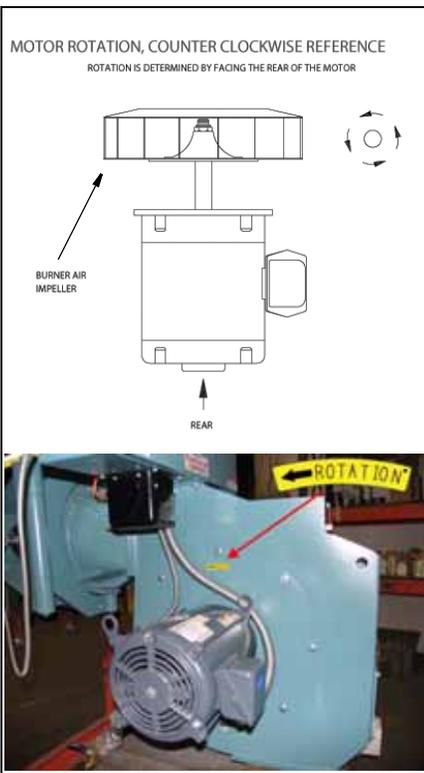


Figure 2-1 Motor Rotation

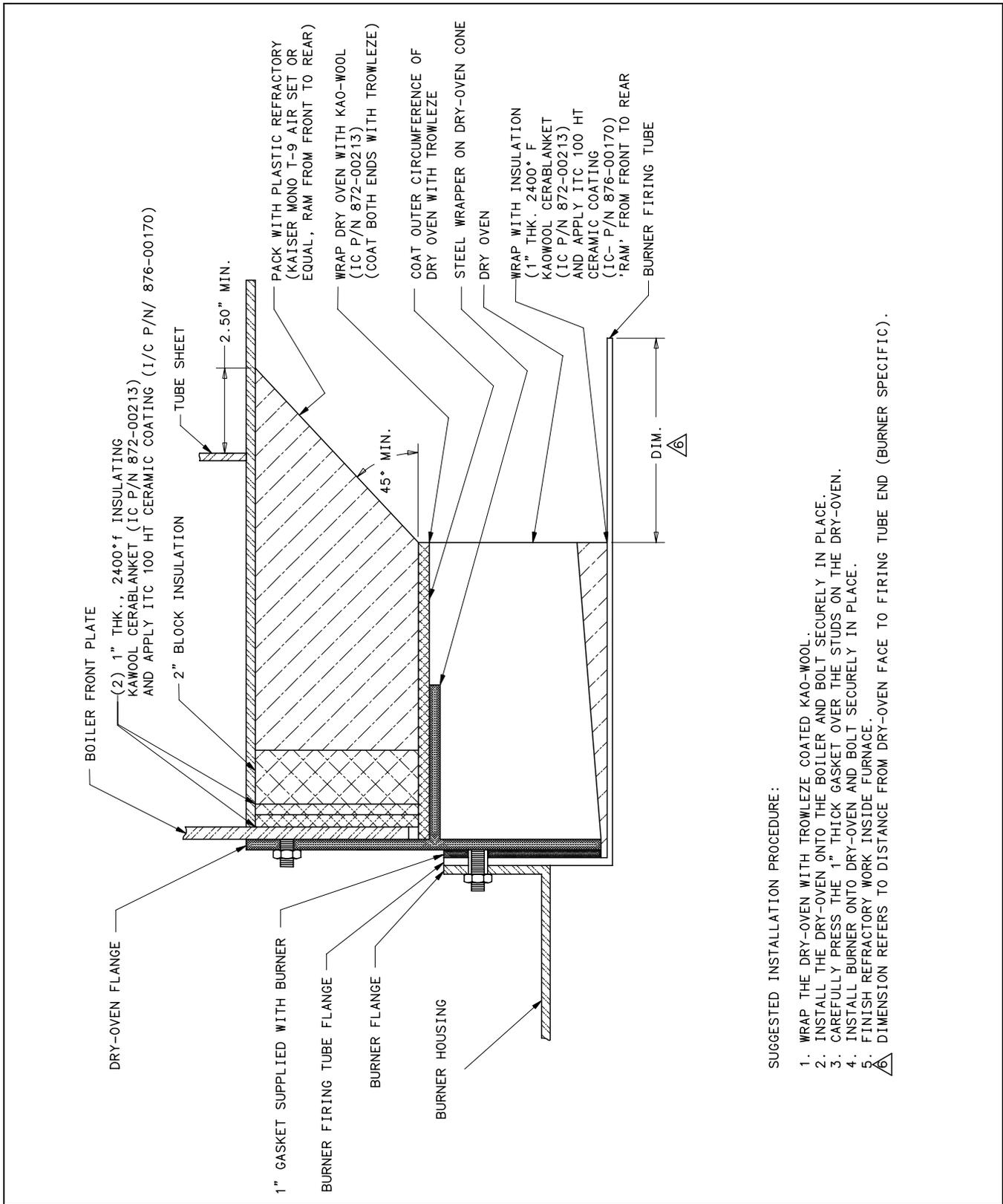
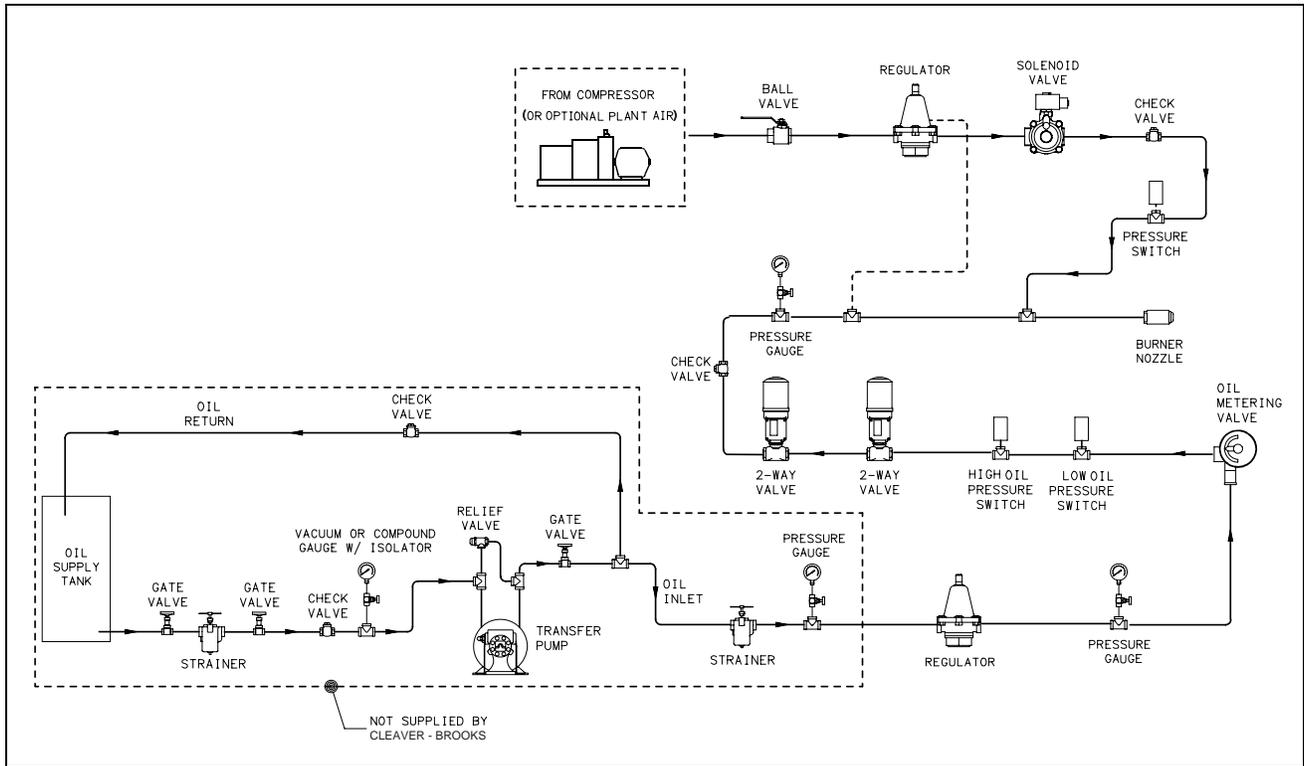


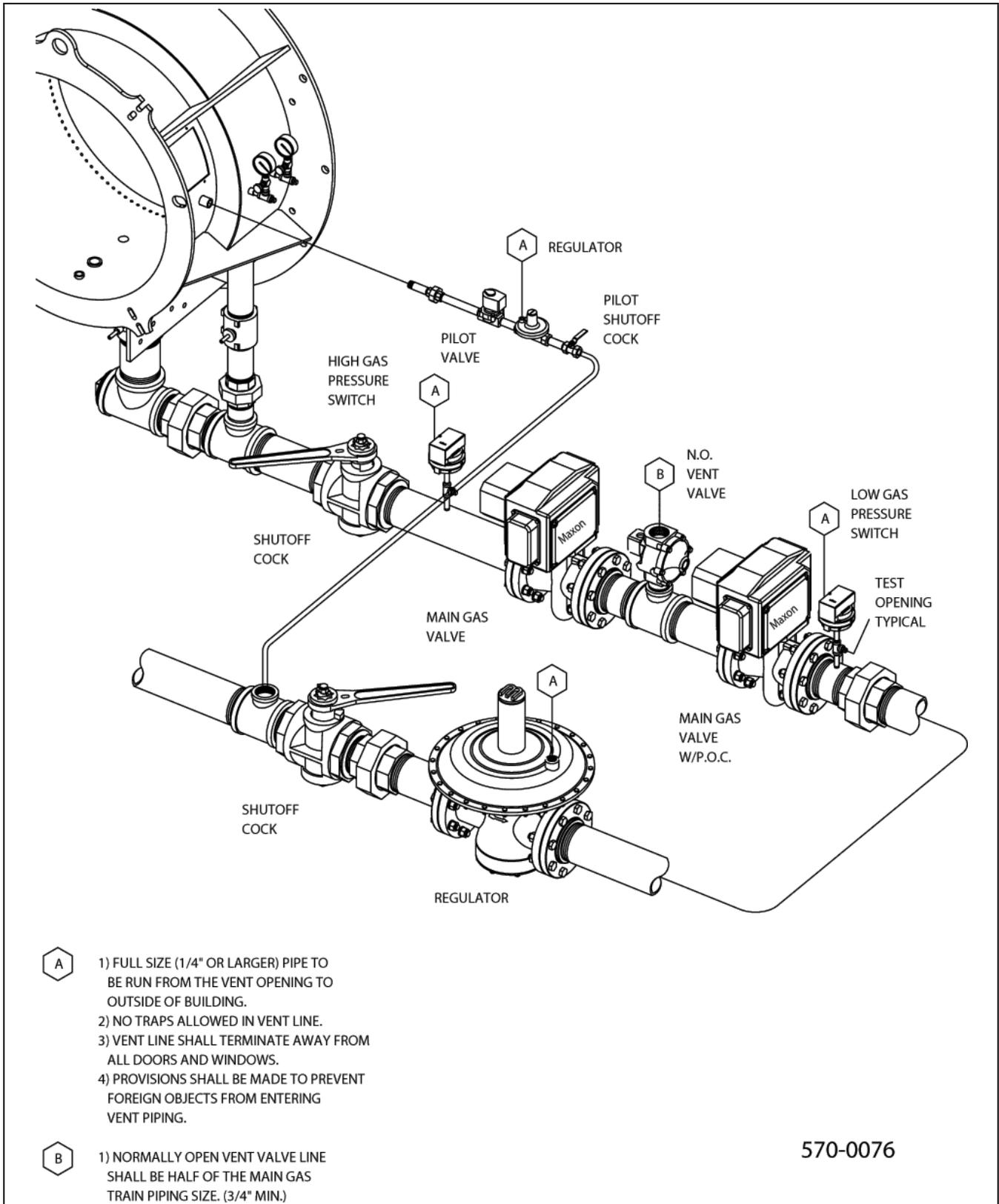
Figure 2-2 Dry Oven Installation Procedure



**Figure 2-3 Burner Oil and Atomizing Air Flow**

**Caution**

Lubricating oil is drained from the air-oil tank before shipment. Before attempting to start the burner, add oil to the recommended level. Fill tank with non-detergent SAE 30 oil to a level midway up the sight glass. Remove the oil filter, fill with oil, and re-install. Do not overfill tank.



**Figure 2-5 Gas Piping Arrangement**



## Section 3

# Sequence of Operation

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**Note:** The make or model of the program relay provided will vary depending upon job specifications. The following sequence applies regardless of the make or model. Please refer to the Wiring Diagram (WD) for your specific installation.

To comply with requirements of insurance underwriters such as Factory Mutual (FM), Industrial Risk Insurers (IRI) or others, additional interlock devices may be used in addition to the circuits mentioned.

## A. General

This section outlines the electrical sequencing of various controls through the pre-purge, ignition, run, and shutdown cycles of the burner.

The program relay establishes the sequence of operation and directs the operation of all other controls and components to provide an overall operating sequence.

The sequences outlined in this section employ specific nomenclature to aid in applying the text to the wiring diagram.

The burner and control system are in starting condition when the following conditions exist:

1. Boiler water is up to the correct level, closing the low-water cutoff switch.
2. The operating limit pressure control (steam boiler) or the operating limit temperature control (hot water boiler) and high limit pressure or temperature control are below their cutoff setting.
3. All applicable limits are correct for burner operation.
4. Manual resets are set (water, fuel pressure, operating limits).
5. All entrance switches are closed and power is present at the line terminals of:
  - Blower motor starter
  - Air compressor motor starter (if provided)
  - Oil pump motor starter (if provided)

The sequences do not attempt to correlate the action of the fuel supply system or feedwater system except for the interlock controls that directly relate to the action of the program relay. Chapter 4 and Chapter 6 contain operating instructions and specific information on setting, adjusting, and troubleshooting the controls.

## B. Circuit and Interlock Controls

The burner control circuit is a two-wire system designed for 115 VAC, 60 Hz, single-phase power.

The electrical portion of the boiler is made up of individual circuits with controls that are wired in a manner designed to provide a safe workable system. The program relay provides connection points for the interconnection of the various circuits.

The controls used vary depending upon the fuel (oil or gas) and the specific requirements of applicable regulatory bodies. Refer to the boiler wiring diagram to determine the actual controls provided (some example circuits are shown). The circuits and controls described below illustrate a typical burner application, and will be referred to in Section C, Sequence of Operation.

### Limit Circuit

- Burner switch (BS)
- Operating limit control (OLC) – pressure or temperature
- High limit control (HLC) – pressure or

---

temperature

- Low-water cutoff (LWCO)
- Gas-oil selector switch (GOS) – (Combination burner only)
- Low gas pressure switch (LGPS)
- High gas pressure switch (HGPS)
- Fuel valve over travel interlock circuit
- Main gas valve auxiliary switch (MGVAS)

#### **Blower Motor Starter Circuit**

- Blower motor starter (BMS)
- Air compressor motor starter (ACMS) (if provided)

#### **Running Interlock Circuit**

- Blower motor starter interlock (BMSI)
- Combustion air proving switch (CAPS)
- Atomizing air proving switch (AAPS) (if provided)

#### **Low Fire Proving Circuit**

- Low fire switch (LFS)

#### **Pilot Ignition Circuit**

- Gas pilot valve (GPV)
- Ignition transformer (IT)
- Gas pilot vent valve (GPVV) (if provided)

#### **Flame Detector Circuit**

- Flame detector (FD)

#### **Main fuel valve circuit**

- Main gas valve (MGV)
- Main gas vent valve (MGVV) (if provided)
- Oil valve (OV)
- Main fuel valve light (FVL)

#### **Firing Rate Circuit**

- Modulating damper motor (MDM)
- Manual-automatic switch (MAS)
- Manual flame control (MFC)
- Modulating control (MC)

#### **High Fire Proving Circuit**

- High fire switch (HFS)

#### **Running Interlock and Limit Circuit**

- Low oil pressure switch (LOPS)
- High oil temperature switch (HOTS)
- Auxiliary low-water cutoff (ALWCO)

## C. Sequence of Operation — Oil or Gas

On a combination fuel unit, the gas/oil switch must be set for the proper fuel.

The following sequence occurs with power present at the control panel and with all other operating conditions satisfied.

### 1. Pre-purge Cycle

When the burner switch is turned ON, controls wired in the limit and fuel valve interlock circuits are closed, and no flame signal is present, the blower motor start circuit is powered and the blower motor starter will energize. The load demand light turns on. When firing oil, the air compressor motor starter (if provided) is also powered.

At the same time, the control program signals the air actuator to open the air damper. The damper begins to open and drives to its full open or high fire position. Opening the damper motor allows a flow of purging air through the boiler prior to the ignition cycle.

On all boilers the circuitry will include a high fire switch. The purpose of the switch is to prove that the air damper is in its fully open position during the pre-purge cycle.

The controls wired into the running interlock circuit must be closed within 10 seconds after the start sequence. In the event any of the controls are not closed at this time, or if they subsequently open, the program relay will go into a safety shutdown.

At the completion of the high fire purge period, the control program signals the air damper actuator to drive the air damper to its low fire position.

To assure that the system is in low fire position prior to ignition, the low fire switch must be closed to complete the low fire proving circuit. The sequence will stop and hold until the air damper has returned to the low fire position and the contacts of the low fire switch are closed. Once the low fire switch is closed, the sequence is allowed to continue.

**Note:** The ignition trial cannot be started if flame or a flame simulating condition is sensed during the pre-purge period. A safety shutdown will occur if flame is sensed at this time.

### 2. Ignition Cycle

The ignition transformer and gas pilot valve are energized from the appropriate pilot ignition terminal.

The pilot flame must be established and proven by the flame detector within a 10 second period in order for the ignition cycle to continue. If for any reason this does not happen, the system will shut down and safety lockout will occur.

With a proven pilot, the main fuel valve(s) (oil or gas) is energized and the main fuel valve light in the panel is lighted. The main flame is ignited and the trial period for proving the main flame begins. It lasts 10 seconds for light oil and/or natural gas. At the end of the proving period, if the flame detector still detects main flame, the

ignition transformer and pilot valve are deenergized and pilot flame is extinguished.

**Note:** If the main flame does not light, or stay lit, the fuel valve will close. The safety switch will trip to lock out the control. Refer to Flame Loss Sequence (**Section D**) for description of action.

 **Warning**

The cause for loss of flame or any other unusual condition should be investigated and corrected before attempting to restart. Failure to follow these instructions could result in serious personal injury or death.

### 3. Run Cycle

With main flame established, the program releases the air damper actuator from its low fire position to either manual or automatic control, depending upon whether MAN or AUTO is selected at the control panel. This allows operation in ranges above low fire.

With the manual-automatic switch set at automatic, subsequent modulated firing will be at the command of the PLC, which governs the position of the actuators for air, fuel, and FGR.

**Note:** Normal operation of the burner should be with the MAN/AUTO switch in the automatic position and under the direction of the modulating control. The manual position is provided for initial adjustment of the burner over the entire firing range. When a shutdown occurs while operating in the manual position at other than low fire, the damper will not be in a closed position, thus allowing more air than desired to flow through the boiler. Excess air flow subjects the pressure vessel metal and refractory to undesirable conditions.

The burner starting cycle is now complete. The load and fuel valve lights on the panel remain lit. Demand firing continues as required by load conditions.

### 4. Burner Shutdown — Post Purge

The burner will fire until steam pressure or water temperature in excess of demand is generated. With modulated firing, the actuators should return to the low fire position before the operating limit control (OLC) opens. When the limit control circuit is opened, the following sequence occurs:

1. The main fuel valve circuit is de-energized, causing the main fuel valve (gas or oil) to close. The flame is extinguished. The control panel load and fuel valve lights are turned off. The blower motor continues to run to force air through the boiler for the post purge period.
2. The blower motor start circuit is de-energized at the end of the post purge cycle and the shutdown cycle is complete.
3. The program relay is now ready for subsequent recycling, and when steam pressure or water temperature drops to close the

contacts of the operating control, the burner again goes through its normal starting and operating cycle.

## D. Flame Loss Sequence

The program relay will recycle automatically each time the operating control closes, or after a power failure. It will lockout following a safety shutdown caused by failure to ignite the pilot, or the main flame, or by loss of flame. Lockout will also occur if flame or flame simulating condition occurs during the pre-purge period or any time the burner switch is open.

The control will prevent start-up or ignition if limit circuit controls or fuel valve interlocks are open. The control will lock out upon any abnormal condition affecting air supervisory controls wired in the running interlock circuit.

---

 **Caution**

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The lockout switch must be manually reset following a safety shutdown. The cause for loss of flame or any unusual condition should be investigated and corrected before attempting to restart. Failure to follow these instructions could cause damage to the equipment.

### 1. No Pilot Flame

The pilot flame must be ignited and proven within a 10-second period after the ignition cycle begins. If not proven within this period, the main fuel valve circuit will not be powered and the fuel valve(s) will not be energized. The ignition circuit is immediately deenergized and the pilot valve closes, the reset switch lights and lockout occurs immediately.

The blower motor will continue to operate. The flame failure light and the alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

### 2. Pilot But No Main Flame

When the pilot flame is proven, the main fuel valve circuit is energized. The pilot flame will be extinguished 10 seconds later. The flame detecting circuit will respond to deenergize the main fuel valve circuit within 2 to 4 seconds to stop the flow of fuel. The reset switch lights and lockout occurs immediately. The blower motor will continue to operate.

The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

### **3. Loss of Flame**

If a flame outage occurs during normal operation and/or the flame is no longer sensed by the detector, the flame relay will trip within 2 to 4 seconds to de-energize the fuel valve circuit and shut off the fuel flow. The reset switch lights and lockout occurs immediately. The blower motor continues operation. The flame failure light and alarm bell (optional) are energized 10 seconds later.

The blower motor will be deenergized. The lockout switch must be manually reset before operation can be resumed. (Refer to the previous caution.)

If the burner will not start, or upon a safety lockout, refer to the troubleshooting section in Chapter 5 for assistance in pinpointing problems that may not be readily apparent.

The control system has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the controls manual for specifics and suggested remedies. Familiarity with the program relay and other controls in the system can be obtained by studying the contents of the manual and this bulletin.

Knowledge of the system and its controls will make troubleshooting much easier. Costly down time or delays can be prevented by systematic checks of the actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

Remember, a safety device, for the most part, is doing its job when it shuts down or refuses to operate. Never attempt to circumvent any of the safety features.

Preventive maintenance and scheduled inspection of all components should be followed. Periodic checking of the relay is recommended to see that a safety lockout will occur under conditions of failure to ignite either pilot or main flame, or from loss of flame.



## Section 4

# Commissioning

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 **Warning**

It is recommended that the starting instructions be read completely until they are thoroughly understood, before attempting to operate the burner, rather than performing each operation as it is read for the first time. Failure to follow these instructions could result in serious personal injury or death.

 **Warning**

Prior to firing a boiler, be sure that discharge piping from safety valves or relief valves, and discharge piping from all blowdown and drain valves, is piped to a SAFE point of discharge, so that emission of hot water or steam cannot possibly cause injury. Failure to follow these instructions could result in serious personal injury or death.

 **Important**

All work on the burner should be performed by qualified persons knowledgeable in applicable codes. Wiring should be in accordance with the National.

 **Caution**

Attempting initial burner start-up with insufficient knowledge of the equipment and start-up procedures can result in serious damage to the equipment. The operator must be totally familiar with the entire start-up and adjustment process before attempting to operate the burner.

## A. General

Instructions are all based upon installation being complete and all electrical, fuel, water and vent stack connections made.

The operator should be familiar with the burner, boiler, and all controls and components. To quickly locate and identify the various controls and components mentioned in the following paragraphs, refer to the illustrations and the contents of Sections 1, 2 and 3. Instructions for adjusting major components are given in this section and should be reviewed prior to firing. The wiring diagram should also have been studied, along with the firing sequence outlined in Section 3.

Verify supply of fuel and proper voltage. Check for blown fuses, open circuit breakers, dropped out overloads, etc. Check reset of all starters and controls having manual reset features. Check the lockout switch on the programmer and reset if necessary.

Check to see that water column gauge glass isolation valves are open, and that feedwater pump controls operate correctly. The boiler should be filled with water to the proper operating level using water at ambient temperature. Be sure that treated feedwater is available. In hot water applications, the entire system should be filled and vented. On a steam boiler, open the vent valve to vent air displaced during filling. Leave the vent valve open until the escape of steam is noted after the burner is operating.

Check for rotation of all motors by momentarily closing the motor starter or relay. The blower impeller rotation is counter-clockwise, when viewed from the motor side of the burner. The atomizing air pump rotation is clockwise when viewed from its drive end.

## B. Preparation for Initial Start-Up

### 1. Prestart Tasks and Checklist — All Fuels

Before proceeding with system start-up and adjustment, be sure that overall installation is complete. Review this manual carefully to verify that the boiler is properly set up for operation. Check that all shipped-loose items (those items not installed when shipped) have been correctly installed. Verify the supply of fuel. Check to make sure the burner is wired as shown on the wiring diagram. Ensure that all control wiring terminals are tight.

Complete the following checklist in preparation for system startup:

1. Confirm that the fuel and electrical connections have been completed in accordance with the applicable codes and insurance requirements (if necessary), and that connections comply with the piping schematic and wiring diagram. A copy of the wiring diagram is located inside the control panel.
2. Check the combustion air fan motor for correct rotational direction (**Figure 4-1**).
3. Check that the boiler is filled with water to the proper level, and that all circulating pumps (hot water units) are correctly installed and operational.
4. A representative of the gas utility should turn on the gas. Verify that there is proper gas pressure at the gas train, and pilot, if this is a gas or combination burner. See the burner specification plate for minimum and maximum natural gas pressure requirements. The data label is located inside the control panel. Make sure that the correct regulator and spring are installed in the main and pilot line. With the gas train pressurized, verify that the motorized main gas valves shut tightly, with no leakage past these valves.
5. For oil burners confirm that the atomizing air supply has adequate flow and pressure to provide the correct oil atomizing requirement.
6. Check that the flame safeguard has been properly installed inside the control panel.
7. Verify that the prestart checklist for the boiler has been thoroughly completed.
8. Provide the following test equipment on site:
  - A. Combustion analyzer for O<sub>2</sub>.
  - B. U-tube manometer, or pressure gauge, to measure gas pressures (main and pilot).
  - C. Inclined manometer to measure draft pressures.
  - D. Smoke spot tester for oil fired units. (CO analyzer for gas fired burners).
  - E. Voltmeter.
  - F. Thermometers and thermocouples.



**Figure 4-1** Check Motor Rotation

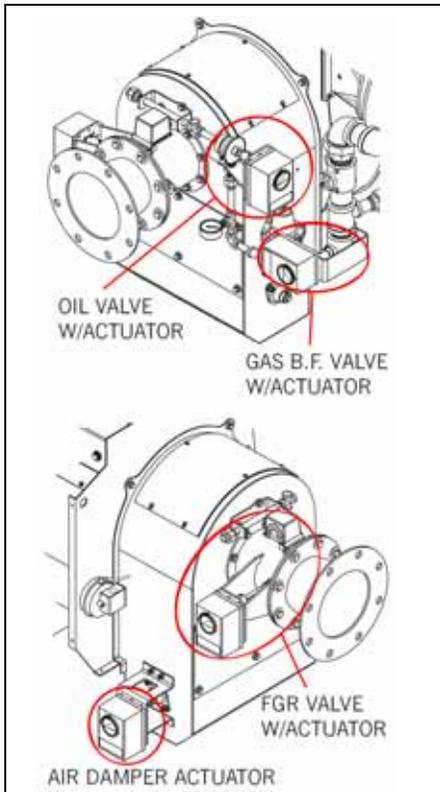


Figure 4-2 Parallel Positioning fuel, air, and FGR controls

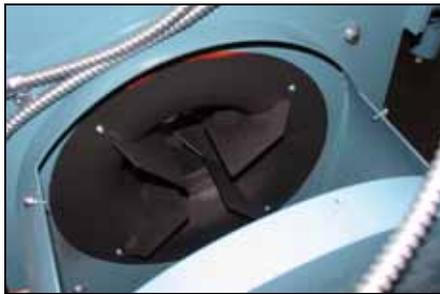


Figure 4-3 Air Inlet Cone



Figure 4-4 Rotary Air Damper

## 2. Air and Fuel Controls

The combustion system fuel and air controls have been factory adjusted, and the unit has been test fired before it was shipped. Regardless of preliminary adjustment and operation, it may be necessary to readjust the controls for local conditions:

- The fuel flow controls may require adjustment to establish the rated fuel input over the full range of firing-rate modulation.
- The air controls may need to be adjusted, relative to the established fuel flow rates, to provide the correct amount of air for complete, efficient combustion.
- Gas pressure to the regulator must be a minimum of 10 psig. A minimum of 3 psig is required at the regulator outlet.
- The inner and outer manifold pressures must be balanced to provide a stable flame. The balancing of the inner and outer manifold gas pressures will vary somewhat, depending on altitude, weather and barometric conditions.

Fuel and air adjustments are similar on all ProFire burners, whether gas-fired, oil-fired, or combination gas/oil fired. The following topics describe air and fuel flow rate adjustments, and the combustion set-point objectives for optimum combustion performance:

### Air Flow Control

The NTH burner incorporates a rotary damper combustion air control system.

The air damper is almost closed in the low fire position and fully open in high fire.

### Fuel and Air Flow Settings

Fuel and air flow rates can be 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. Adjustments may be required to meet certain environmental emissions criteria, such as NO<sub>x</sub> or CO. Combustion adjustments also vary with specific system applications.

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

Excess air (O<sub>2</sub>) and unburned fuel (CO) levels in boiler flue gases are used to determine combustion efficiency and as a tool in adjusting fuel and air inputs. 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.

ProFire burners are capable of operating at CO levels of less than 50 ppm at all firing rates. 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 buildup in the boiler.

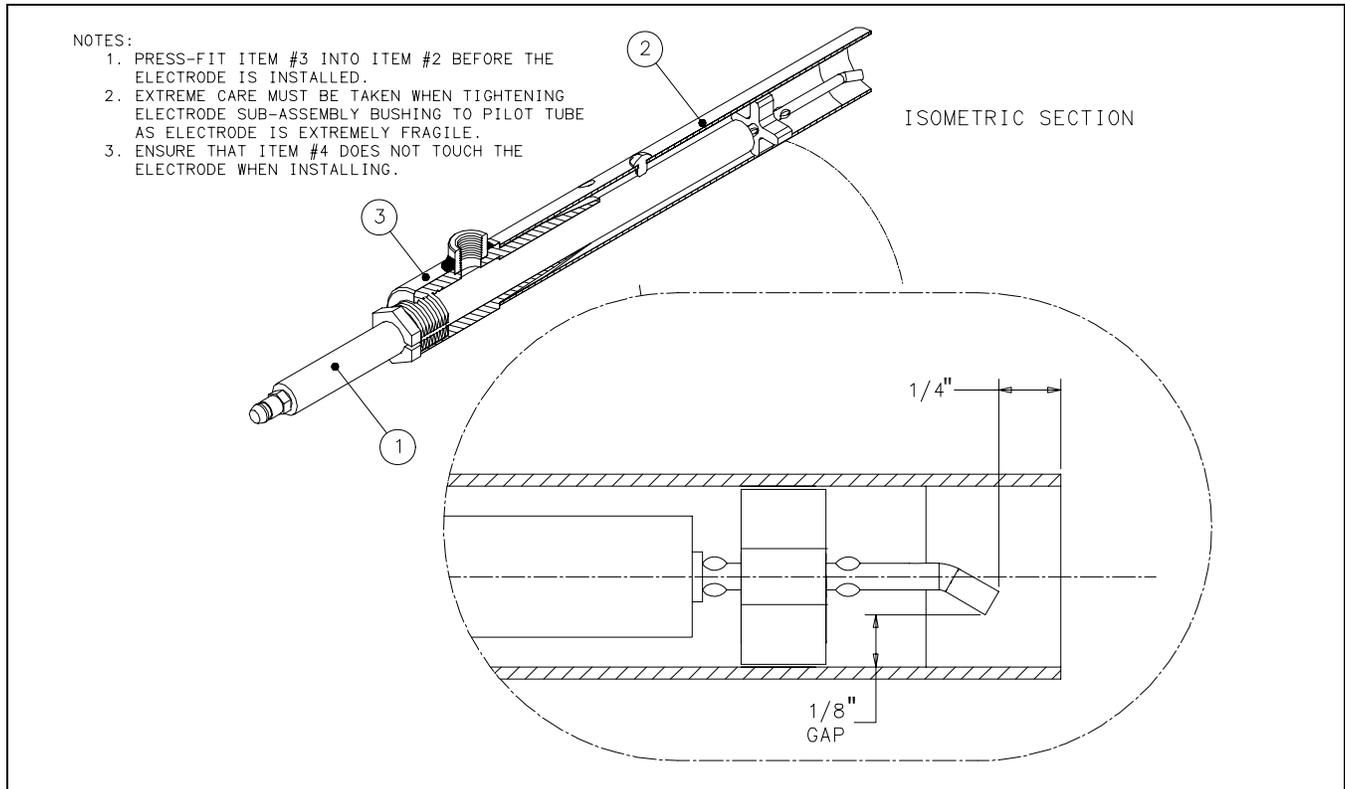
### 3. Fuel Supply

Before initial start-up, verify that all fuel connections are tight. Fuel supply lines should be securely connected, correctly supported, and leak tested.

The gas train for gas-fired, or combination gas/oil, burners is provided with the overall burner package. Configuration of the appropriate gas train is based on minimum requirements established by Underwriter's Laboratories/CGA and the responsible insurance carrier, if applicable.

The pilot gas train is supplied with the burner, and is factory-installed.

Fuel oil piping for oil-fired systems is shown pictorially in **Section 2 - Installation**. In this circuit, an oil supply line from the oil tank is connected to the inlet port of the oil pump, and an oil return line from the pump circulates excess oil from the pump back to the oil supply tank.



**Figure 4-5 Ignition Electrode Setting**

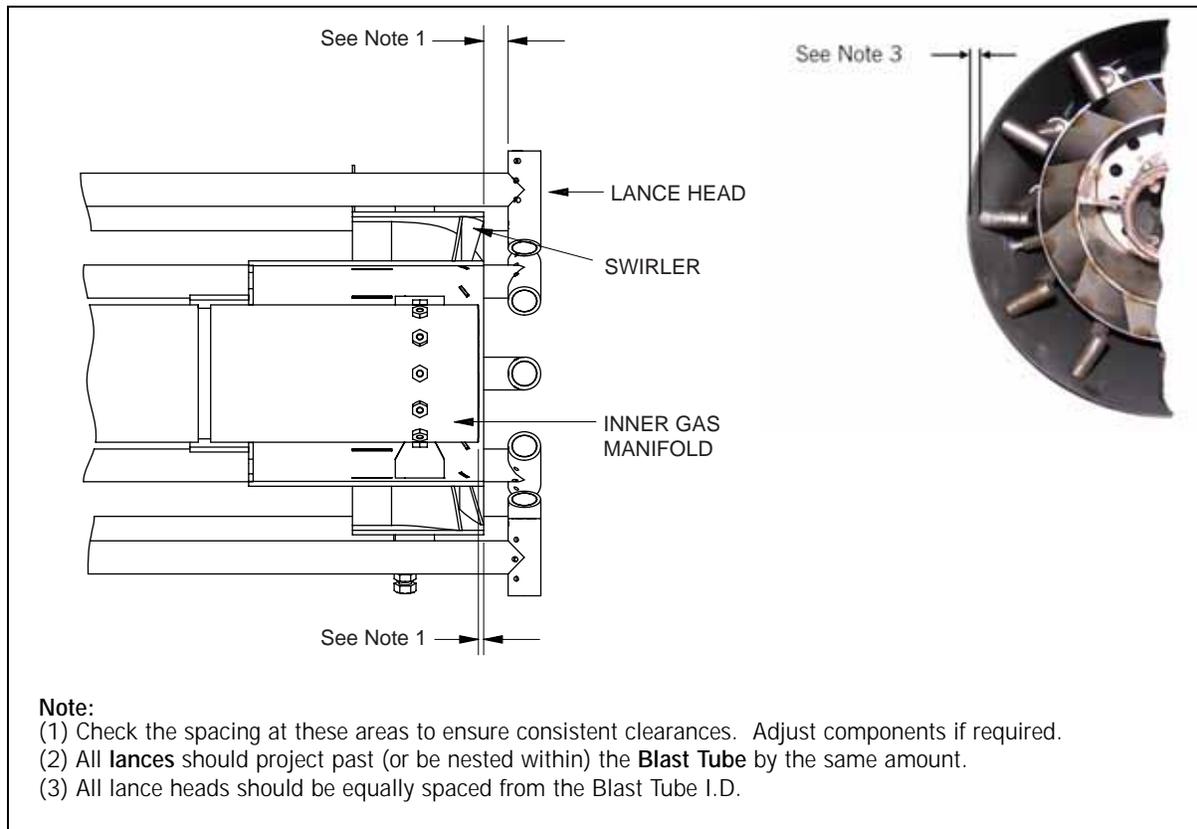


**Figure 4-6 Electrode**

Before burner start-up, the two oil solenoid valves are in the closed (de-energized) position and the oil metering valve is in its most closed position. Under this condition (with the pump operating), oil cannot flow to the oil burner nozzle, but circulates through the oil metering valve bypass to return line and back to the oil tank. When the flame safeguard control calls for the main flame, the two oil solenoid valves are electrically energized. After opening, oil flows through the nozzle at the low-fire flow rate.

#### 4. Burner Settings

To ensure reliable and safe burner performance, the pilot electrode setting, diffuser location and the relative positions of the burner nozzle and diffuser components must be correctly set (see **Section 6 - Inspection and Maintenance**). 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 positions.



**Figure 4-7 Firing Head Alignment**

Verify the following:

- Burner drawer center tube and firing head center tube must be concentric and aligned for free fit of the oil gun. Even when firing gas only, these two components should be carefully aligned to ensure proper gas and air delivery.
- Ensure the oil nozzle is centered in the firing head center tube (and cone if equipped). Prior to closing the rear head, verify correct nozzle positioning.

**Notice**

The gap between the lances and the blast tube must be consistent around the entire inside diameter of the blast tube. Centering and concentricity is critical for all NT burner head components.

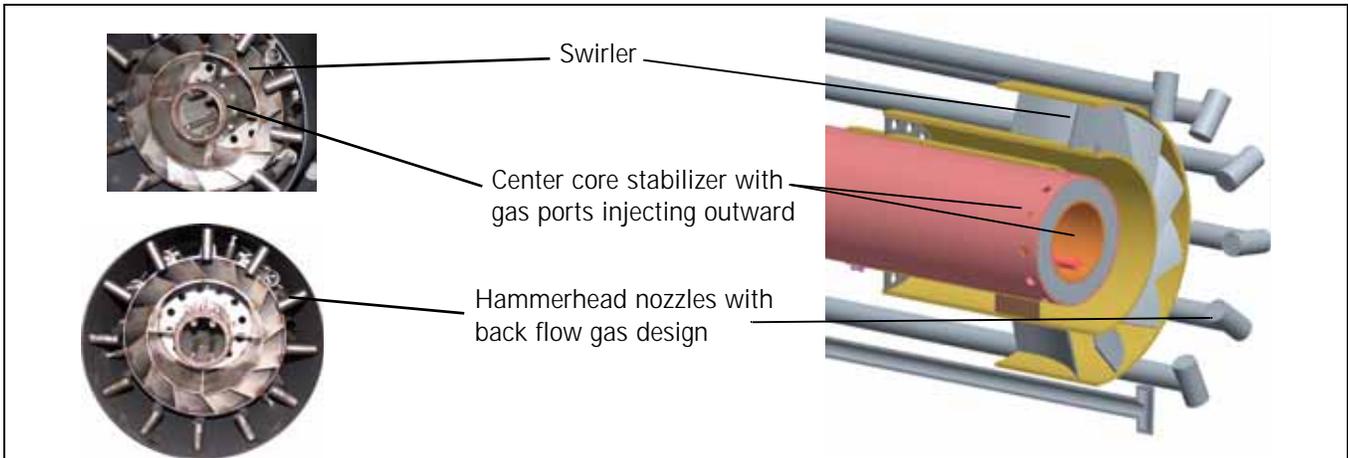


Figure 4-8 NTH Burner Head (Front)

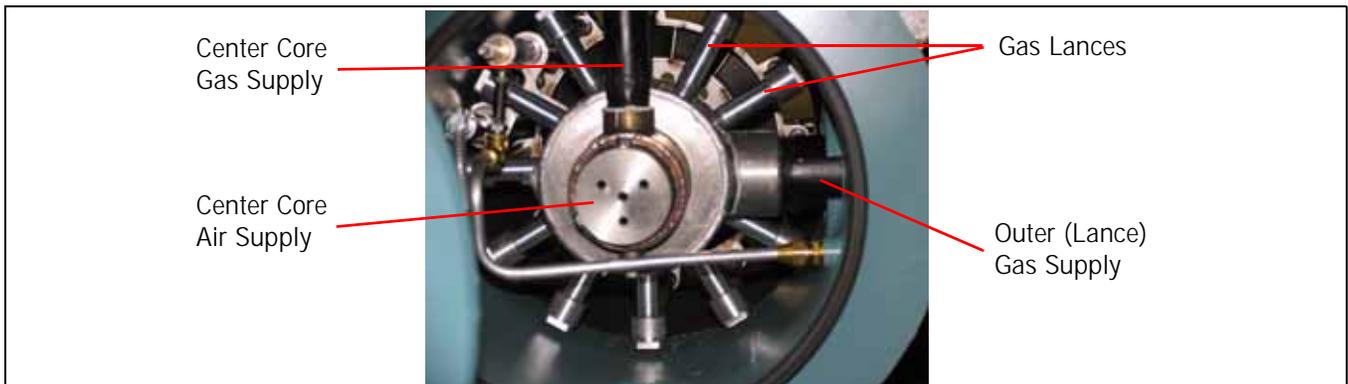


Figure 4-9 Gas and Air Supply, NTH Burner Head (Rear)

## 5. Spark Pickup Test

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

### GAS FIRED:

Close the pilot and the main line manual gas valves.

Start the burner and allow to run through prepurge. When the burner gets to pilot trial for ignition, switch the flame safety to TEST mode. The flame signal should read zero. During the pilot trial for ignition with spark only, the flame relay should not pull in (i.e. energize).

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

#### **OIL FIRED:**

Shut off the manual oil valve and manual pilot gas valve.

Start the burner and allow to run through prepurge. When the burner gets to pilot trial for ignition, switch the flame safety to TEST mode. The flame signal should read zero. During the pilot trial for ignition with spark only, the flame relay should not pull in (i.e. energize).

#### **Warning**

If the flame signal is strong enough (greater than zero) when doing the spark pickup test the burner should not be operated. Call Cleaver-Brooks service representative for service advice. Failure to follow this warning could result in serious personal injury or death.

## 6. Gas Pilot Flame Adjustment

The gas pilot flame is regulated by adjusting the pressure setting of the gas pilot regulator. Normal setting is 18" to 20" inches of water column, when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame. To adjust pilot gas pressure, unscrew regulator cap and turn the adjusting screw in or out.

Although it is possible to visibly adjust the size of the pilot flame, it is preferable to obtain a proper DC volt or micro amp 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.

The flame safeguard systems equipped with a message display will show the pilot flame signal strength. For the Honeywell control, the flame relay will pull-in with a flame signal above 1.25, and drop out with a flame signal below that value. Normal should be 3 to 5. For the Fireye control, 10 is the minimum signal value, with the normal signal strength at a value of 20 or higher.

## 7. Pilot Turn Down Test

Make sure the MANUAL-AUTO switch is on MANUAL, and the MODULATING potentiometer is on the CLOSE position to keep the burner in the low fire position. Open the control panel to have access to the flame safeguard.

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

- Turn the burner switch on. This will start the blower motor and initiate the pre-purge sequence. Make sure a pressure gauge or manometer is installed in the pilot line to monitor the gas pressure.

#### **Notice**

Once all areas check out and are properly aligned, proceed to the next section. Do not continue if the listed areas have not been reviewed for accuracy.

#### **Notice**

Refer to the flame safeguard control manual for instructions.

- When the pilot comes on, put the flame safety into test mode.
- Check the flame signal strength. Adjust the flame signal by increasing or decreasing pilot gas pressure with the regulator. Normal setting is 18 inches of water column to 20 inches water column.
- Perform a pilot turn down test by reducing the pilot pressure very slowly until the flame signal falls below the minimum required to hold in the flame detector relay. Note the gas pilot line pressure at this point, and adjust the gas pilot regulator for a slightly higher pressure. Test again for maintained flame signal with the programmer switch in the test position. If the flame signal is maintained, put the programmer switch in the run position and test for reliable main flame ignition. If main flame ignition is not reliable at this pilot gas setting, pilot gas pressure and pilot flame size must be increased.
- After adjusting the pilot gas pressure back to normal level, and with the programmer switch in the “Run” position, allow the programmer to sequence through to main flame. Main flame will come on and the burner will run at the low fire rate.
- Start and stop the burner several time to ensure proper pilot setting and reliable light off.

**Note:** If installing the burner on a new boiler, consult the boiler manual for appropriate initial startup procedures. It is advisable in most cases to conduct a boilout before placing a new boiler into service.

**Notice**

**For combination burners oil combustion must be set up before gas combustion.**

### C. Burner Commissioning

Access to all burner commissioning functions is provided through the HAWK ICS controls.

To access the commissioning settings, choose <Start Up> from the Screen Select Menu.

The following screen will appear:



**Figure 4-10 HAWK ICS Screen Select Menu**

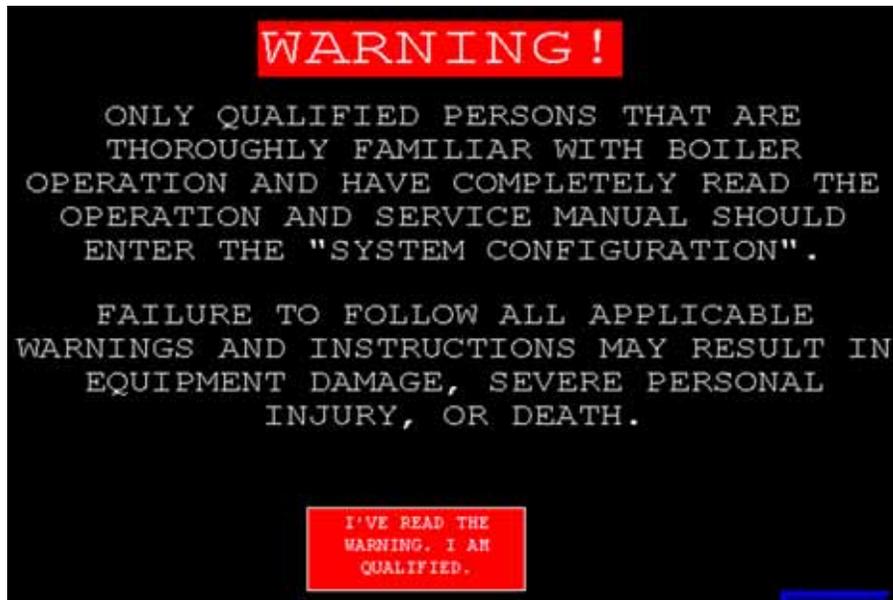


Figure 4-11 Warning Screen

Read the warning message and acknowledge it by pressing <I'VE READ THE WARNING, I AM QUALIFIED> button.

**Enter password "5463".**

The following screen will appear:



Figure 4-12 Warning Screen

Press <Combustion Set Up> button.

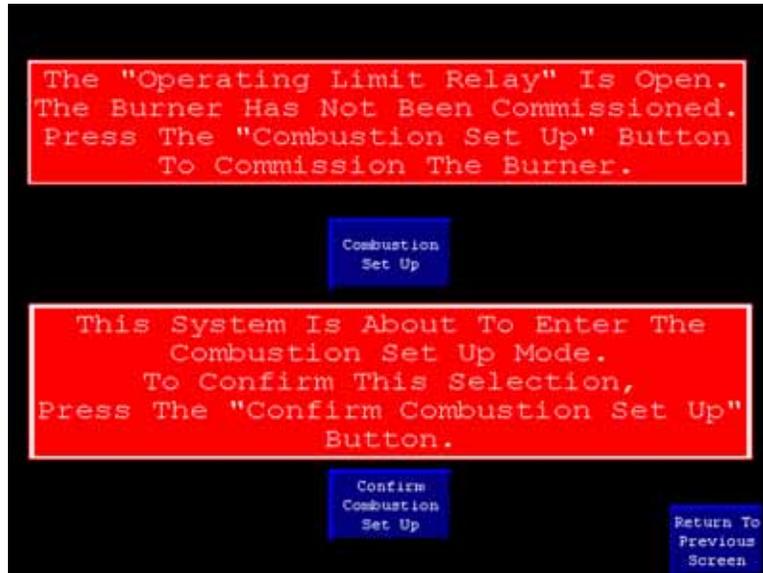


Figure 4-13 Warning Screen

Press the <Confirm Combustion Set Up> push button to choose the Actuator Selection screen.



Figure 4-14 Actuator Selection Screen

Note: If the FGR option is not selected, the FGR actuator will not be displayed.

In order to proceed with the combustion set up, the actuators must be commissioned.

Note: For a single fuel unit or if a second fuel is not used at this time, the second fuel actuator can be left unconfigured (color red).

## 1. Setting Actuator Stroke

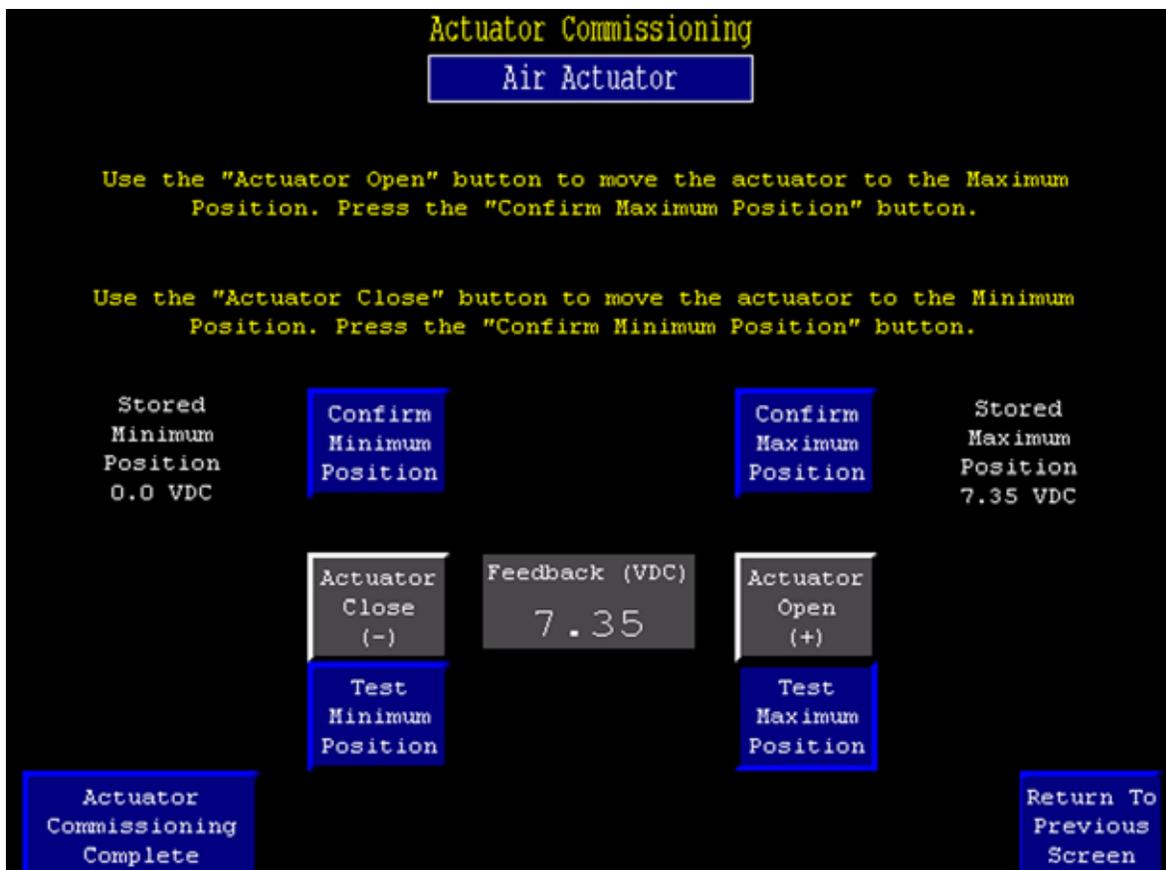
Actuator travel has been factory pre-set to 90° rotation. It is recommended not to change the end switches setting. For a detailed procedure on how to stroke the actuator, refer to the HAWK ICS Parallel Positioning manual (#750-217).

The wiring has been set up such that the direction for open travel is counter-clockwise as viewed from the potentiometer end. If this rotation is not correct, you can swap the wires on 2 & 3 and 5 & 7 to change the direction of travel.

Make sure that all output shafts couplings and setscrews are loose and that the valves can be rotated freely.

Press the "Commission Actuator" push button. Using the "Actuator Close" pushbutton move the actuator to the full close position. Close the damper (valve) and tighten couplings and set screws.

Drive the actuator to the mechanical open limits of the damper (valve). Back the actuator off a little (0.05-0.1V) and press the "Confirm Maximum Position" push button. The stored maximum position will be displayed.



**Table 4-1 Actuator Commissioning Screen (Confirm Maximum Position)**

Drive the actuator to the mechanical close limit of the damper (valve). After the actuator reaches the mechanical stop, drive the actuator up a little (0.05-0.1V) and press the "Confirm Minimum

**Position"** push button. The stored minimum position will be displayed.

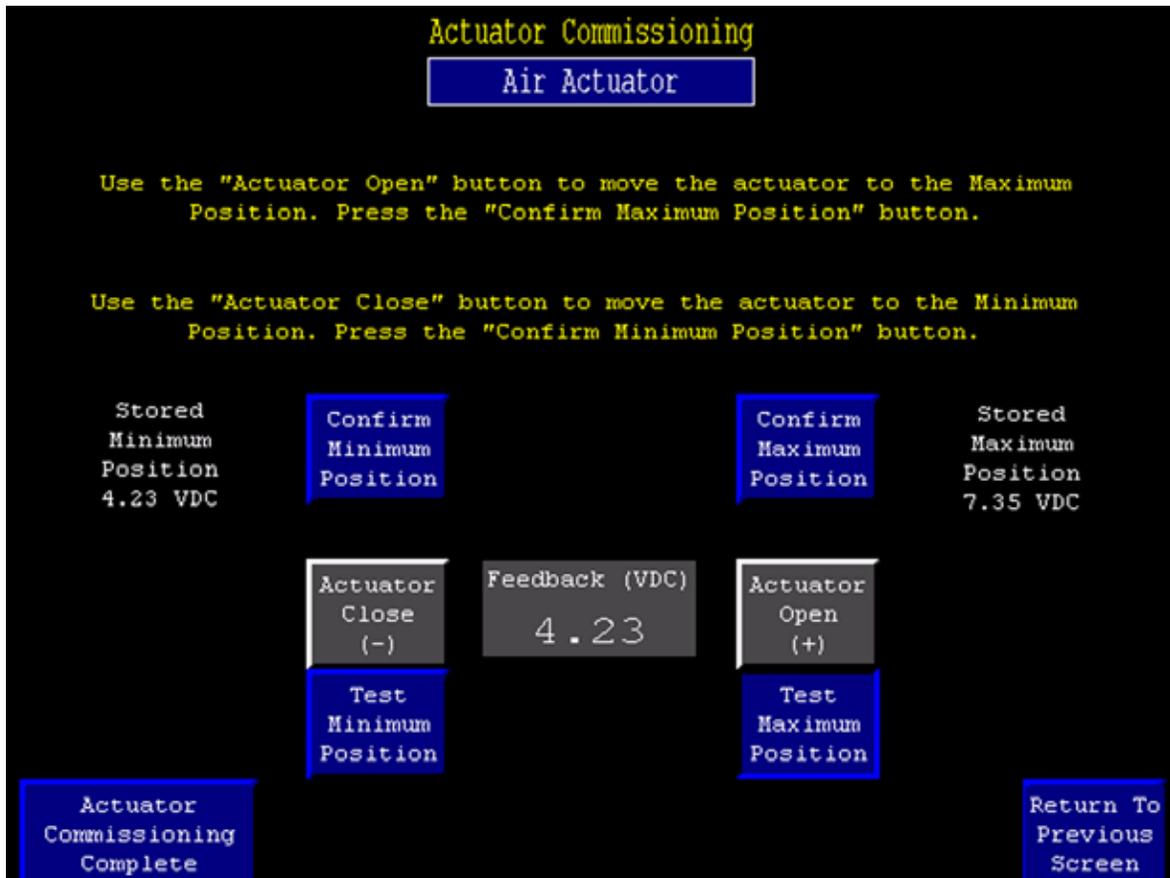


Figure 4-15 Actuator Commissioning Screen (Confirm Minimum Position)

**Note:** The recommended reading for minimum position is from 4.2 to 4.5 VDC. The recommended reading for the maximum position is from 7.2 to 7.5 VDC.

- Valid values for minimum position are as follows: Greater than 1 VDC, but at least 1VDC lower than the maximum position.
- Valid values for maximum position are as follows:  
Less than 9 VDC, but at least 1VDC greater than the minimum position.

Press **"Actuator Commissioning Complete"** push button. The display on the actuators' overview will change to **"Actuator Commissioned"**.

Repeat actuator-commissioning steps for each actuator.

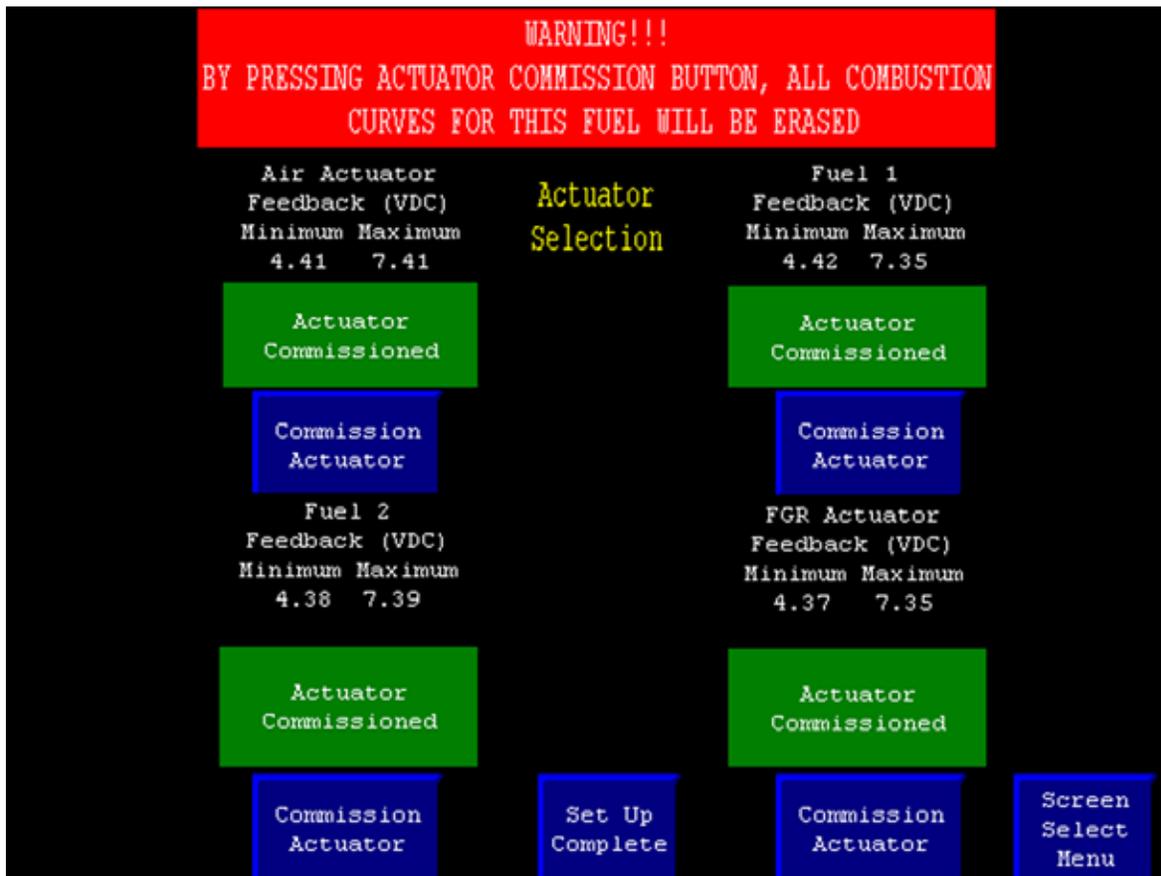


Figure 4-16 Actuators Selection Screen (Actuators Configured)

Press "Set Up Complete" push button.

Note: If "Set Up Complete" push button is not present, make sure that the fuel selector switch is in proper position (Gas or Oil).

## 2. Burner Light Off

Note: In order to more easily view flame safety messages, the flame safe guard modbus communication card can be temporarily replaced during commissioning with a regular CB780 display. Ignore "Modbus Communication Error" alarm.

Alternatively, you can toggle between the Fuel Start Up and Burner Control screens without shutting the burner off.

If commissioning mode is exited, the burner will have to be shut down and a password re-entered before commissioning can begin again.

**⚠ Important**

You can toggle between the **Fuel Start Up** and **Burner Control** screens without shutting the burner off. Accessing Burner Control via the **Screen Select** screen will require a password and burner shutdown.

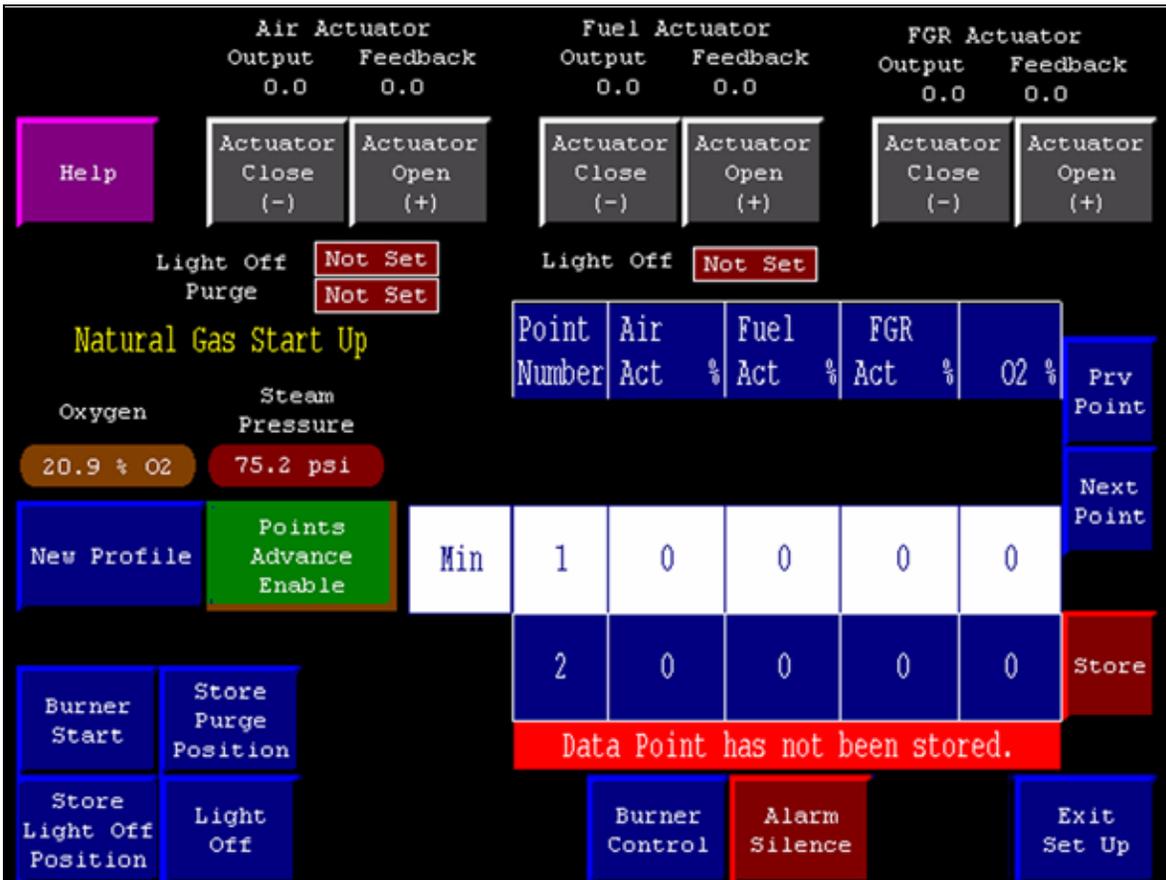


Figure 4-17 Fuel Start Up Screen

It is recommended for a new start-up to begin with a new combustion curve profile.

Press "New Profile" and select "Yes".



Figure 4-18 Confirm New Profile Screen

Note that **<Store Purge Position>** and **<Store Light Off Position>** push buttons are blinking to indicate that these values have not been set.

Open air actuator to the desired purge position and press **<Store Purge Position>** push button (purge position value can be readjusted later if necessary). Minimum limit for purge position is 50%. After purge position is set, value of purge position will be displayed and air actuator will drive closed.

 **Important**

Make sure that the air actuator is stopped at the desired purge position prior to pressing the **<Store Purge Position>** push button.

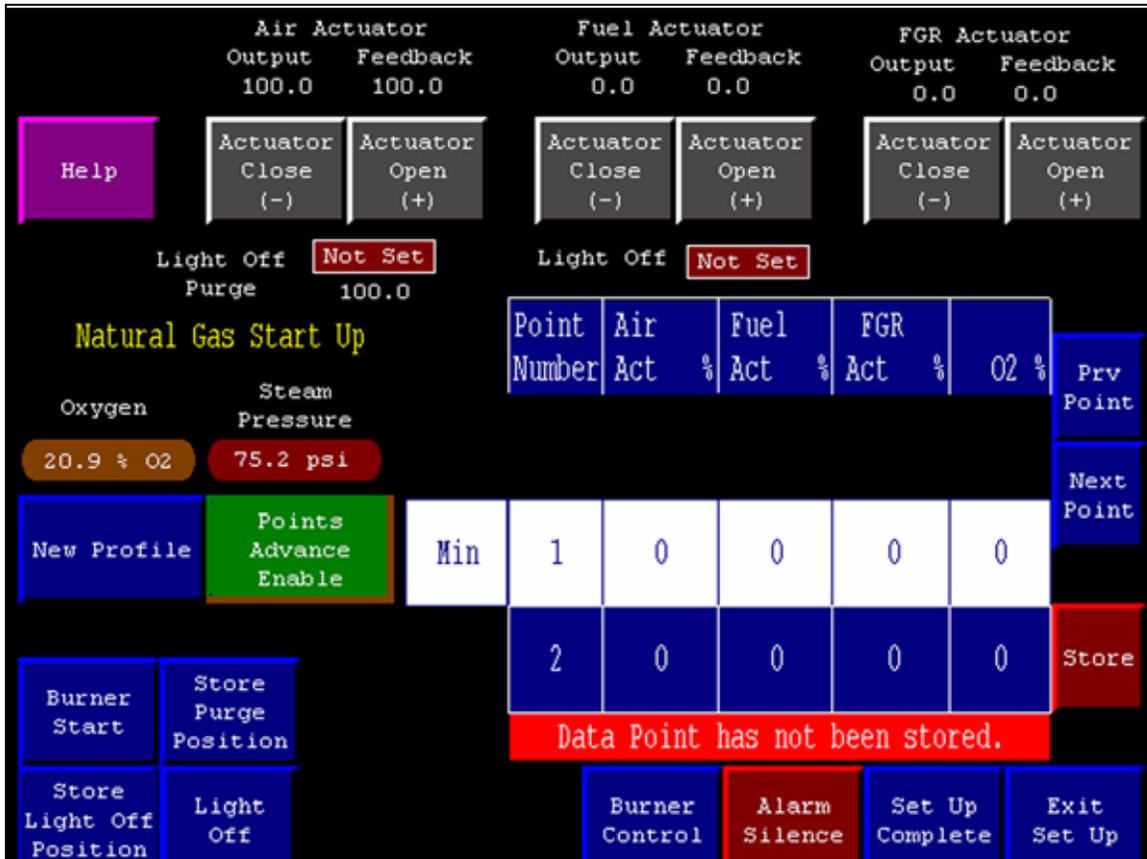


Figure 4-19 Fuel Start Up Screen (Purge Set)

Slightly open the air and fuel actuators and press the <Store Light Off Position> push button (light off position values can be readjusted later if necessary). The maximum limit for the light off position is 25% (air and fuel). After the light off position is set, the values of light off position will be displayed.

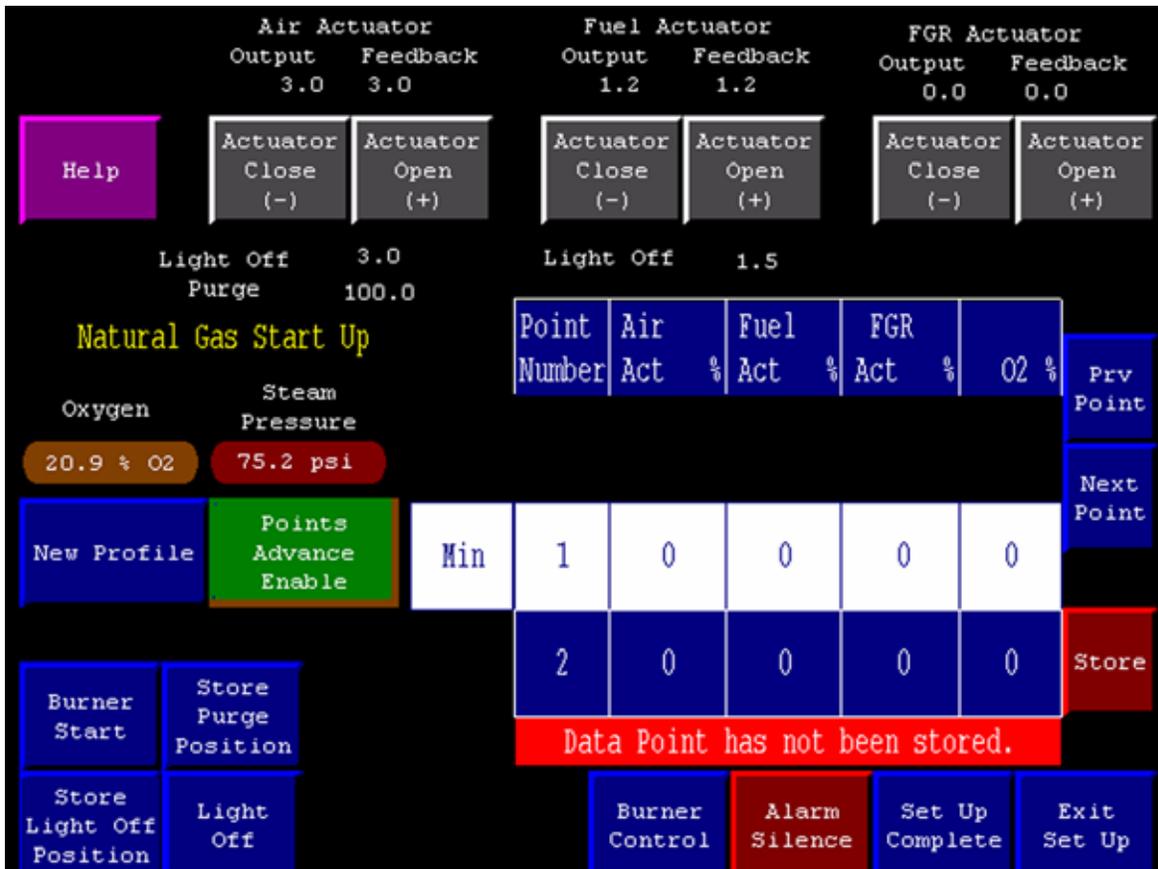


Figure 4-20 Fuel Start Up Screen (Light Off Set)

Make sure that the natural gas manual shutoff valve is closed. Turn the burner switch **<On>**.

The **<Burner Start>** pushbutton has to be blinking at the left bottom corner of the screen (if not, check the operating limits inputs 2/5 and 2/6). Press the **<Burner Start>** push button. The combustion air blower will start and the air damper will drive to the open position.



Once purge is complete, the air damper will move to the close (light off) position.



When the air damper is closed, the **<Light Off>** push button will start blinking at the bottom left corner.

Place flame relay in the "Test" mode and press **<Light Off>** pushbutton. Burner pilot will come on. If air and fuel position has to be adjusted, shut the burner down and make the necessary adjustments and press **<Store Light Off Position>** push button. Adjust air and fuel positions; if necessary, store light off position again. Stop and start burner several times to make sure that pilot is stable.

Open manual gas shut off valve and place flame relay in the "Run" mode. Main flame should come on.

Adjust flame by changing positions of the air and gas actuators. Once flame is adjusted, press <Store Light Off Position> push button.

Turn the burner "Off" and start it again. Make sure that burner lights off successfully.

### 3. Setting Combustion Curve

**Note:** Efficient combustion cannot be properly judged by flame appearance, although observing the flame 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 (CO<sub>2</sub>), oxygen (O<sub>2</sub>), and carbon monoxide (CO).

Start the burner. Once burner is started and main flame is established, screen should look like the one shown below.

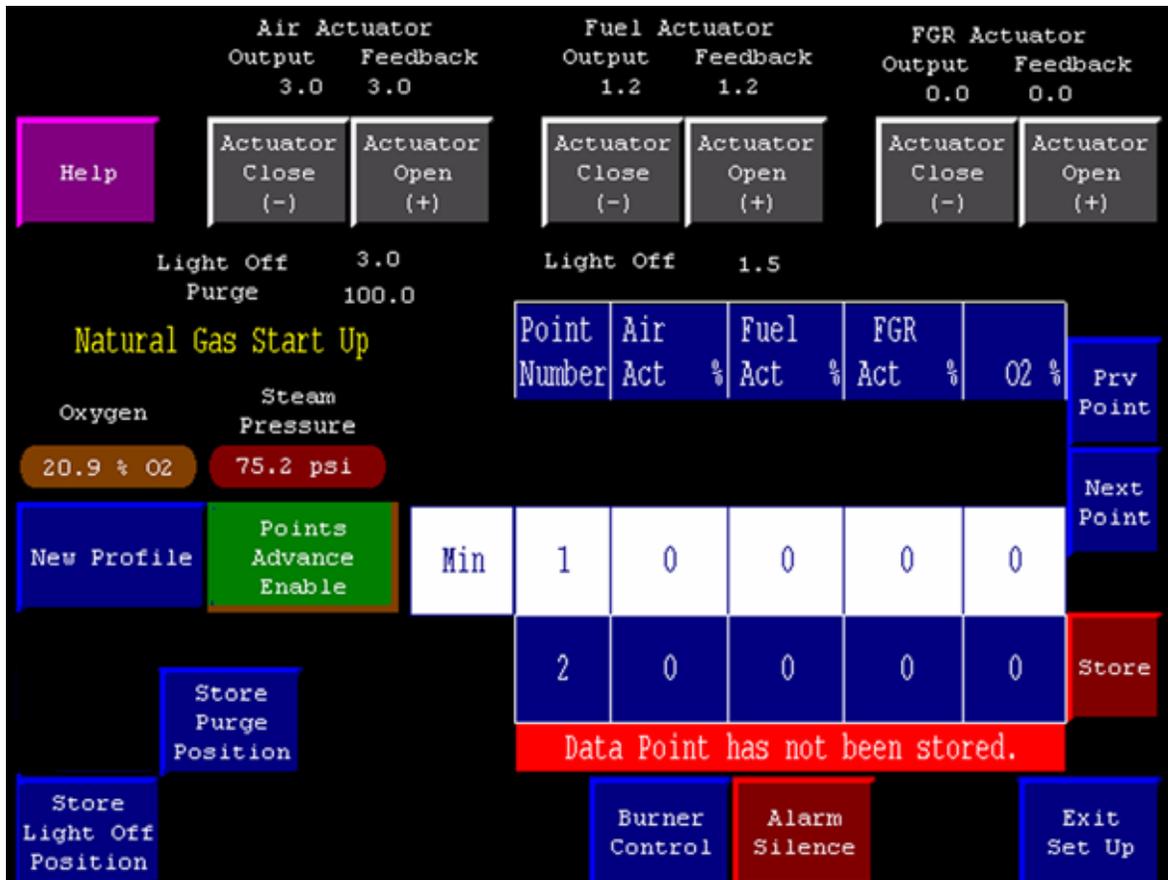


Figure 4-21 Fuel Start Up Screen (Minimum Point)

Please note that point #1 with "Min" indicator to the left is highlighted.

**Note:** The highlighted point is the active point to be adjusted.

Adjust the minimum position point by adjusting the air, fuel and FGR (if applicable) actuator positions to achieve good combustion.

When you are satisfied with the combustion reading press the "Store" push button.

 **Important**

Always use a calibrated portable flue gas analyzer to adjust combustion!

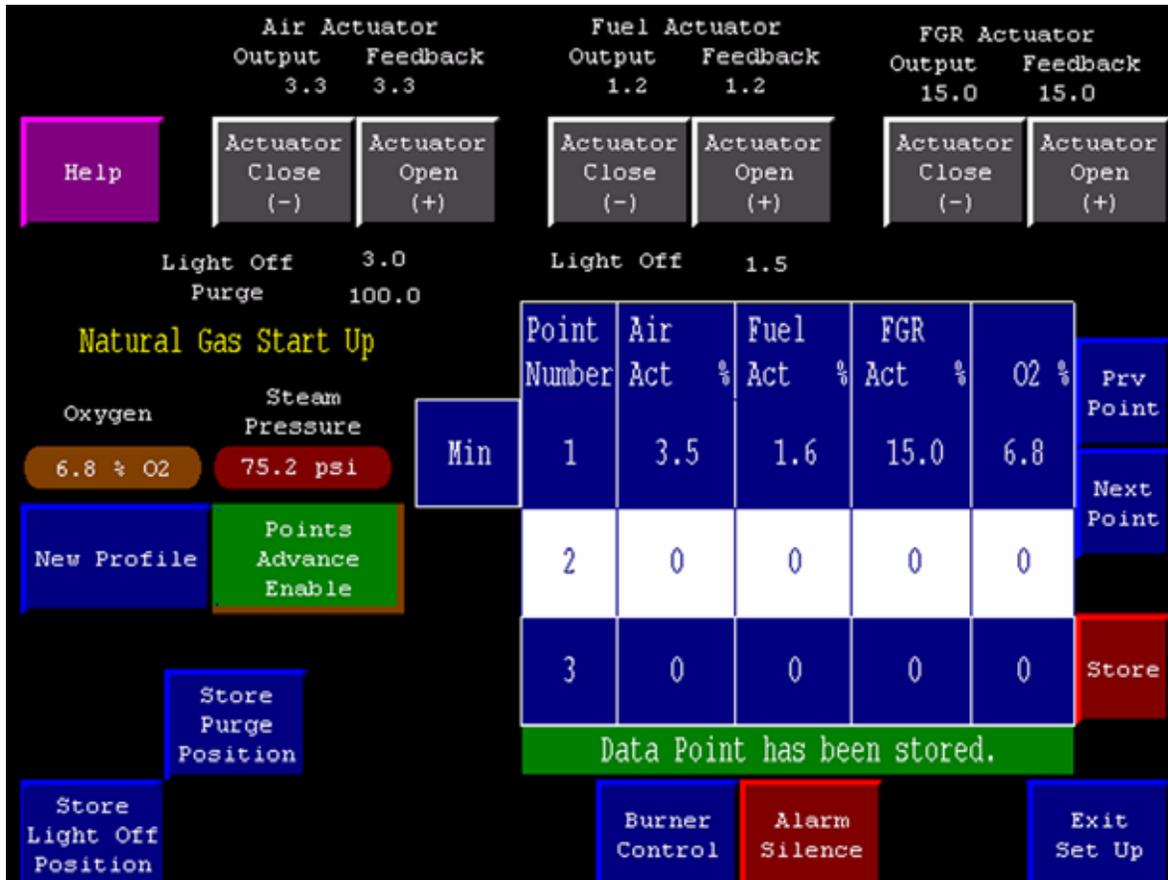
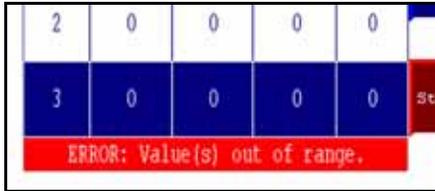


Figure 4-22 Fuel Start Up Screen (Minimum Point Set)

Note that the numbers on the highlighted Min row have changed. The text on the bottom row of the table will change (for a short period) from "Data Point has not been stored" to "Data Point has been stored" and once the <Store> button is released, number 2 row will be highlighted.

**Note:** If O2 trim or FGR are not used, the numbers in those columns will be left at 0.



Adjust combustion similar to the previous point and press the <Store> pushbutton.

If the point to be set is not within acceptable limits, the bottom row will display "Error: Value(s) out of range" message and the point will not be stored.

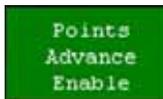
Conditions for the point to be valid are; air and fuel position values for the point to be set must be greater than a previous point and less than next point (if the next point has been set).

You can also skip a point. The values for skipped point are calculated as an average between the previous and the next point.

**Note: Only one point can be skipped at a time. If more than one point is skipped, the <Store> pushbutton will disappear.**

If <Points Advance Enable/Disable> is set to 'Disable', the actuators will remain in their current positions when the next point is selected.

Once the # 10 point is set, you should see the <Set Up Complete> pushbutton on the bottom of the screen. This means that the minimum requirements for the combustion profile curve have been met.



**Air Actuator**  
Output: 100.0    Feedback: 100.0

**Fuel Actuator**  
Output: 57.7    Feedback: 57.7

**FGR Actuator**  
Output: 66.2    Feedback: 66.2

Buttons: Help, Actuator Close (-), Actuator Open (+), Light Off, Purge, New Profile, Points Advance Enable, Store Purge Position, Store Light Off Position, Burner Control, Alarm Silence, Set Up Complete, Exit Set Up

**Natural Gas Start Up**  
Oxygen: 3.0 % O2    Steam Pressure: 75.2 psi

Point Number	Air Act %	Fuel Act %	FGR Act %	O2 %	Prv Point	Next Point	Store
10	100.0	57.7	66.2	3.0			
11	0	0	0	0			
12	0	0	0	0			

Data Point has been stored.

Figure 4-23 Fuel Start Up Screen (#10 Point is Set)

If the burner is at its maximum firing rate, the combustion profile setting can be finished at this time.

If the burner is not at maximum firing, continue setting points. A maximum of 20 points can be set.

Once the maximum firing rate is set, it is recommended to confirm the combustion set up by moving from point to point using **<Prv Point>** pushbutton. Once the previous point is highlighted, the actuator will move to the position set for this point. If adjustments have to be made to the point, do it by using the **<Actuator Open>** and **<Actuator Close>** pushbuttons and then confirm the setting by pressing **<Store>**.

When you are satisfied with the combustion curve profile, press **<Set Up Complete>**.



Figure 4-24 Confirm Set Up Message

Confirm profile by selecting "Yes".

The screen will change to the Tuning display.

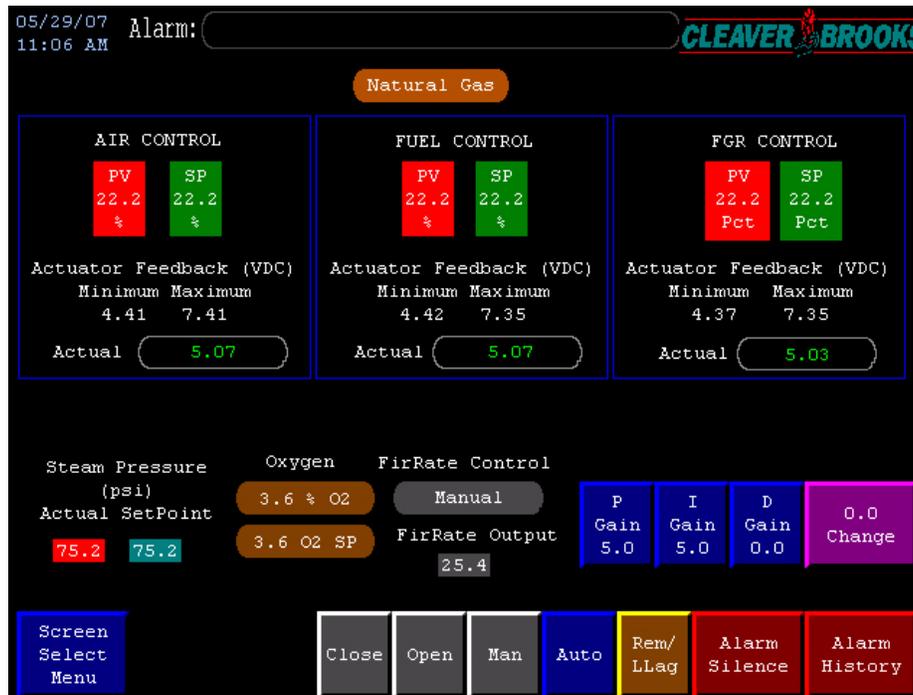


Figure 4-25 Tuning Screen.

There are three sets of indicators, showing set points (SP) and actual positions of the actuators (PV). These values are in % of actuator travel.

There is a feedback signal indication for each actuator in VDC. Note that the minimum and maximum values that were set during the actuators' commissioning are also displayed.

Steam pressure and set point are displayed.

If the unit is supplied with an O2 analyzer and trim, the actual O2 and O2 trim set points are displayed.

Firing rate mode can be changed using <Man>, <Auto> or <Rem/Llag> push buttons. When the firing rate control is in manual mode, the firing rate can be changed using <Close> and <Open>.

The firing rate control response to the load changes can be adjusted using the <P Gain> (Proportional Gain), <I Gain> (Integral Gain) and <D Gain> (Derivative Gain) pushbuttons.

Increasing proportional and integral gain values will make the control respond faster to the load changes and vice versa. Derivative gain normally is kept at 0.

## D. Gas Pressure Check

The NT firing heads have two separate gas manifolds (Lance Gas and Center Gas) with a separate butterfly valve for each manifold. The fuel pressure in each manifold should be near equal throughout the firing range.

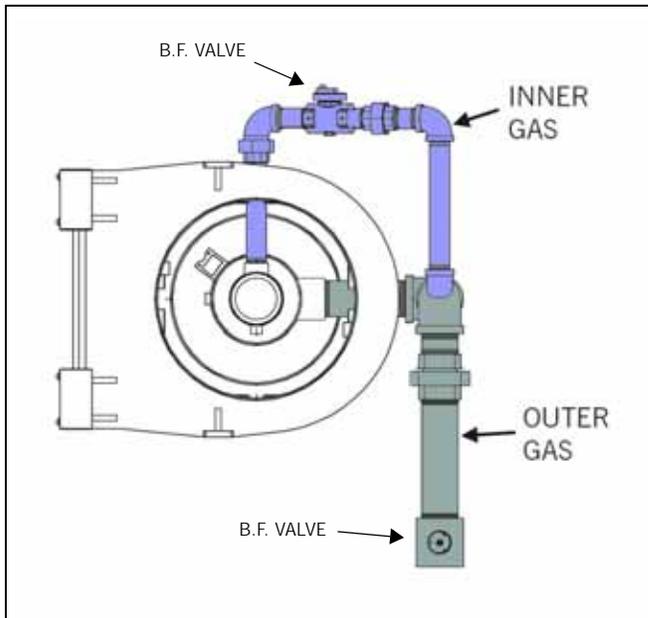


Figure 4-27 Inner and Outer Gas Manifolds

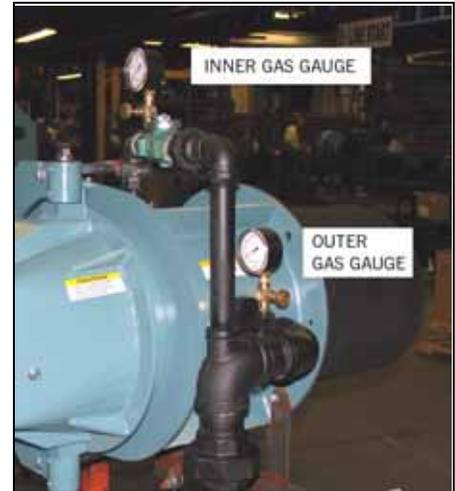


Figure 4-26 Inner and Outer Gas Manifold Pressure Gauges

At the low fire operating position recheck low fire gas pressures and fuel input. Manually modulate the burner from low fire to high fire verifying combustion and smooth burner operation.

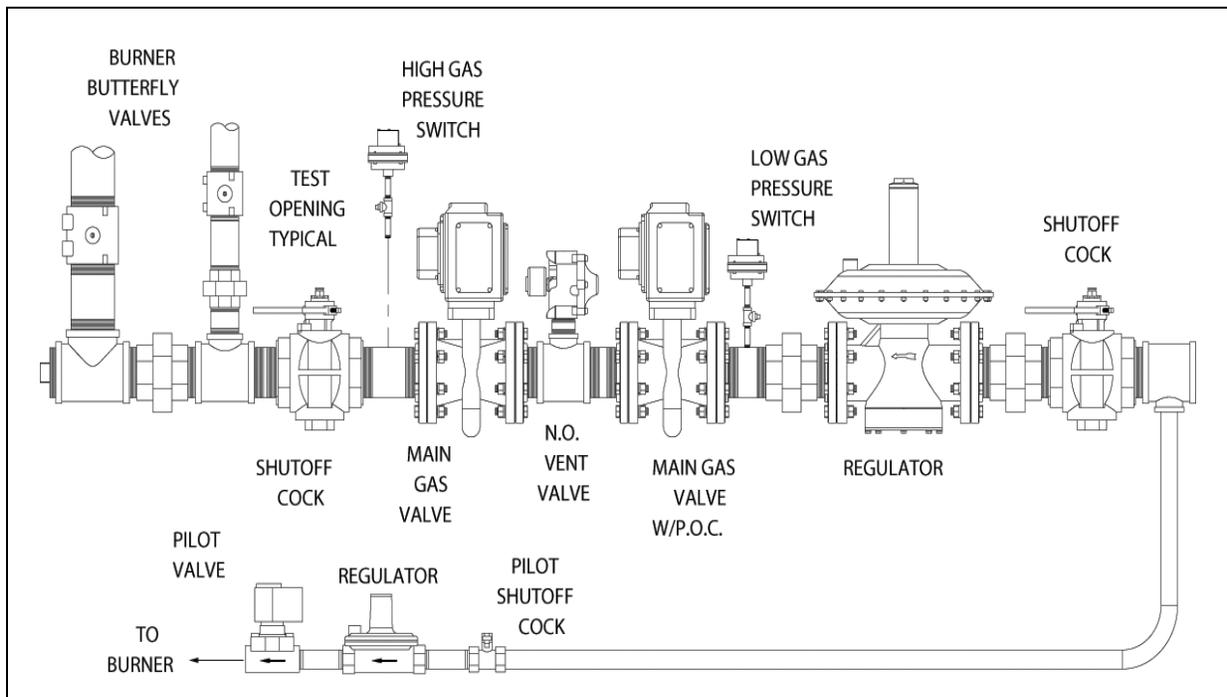


Figure 4-28 Gas Train

At this time the high and low gas pressure switches can be set using the following procedure:

#### **Low Gas Pressure Switch**

Turn adjusting screw until indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this set point. The control should be finally adjusted to prevent operation with low gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur.

The switch must be manually reset after tripping. To reset, allow gas pressure to rise and press the manual reset button.

#### **High Gas Pressure Switch**

Turn adjusting screw until indicator moves to a pressure setting slightly above the maximum operating gas pressure. The control will break a circuit if pressure exceeds this value. The control should be adjusted to prevent operation with excessive gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur.

This switch must be manually reset after tripping. To reset, allow gas pressure to drop and press the manual reset button.



**Figure 4-29 Gas Train**

### **E. Oil Pressure & Atomizing Air Check**

Before checking atomizing air supply, inspect the oil pump lube oil level. Add oil if necessary to bring the level to the mid point or slightly higher on the sight glass.

#### **Atomizing Air Pressure**

Atomizing air pressure is indicated by the pressure gauge at the oil gun. Pressure is adjusted using the regulator downstream of the compressor module or the regulator for plant air (if used). A minimum of 10 to 12 psi air pressure at low fire is suggested. As the firing rate increases, the air pressure also increases. Air pressure will be less with light oils. If any change in atomizing air pressure is made, check ignition several times for reliable light off. Adjustments should be set to obtain reliable ignition with best low and high fire combustion results.

The atomizing air and high and low oil pressure switches can be adjusted using the following procedures.

#### **Atomizing Air Proving Switch**

The knurled nut between the switch and bellows is turned in to raise the atomizing air pressure setting. The minimum atomizing air pressure is developed during pre- and post-purge. During pre-purge, adjust the atomizing air pressure proving switch until it breaks the circuit. Readjust switch above this circuit break point to actuate under a condition of minimum pressure, but not so close as to cause

nuisance shutdowns. Since the pressure of the atomizing air is at minimum when no fuel is present at the nozzle, adjustment of the switch should be made while the unit is purging, but not firing.

### High and low oil pressure switches

The high oil pressure switch is set 1-2 psig. over the maximum system pressure. The low oil pressure switch is set 1-2 psig. below the minimum system pressure.

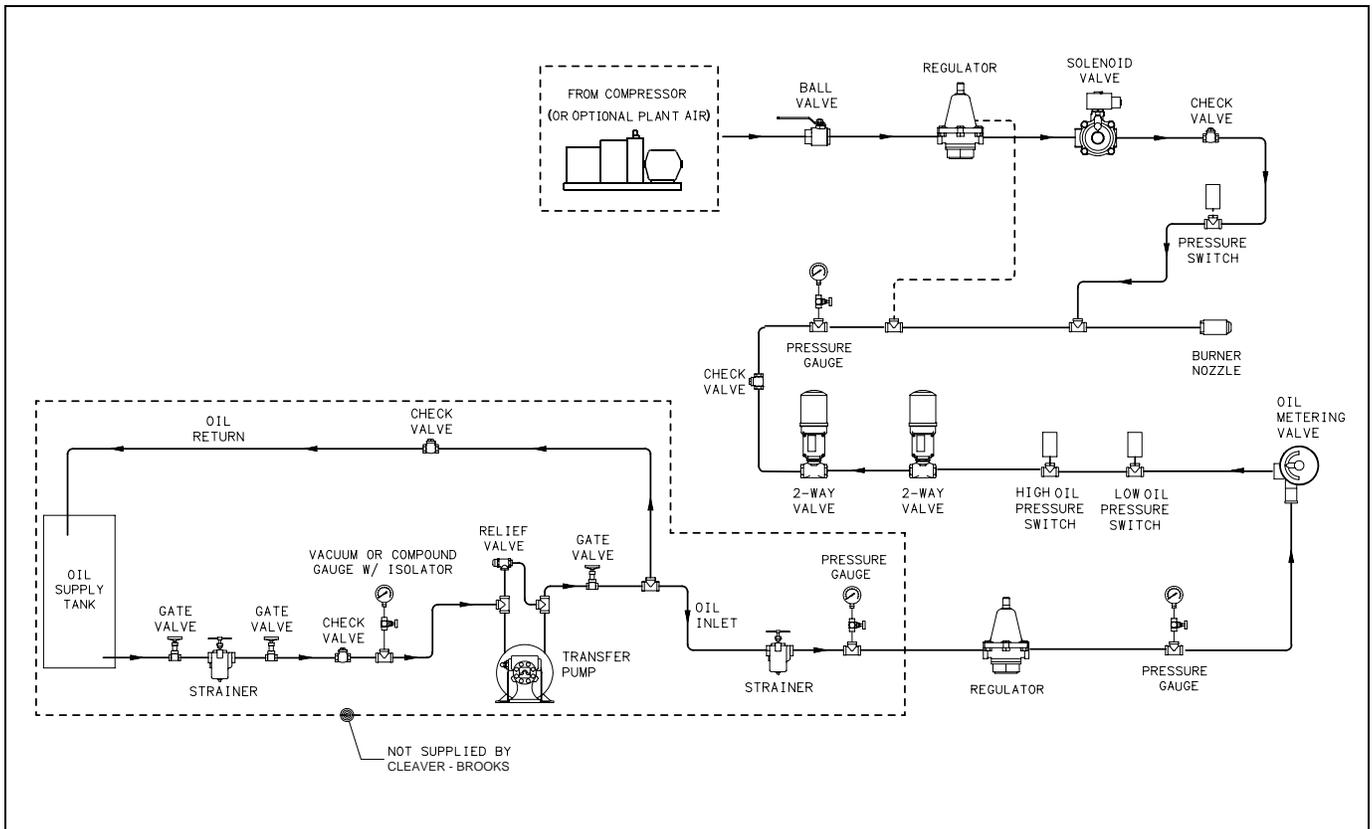


Figure 4-30 Oil System

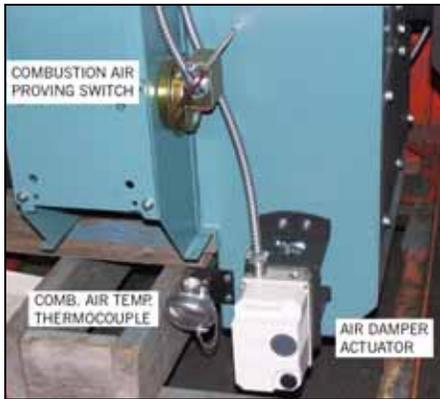


Figure 4-31 Combustion Air Controls

## F. Combustion Air Proving Switch

A Combustion Air Proving Switch (CAPS) is provided to shut the burner off if sufficient air is not provided for combustion. After the burner is set up, dial the switch setting upward and restart the burner. Set just below the point the switch breaks at low fire speed.

## G. Operating

Normal operation of the burner should be with MAN/AUTO control in the automatic position, and with the burner firing under the direction of the modulating control. The manual position is provided for initial adjustment of the burner over the entire firing range. When a shutdown occurs while operating in the manual position at other than low fire, the damper will not be in a closed position, thus allowing more air than desired to flow through the boiler. As the resulting hot flame to cool air cycling subjects the pressure vessel metal and refractory to undesirable stress conditions.

With the controls set to AUTO, the burner will operate on a modulating basis according to the load demand.

The burner will continue to operate with modulated firing until the operating limit pressure or temperature is reached, unless:

**The burner is manually turned OFF.**

**A low-water condition is detected by low-water level control.**

**The electrical or fuel supply is interrupted.**

**The combustion air pressure, fuel pressure, or atomizing air pressure drops below minimum level.**

There can be other reasons for shutdown such as motor overload, flame outages, tripped circuit breakers, blown fuses, or through other interlock devices in the circuitry.

When the burner is shut down normally, by either the operating limit control or by manually switching the burner off, the load demand light will go out.

Shutdown through conditions causing safety or interlock controls to open will actuate the flame failure light (and alarm if present) and the load demand light will remain lit. The cause of this type of shutdown will have to be located, investigated, and corrected before operation can be resumed. Refer to the troubleshooting section in Section 5.

## H. Shutdown

When the operating limit control setting is reached to open the circuit or if the burner switch is turned OFF, the following sequence occurs.

The fuel valve is de-energized and the flame is extinguished. The timer begins operation and the blower motor continues running to force air through the furnace in the post-purge period.



### Important

When adjusting a burner for NO<sub>x</sub>, a properly calibrated combustion analyzer must be used at all times.

At the end of the programmed post-purge period, the blower motor is turned off. The timer has returned to its original starting position and stops. The unit is ready to restart.



## Section 5

# Troubleshooting

Burner Does Not Start . . . . .	2
No Ignition . . . . .	3
Pilot Flame, But No Main Flame . . . . .	3
Burner Stays in Low Fire . . . . .	4
Shutdown Occurs During Firing . . . . .	4
Parallel Positioning Controls. . . . .	5



 **Warning**

Troubleshooting should be performed only by personnel who are familiar with the equipment and who have read and understand the contents of this manual. Failure to follow these instructions could result in serious personal injury or death.

 **Warning**

Disconnect and lock out the main power supply in order to avoid the hazard of electrical shock. Failure to follow these instructions could result in serious personal injury or death

This chapter assumes that the unit has been properly installed and adjusted, and that it has been running for some time. It is further assumed that the operator has become thoroughly familiar with both burner and manual by this time. The points under each heading are set down briefly as possible causes, suggestions or clues to simplify locating the source of trouble. Methods of correcting the trouble, once it has been identified, may be found elsewhere in this manual.

If the burner will not start or operate properly, this trouble-shooting chapter should be referred to for assistance in pinpointing problems that may not be readily apparent.

The control system has the capability to self-diagnose and to display a code or message that indicates the failure condition. Refer to the controls manual for specifics and suggested remedies. Knowledge of the system and its controls will make troubleshooting much easier. Costly downtime or delays can be prevented by systematic checks of actual operation against the normal sequence to determine the stage at which performance deviates from normal. Following a routine may possibly eliminate overlooking an obvious condition, often one that is relatively simple to correct.

If an obvious condition is not apparent, check the continuity of the circuits with a voltmeter or test lamp. Each circuit can be checked and the fault isolated and corrected. Most circuitry checking can be done between appropriate terminals on the terminal boards in the control cabinet or the entrance box. Refer to the schematic wiring diagram for terminal identification.

## A. Burner Does Not Start

### 1. No voltage at control panel power input terminals.

- A. Main disconnect switch open.
- B. Blown control circuit fuse.
- C. Loose or broken electrical connection.

### 2. Limit circuit not completed — no voltage at end of limit circuit program relay terminal.

- A. Pressure or temperature is above setting of operation control. (Load demand light will not glow.)
- B. Water below required level.
  - 1. Low-water light (and alarm horn) should indicate this condition.
  - 2. Check manual RESET button, if provided, on low-water control.
- C. Fuel pressure must be within settings of low pressure and high pressure switches.

### 3. Fuel valve interlock circuit not completed.

- A. Fuel valve auxiliary switch not closed.

---

## B. No Ignition

### 1. Lack of spark.

- 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.

- A. Lack of fuel — no gas pressure, closed valve, empty tank, broken line, etc.
- B. Inoperative pilot solenoid.
- C. Insufficient or no voltage at pilot ignition circuit terminal.
- D. Too much air.

### 3. Low fire switch open in low fire proving circuit.

- A. Defective switch.
- B. Damper motor not closed or damper jammed.

### 4. Running interlock circuit not completed.

- A. Combustion or atomizing air proving switches defective or not properly set.
- B. Motor starter interlock contact not closed.

### 5. Flame detector defective, sight tube obstructed, or lens dirty.

## C. Pilot Flame, but No Main Flame

### 1. Insufficient pilot flame.

### 2. Gas fired unit:

- A. Manual gas cock closed.
- B. Main gas valve inoperative.
- C. Gas pressure regulator inoperative.

### 3. Oil fired unit:

- A. Oil supply cut off by obstruction, closed valve, or loss of suction.
- B. Supply pump inoperative.
- C. No fuel.
- 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

### **D. Burner Stays in Low Fire**

1. Pressure or temperature above modulating control setting.
2. Manual-automatic switch in wrong position.
3. Defective modulating control.

### **E. 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. Lens dirty or sight tube obstructed.
5. If the programmer lockout switch has not tripped, check the limit circuit for an opened safety control.
6. If the programmer lockout switch has tripped:
  - 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 (lean fire).**

- A. Damper stuck open.
- B. Fluctuating fuel supply.
  1. Temporary obstruction in fuel line.
  2. Temporary drop in gas pressure.

### **8. Interlock device inoperative or defective.**

## F. Parallel Positioning Controls

Problem	Possible Cause	Corrective Action
"Start Up" screen selector push button is not present on Screen Select Menu	Parallel positioning control is not selected.	From "Factory Only" configuration screen. Select "Par. Pos. (Slot 10,11)" and (if applicable) "Par. Pos. (Slot 12)"
FGR actuator is not present on the "Actuator Selection" screen.	FGR option is not selected.	From "Config 1" screen. Select FGR.
Actuator does not move during commissioning of the actuator.	Wiring	Check for neutral wire on terminal (1) of the actuator. Check power on terminals VAC1 and VAC2 of the slot 10. Should be 120 VAC. If power is not present, check wiring.
Actuator rotation wrong	Wiring	Switch wires between terminals (2) and (3) on the actuator.
Feedback voltage decreases when actuator is opening.	Feedback wiring	Switch wires between terminals (5) and (7) on the actuator.
Maximum or minimum position of the actuator is not accepted during actuator commissioning.	Feedback signal is not within the limits.	Make sure that maximum and minimum positions are within acceptable limits. Minimum feedback signal is greater than 1 VDC, but at least 1 VDC less than maximum feedback. Maximum feedback signal is less than 9 VDC, but at least 1 VDC greater than minimum feedback.
With actuators configured, "Set Up Complete" pushbutton is not present on the "Actuators Selection" screen.	Fuel selector switch is not in proper position.	Check for input 10 (Gas) or 11 (Oil) on the slot 2.
"Light Off Not Set" and "Purge Not Set" are blinking, but fuel and air actuators cannot be moved.	Burner switch is "On"	Turn the burner switch "Off"
"Burner Start" pushbutton is not present on the "Combustion Set Up" screen.	Operating limits are not complete.	Following conditions must be met: Burner control alarm (Input 2:12) Off Operating Limits (Input 2:5) On External Limits (Input 2:6) On Load Demand On

<p>Blower starts and air actuator moves to the open position. Then burner shuts down with high fire switch not proven.</p>	<p>Air actuator is not in proper position for purge. Wiring</p>	<p>Make sure that air actuator's feedback position is within 5.0% of what purge position is set for. Output 13 on slot 12 should be "On" when air actuator is in purge position. If output is "On" check if high fire relay is energized. Make sure that VAC1 and VAC2 terminal on slot 10 are "hot" (120 VAC). Check if air damper binds. If all above fails, re-commission air actuator.</p>
<p>Air actuator comes back to the minimum position, but "Light Off" pushbutton does not appear.</p>	<p>Air and fuel actuators are not in proper positions.</p>	<p>Air and fuel actuators feedback position must be at least within 5.0% of the set light off position. Check for operating limits (Input 2:5 shall be On)</p>
<p>"Light Off" pushbutton does not disappear when pressed and pilot does not come on.</p>	<p>Wiring</p>	<p>Check for low fire relay output (Output 12 slot10). Low fire relay should be energized. Make sure that VAC1 and VAC2 terminal on slot 10 are "hot" (120 VAC).</p>
<p>Burner lights, but "Store" pushbutton is not present</p>	<p>Wiring</p>	<p>Inputs 2 and 7 on the module 2 must be "On".</p>
<p>"Store" pushbutton disappeared.</p>	<p>Set up sequence</p>	<p>No more then one point can be skipped without storing.</p>
<p>Burner has O2 trim control, but all points for O2 on the set up table are filled with zeros.</p>	<p>O2 trim option is not selected.</p>	<p>Select O2 trim option from "Config. 1" screen.</p>
<p>"Error Value Out of Range" is displayed when trying to set combustion curve point</p>	<p>1. Air and fuel position values shall be greater than the previous point and lower than the next point. 2. O2 value is lower than 1% or the O2 trim option is selected by mistake.</p>	<p>1. Readjust combustion curve point 2. Make adjustments to correct O2 value or de-select O2 trim if it is wrongly selected.</p>

With the burner switch "On", message comes up "Fuel Commission Is Not Complete" and burner does not start.	Fuel is not commissioned.	Go through commissioning procedure.
Blower starts and air actuator moves to the open position. Then burner shuts down with high fire switch not proven.	Air actuator is not in proper position for purge. Wiring	Make sure that air actuator's feedback position is within 5.0% of what purge position is set for. Output 13 on slot 12 should be "On" when air actuator is in purge position. If output is "On" check if high fire relay is energized. Make sure that VAC1 and VAC2 terminal on slot 10 are "hot" (120 VAC). Check if air damper binds. If all above fails, re-commission air actuator.
Pilot does not energize and flame safeguard displays alarm indicating low fire switch not proven.	Air and fuel actuators are not in proper positions. Wiring	Air and fuel actuators feedback position must be at least within 5.0% of the set light off position. Check for operating limits (Input 2:5 shall be On) Check for low fire relay output (Output 12 slot10). Low fire relay should be energized. Make sure that VAC1 and VAC2 terminal on slot 10 are "hot" (120 VAC).
Burner shuts down with "Actuator Out Of Position" alarm message	Bad actuator.	Check feedback voltage. If not within limits of actuator's configuration, replace actuator, commission it and set combustion.

 **Warning**

The cause for loss of flame or any other unusual condition should be investigated and corrected before attempting to restart. Failure to do so may result in serious personal injury or death.

 **Warning**

Do not repeat unsuccessful lighting attempts without rechecking the burner and pilot adjustments. Damage to the boiler or serious personal injury or death may result.

 **Warning**

Do not re-light the pilot or attempt to start the burner, on either oil or gas, if the combustion chamber is hot and/or if gas or oil vapor combustion gases are present in the furnace or flue gas passages, or when excess oil has accumulated. Promptly correct any condition causing leakage. Failure to follow these instructions could result in serious personal injury or death.

 **Important**

In case of emergency, shut down the burner by turning the On-Off switch to the "Off" position. Turn the fuel selector switch to the "Off" position. Shut off the main manual fuel shut off valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect the burner carefully and troubleshoot before re-starting the unit.

## Section 6

# Inspection and Maintenance

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 **Warning**

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.

## 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.

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.

## B. Electrical System

Because of the many types of flame safeguard systems applicable to this equipment, complete descriptions of burner electrical systems are beyond the scope of this manual. An individual electrical schematic drawing is shipped with each burner and complete operation and troubleshooting instructions are available from the various flame safeguard system manufacturers. Basic maintenance is provided in this chapter.

### 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.

### 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 manufacturers bulletin.

### Electric Motors

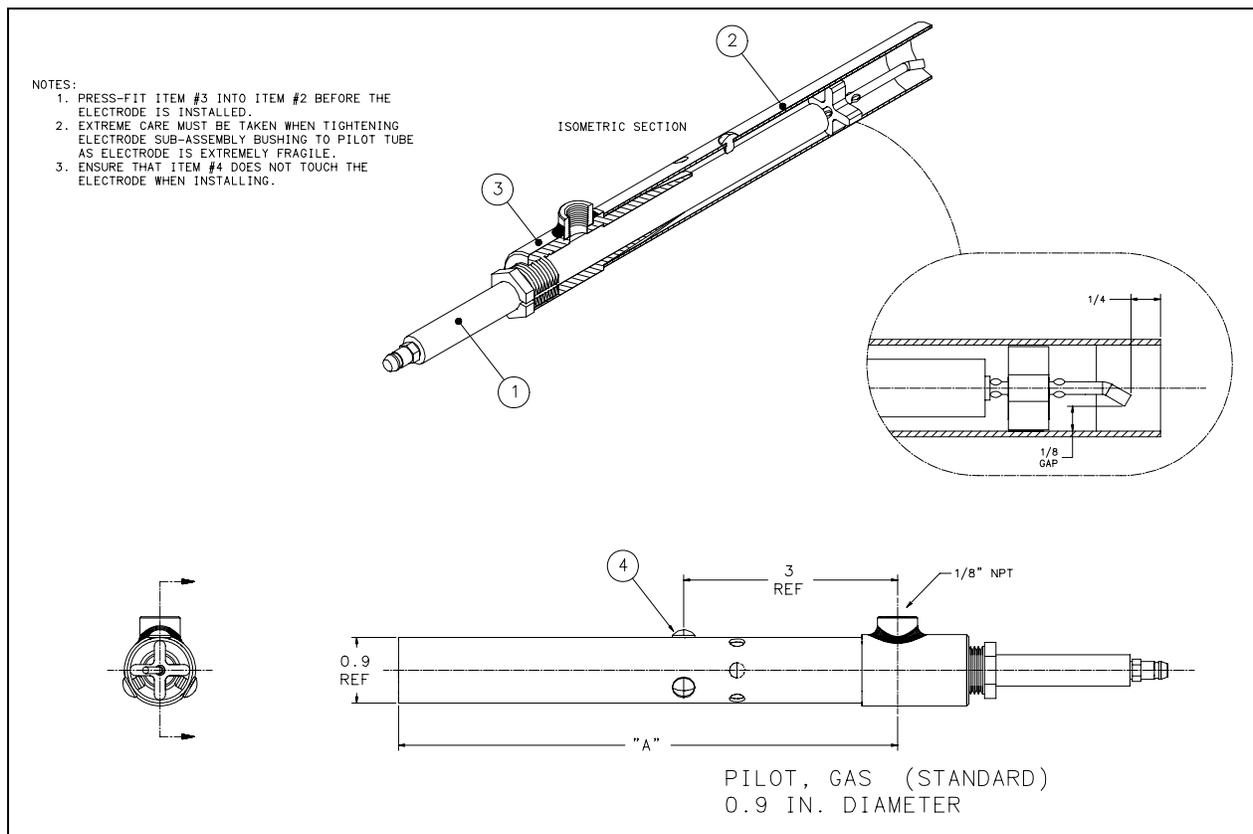
Motor supply voltage must not vary more than 10 percent from nameplate ratings. At initial start-up and at 1 year thereafter, check the motor current with a meter while the burner is in high fire position. If the reading exceeds the nameplate rating plus service

factor, determine the cause and correct it immediately. In dusty locations, clean the motor regularly to assure adequate cooling. Lubricate in accordance with the manufacturer's instructions.

## C. Checking Flame Failure

### Checking Pilot Flame Failure

Close the gas pilot shutoff cock. Also Shut off the main fuel supply. Turn the burner switch on. The pilot ignition circuit will be energized at the end of the pre-purge period. There should be an ignition spark, but no flame. Since there is no flame to be detected, the program relay will signal the condition. The ignition circuit will de-energize and the control will lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower will run through the post-purge and stop. Turn the burner switch off. Reset the safety switch. Re-open the gas pilot shutoff cock and re-establish main fuel supply.



**Figure 6-1 Electrode Setting**

ASSEMBLY NO.	DIM. "A"	ITEM	QTY.	PART NO.	DESCRIPTION
125-00001	7"	1	1	873-00125	ELECTRODE, ASSEMBLY
		2		090-00821	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
125-00002	15"	1	1	873-00126	ELECTRODE, ASSEMBLY
		2		090-00822	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.
125-00003	18"	1	1	873-00127	ELECTRODE, ASSEMBLY
		2		090-00823	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.
125-00004	21"	1	1	873-00128	ELECTRODE, ASSEMBLY
		2		090-00824	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.
125-00013	24"	1	1	873-00129	ELECTRODE, ASSEMBLY
		2		090-00859	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.
125-00017	8"	1	1	873-00130	ELECTRODE, ASSEMBLY
		2		090-01089	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.
125-00018	10"	1	1	873-00131	ELECTRODE, ASSEMBLY
		2		090-01090	TUBE, PILOT
		3		284-00081	HEAD, GAS INSPIRATING, WELDMENT
		4	3	841-00766	SCREW, #8-32 x 3/16" LG. PH.PAN HD.

### Checking Failure To Light Main Flame

Leave the gas pilot shutoff cock open. Shut off the main burner fuel supply. Turn the switch on. The pilot will light upon completion of the pre-purge period. The main fuel valves will be energized, but there should be no main flame. The fuel valves de-energize within 4 seconds after the main burner ignition trial ends. The control will lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop. Turn the burner switch off. Reset the safety switch. Re-establish main fuel supply.

## Checking Loss of Flame

With the burner in normal operation, shut off the main burner fuel supply to extinguish main flame. The fuel valves will be de-energized and the relay will signal the condition within 4 seconds. The control will then lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge period and stop. Turn the burner switch off. Reset the safety switch. Re-establish main fuel supply.

## D. Firing Head Inspection

Release the impeller housing latch and swing the housing open for access to the firing head. Inspect the flame scanner lens to be sure it is clean and the support tube is in proper position to sight the flame through the hole in the diffuser. Inspect the lead wire to the ignition electrode. It must be firmly attached and the insulation should be clean and free of cracks. The oil nozzle should be inspected periodically depending on the grade of oil burned and the cleanliness of the environment.

If fibrous material is discovered in the gas lance ports, disassemble the lance and back flush with shop air. Further inspection of connection hoses and gaskets must be made to isolate the contaminant source. Be sure when reassembling the lances to orientate the gas orifices in the correct position

## E. Pilot and Ignition Electrode

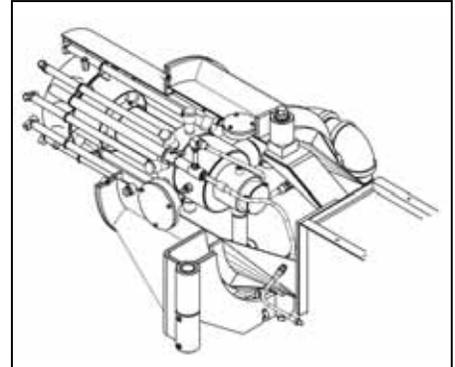
The ignition transformer requires little attention other than making sure the ignition wire is firmly attached to the transformer and the electrode. Be sure the wire insulation is in good condition and not grounded. Failure to keep the ignition electrode clean and properly set can cause faulty operation. Refer to Figure 6-3, for electrode gap setting and position. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire. To remove pilot, first shut off the pilot manual shutoff cock, and disconnect the ignition wire. Unscrew the pilot line at the pilot union, and pull the pilot out. Check electrode gap for wear and carbon buildup. Clean and adjust gap setting. Re-assemble the pilot in reverse order. Open the pilot line shutoff cock and re-adjust the pilot flame using the instructions in the "Starting, Operating and Adjustment Section" of this manual.

## F. Flame Scanner

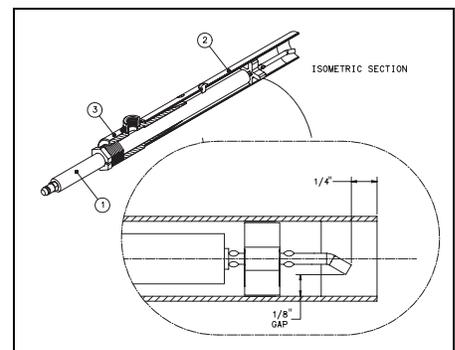
The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth.

### Caution

The housing must be supported when in the open position to prevent damage to the hinges and other components.



**Figure 6-2 NTH Firing Head**



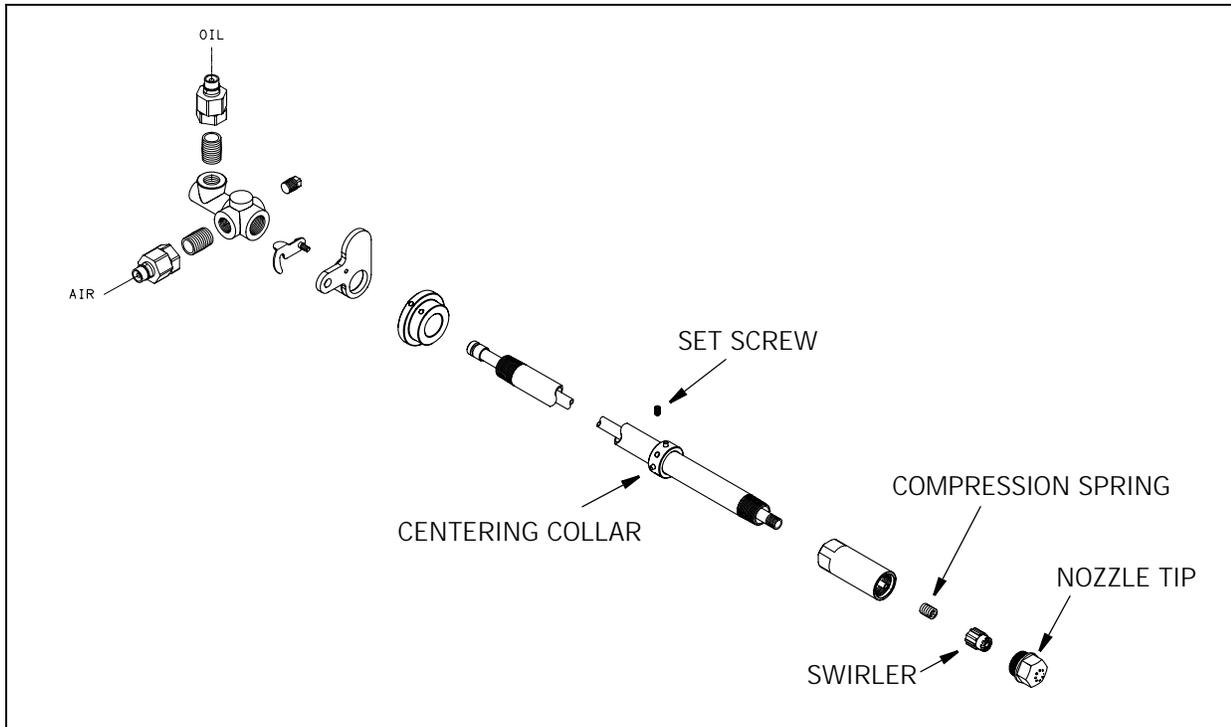
**Figure 6-3 NT Pilot**

## G. Oil Nozzles

### Important

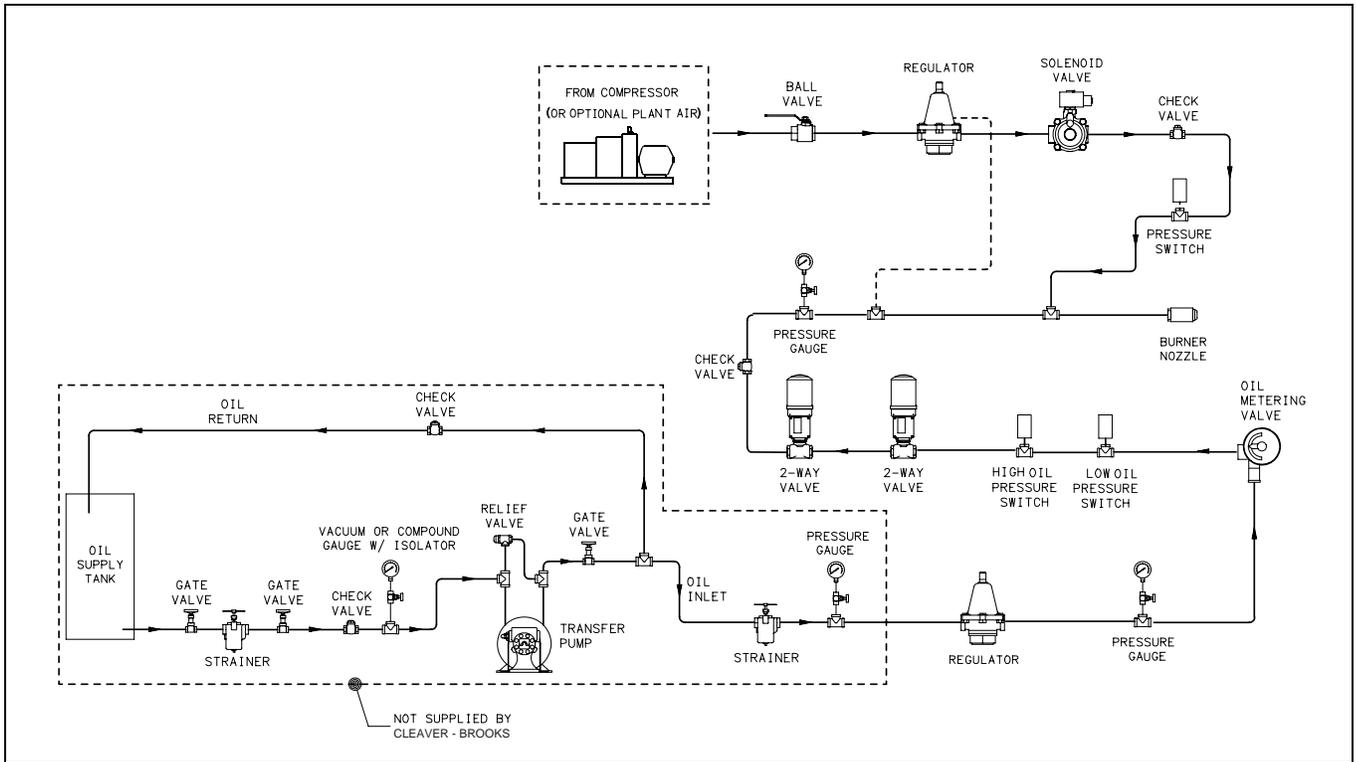
When replacing a nozzle tip and swirler assembly, make sure a new spring is installed to ensure proper fit.

Successful burner operation requires use of the proper style nozzle tip and keeping the orifices clean. Standard nozzle tips furnished on the burners are of a special emulsifying type which delivers a spray of extreme fineness and at an angle which insures proper mixing with the air stream. Unsatisfactory performance and loss of efficiency can result from the use of nonstandard nozzle tips. If the burner flame becomes stringy or lazy, or wetting on the refractory cone is noticed, it is possible that the nozzle spring is not properly in place or the nozzle is clogged.



**Figure 6-4 NTH Oil Gun Assembly**

This problem is usually indicated by an abnormally high reading on the atomizing air pressure gauge on the oil gun. To remove the nozzle, disconnect the oil and air tubes to the nozzle assembly. To clean the nozzle tip and swirler, unscrew the tip from the nozzle body. Use care not to distort the tube. Hold the nozzle body in a vise or use two wrenches, one on the body and one on the tip. Disassemble the nozzle tip. Carefully clean all parts in solvent. Use a brass brush on the nozzle tip. The orifices should be cleaned with a wood toothpick or similar device. Do not use wire or a drill to clean nozzle tip, wire or a drill can resize the orifices detrimentally effecting the flame shape. When reassembling the nozzle components be sure the notch in the nozzle tip lines up with the peg in the barrel. The nozzle can be assembled without the peg seating in the notch. In this case oil atomization will not occur. All "O" rings must be inspected and replaced if hard or distorted. When reinstalling, be sure the nozzle is centered in the blast tube.



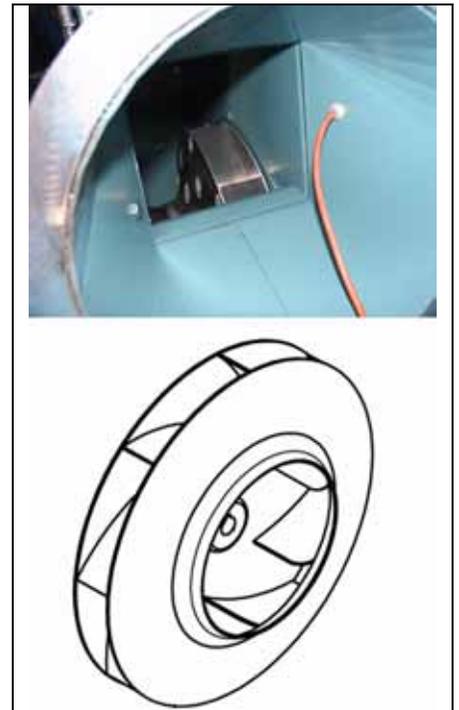
**Figure 6-5 Atomizing Air and Oil Piping**

## H. Firing Rate Controls and Air Handling system

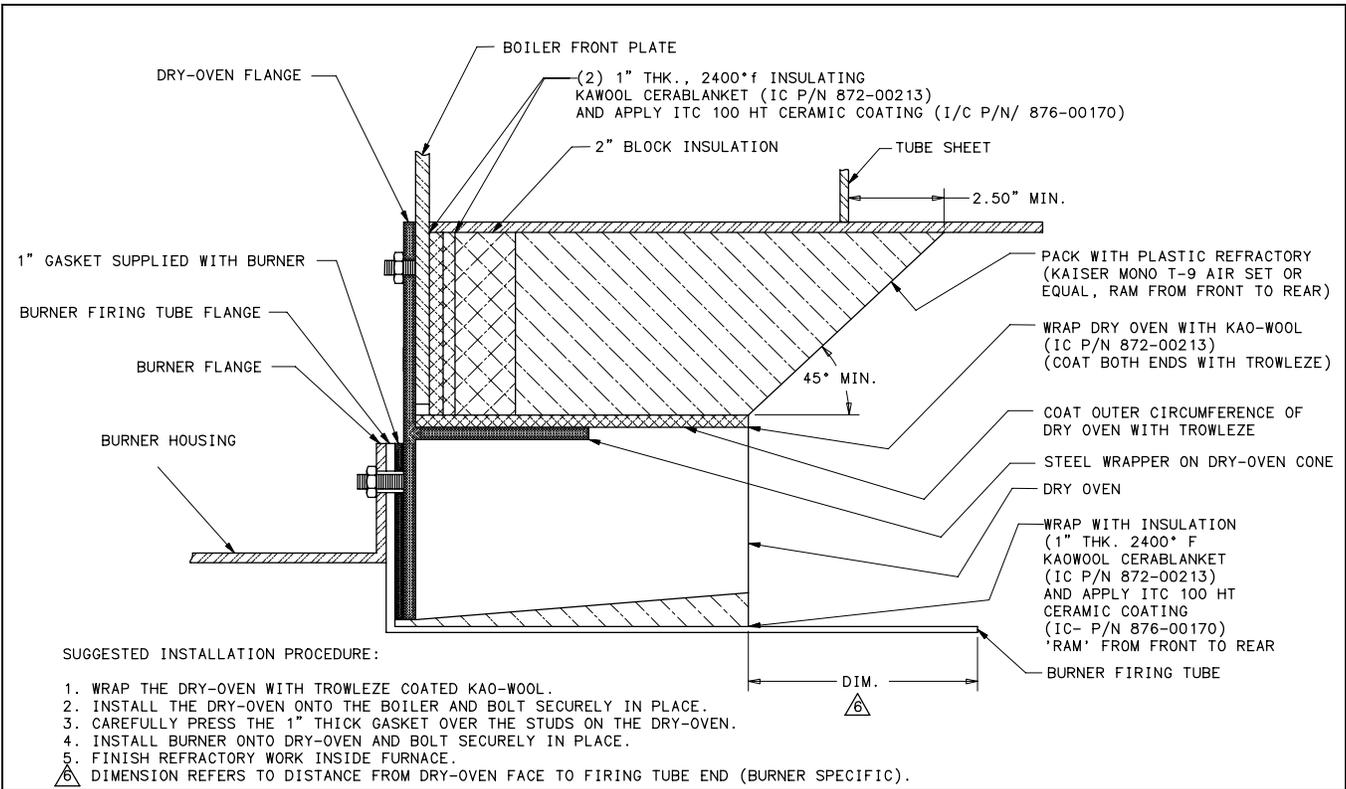
Settings for all actuators can be checked and adjusted if necessary using the HAWK ICS controls. If the actuator travel should require adjustment, refer to the Parallel Positioning manual, #750-217.

A combustion test can be performed as per the Commissioning section in this manual.

The backward inclined aluminum impeller requires minimal maintenance. Check for dirt buildup and clean the blades as necessary. Inspect the impeller hub and blades for cracks. Replace if any are noticed. When removing and installing the impeller it is mandatory to use an impact wrench to remove the lock nut. Shims are used on the motor shaft to position the impeller. Make sure the air inlet cone fits inside the impeller.



**Figure 6-6 NTH Impeller**



**Figure 6-7 Blast Tube Installation Cross Section**

## I. 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 leakage occurs, refer to Chapter 2, Figure 2-3 and 2-4 for proper sealing procedure.

## J. Oil System

Inspect the complete system for any sign of leaks. Check inlet and return oil pressures to assure they are maintained as originally set.

### Fuel Oil Circulating Pump

Failure of the circulating pump to deliver sufficient oil may be due to one of the following reasons:

1. Insufficient fuel oil in the storage tank.
2. Suction line or check valve clogged.
3. Air leaks or air traps in the suction line. If the line has a high point at which an air trap can occur, the line must be changed.
4. Oil strainer clogged (line strainer or burner strainer).
5. Suction line piping too small.
6. Pump rotating in wrong direction.
7. Three phase pump motor operating on single phase because of fuse failure.
8. Low voltage applied to pump motor.

## Air Compressor

The air compressor itself requires little maintenance; however, its life is dependent upon sufficiently clean, cool lubricating oil. The oil level in the air-oil tank must be checked regularly. Lack of oil will damage the compressor. Disassembly or field repairs to the air compressor are not recommended. Check the air-oil tank sight glass for proper oil level. The level should be kept at midpoint of the glass. The compressor rotor must turn freely. All tube connections must be airtight.

Alignment of the compressor and motor sheaves and proper belt tension are important. Belt tension is adjusted according to the displacement on the belt with thumb pressure. The displacement should be 3/8 to 1/2 inch.

To adjust, loosen the two bolts on the compressor mounting flange and the three setscrews which hold the compressor in place. The mounting flange is slotted at the top, which permits belt tightening. If the slot in the mounting flange is insufficient for obtaining proper belt tension, the modular base has two extra holes for this purpose. Move the top bolt to the next hole and adjust. Tighten bolts and set screws. Replace belt guards. If belt becomes frayed or cracked, replace it.

## Oil Strainers

Oil strainers should be cleaned frequently to maintain a free and full flow of fuel. The strainer screen must be removed and cleaned at regular intervals. The screen should be removed and cleaned thoroughly by immersing it in solvent and blowing it dry with compressed air. Light oil strainers should be cleaned each month. Heavy oil strainers should be checked and cleaned as often as the experience indicates the necessity.

## K. Gas System

### Motorized Main Gas Valves

Should the valve fail to operate, check for voltage at the valve. Make certain that the main shutoff 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 shutoff to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

### Solenoid Valves

A slight 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 body. Test for gas leaks and check

 **Caution**

All power must be disconnected before servicing the valves.

valve action several times to ensure proper operation before attempting to relight burner.

### **Gas Pressure regulators**

Check the gas pressure at the outlet of the regulator on the main and pilot lines. Check for abnormal reading and against original pressures set at initial start-up.

### **Gas Pressure Switches**

Inspect the low and high pressure switches settings and correct response to pressure variations.

## **L. 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. Remove the flame safeguard control and store in a dry atmosphere.

## **M. Recommended Inspection Schedule**

### **Daily**

Gauges, monitors, and indicators  
Instrument and equipment settings  
Check combustion visually  
Record flue gas temperature  
Record oil pressures and temperatures  
Record gas pressures  
Record atomizing air pressure  
Record flame signal strength

### **Weekly**

Check for tight closure of fuel valves  
Check fuel and air linkages, and cams  
Check indicating lights and alarm  
Check operating and limit controls  
Check safety and interlock controls  
Check for leaks, noise, vibration, unusual conditions, etc.  
Check ignition system  
Check oil pump and burner strainers, filters. Clean as required



### **Important**

Refer to the boiler operation and maintenance manual for boiler inspection schedule. The boiler controls, low water cut off, blow down, and feed water system, require periodic maintenance. Insurance regulations and local laws require periodic inspection of the pressure vessel by an authorized inspector.

**Monthly**

- Inspect burner system
- Inspect for flue gas leak
- Inspect for hot spots
- Check cams and lube with WD-40
- Analyze combustion
- Inspect oil and gas systems for leaks
- Inspect refractory
- Check nozzle and diffuser, clean as required

**Semi-Annually**

- Clean oil pump strainer, filter
- Clean compressor air cleaner, oil filter, and air-oil separator
- Check air pump coupling alignment, and belt tension
- Remove and clean nozzle line oil heater
- Inspect burner components
- Check combustion, and adjust if required

**Annually**

- Clean boiler
- Clean breeching
- Check operation of safety and relief valves
- Check and adjust all limit controls, and safety interlocks
- Check all vent lines
- Check nozzle, swirler, and spring for wear, replace as required
- Check all fuel valves
- Clean strainers and filters
- Clean compressor assembly
- Adjust burner and controls with a complete combustion test



## Section 7 Parts

### NTH Size 3

Drawer Assembly	7-2
Gas Piping	7-3
Oil Piping	7-4
Oil Valves	7-5
Oil Gun 1	7-6
Oil Gun 2	7-7
Air Handling Assembly	7-8

### NTH Size 4

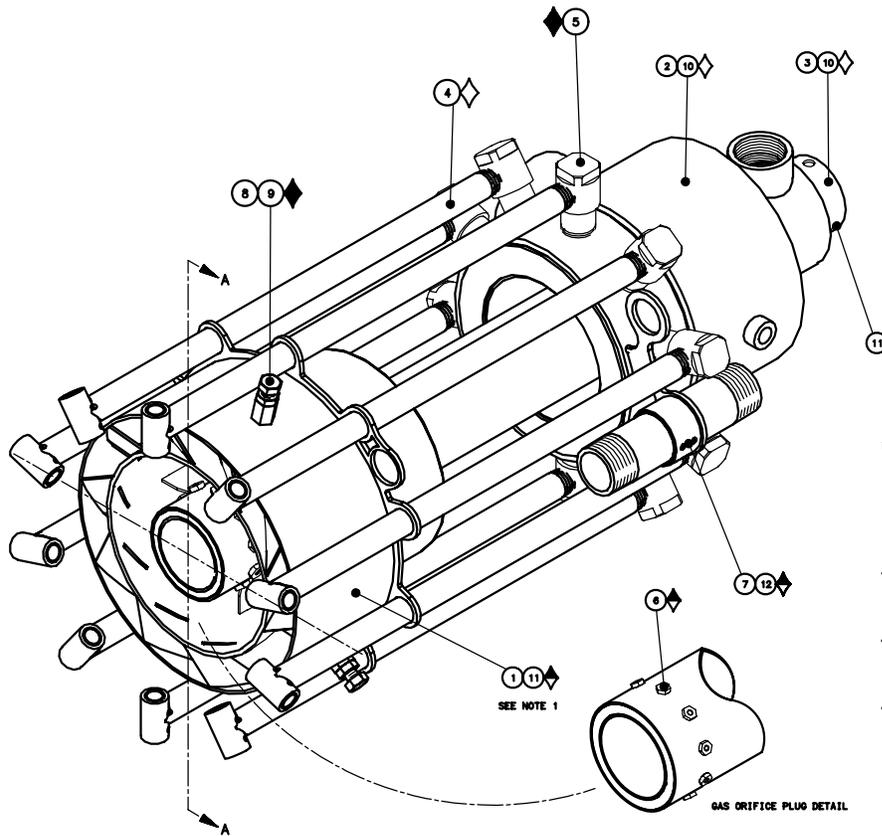
Drawer Assembly	7-9
Gas Piping	7-10
Oil Piping	7-11
Oil Valves	7-12
Oil Gun 1	7-13
Oil Gun 2	7-14
Air Handling Assembly	7-15

### Parallel Positioning Assemblies

Gas Butterfly Valve with Actuator	7-16
Oil Valve Actuator	7-17
Rotary Air Damper Box w/Actuator	7-18
FGR Actuator Assembly	7-19

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NTH SIZE 3



NOTE #1:  
UPON APPLYING THREADLOCKER TO EACH SETSCREW, TIGHTEN SETSCREWS UNTIL CONTACT IS MADE WITH ITEM #3 (INSIDE OF GROOVE). BACK EACH SETSCREW OUT 1/4 TURN. THIS WILL ENSURE ROTATIONAL ADJUSTMENT, BUT LIMIT LINEAR MOVEMENT.

◆ APPLY A UNIFORM COATING OF ANTI-SEIZE I.C. P/N #878-00158 TO DESIGNATED THREADED CONNECTIONS.

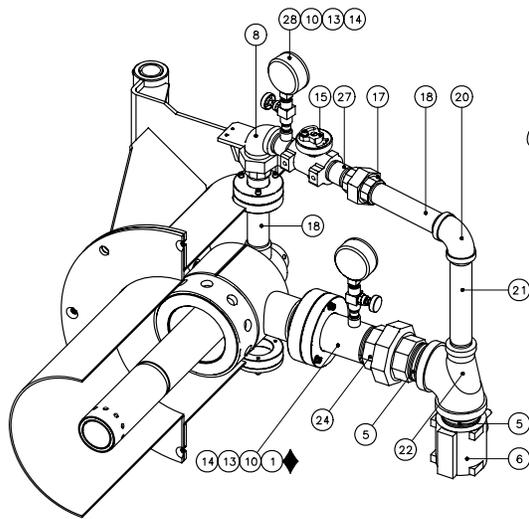
◆ APPLY A UNIFORM COATING OF THREADLOCKER I.C. P/N #878-00148 TO DESIGNATED COMPONENTS.

◆ APPLY A UNIFORM COATING OF SEALANT/THREADLOCKER I.C. P/N #878-00157 TO DESIGNATED THREADED CONNECTIONS.

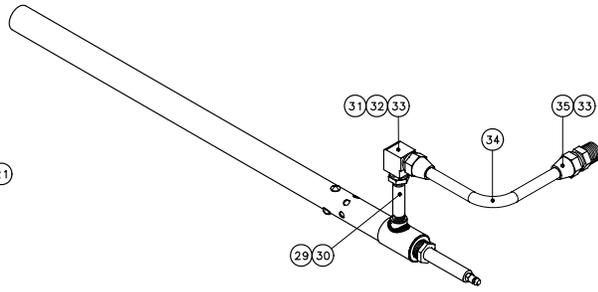
ITEM	QTY.	PART NO.	DESCRIPTION
1	1	GENERIC	SWIRLER WELDMENT, AIR
2	1	GENERIC	MANIFOLD WELDMENT, OUTER GAS
3	1	GENERIC	MANIFOLD WELDMENT, STABILIZER GAS
4	12	GENERIC	NOZZLE, GAS
5	12	GENERIC	COUPLING, NOZZLE, GAS
6	12	GENERIC	PLUG, ORIFICE, GAS
7	1	857-00181	NIPPLE, 1" x 5" LG.
8	3	868-00104	CAPSCREW, 5/16-18 UNC x 1" LG. HEX HD.
9	3	869-00216	NUT, JAM, 5/16-18 UNC (S.S.)
10	2	858-00380	PLUG, PIPE, 1/4" NPT (S.S.)
11	5	860-00026A	SETSCREW, #10-32 UNF x 3/8" LG. KNURLED POINT
12	2	860-00302	SETSCREW, #10-32 x 1/8" LG.

BURNER MODEL	DRAWER ASSY.
NTH 040	581-00017
NTH 045	581-00017
NTH 050	581-00018
NTH 052	581-00019
NTH 057	581-00018
NTH 060	581-00020
NTH 063	581-00021
NTH 070	581-00020

Figure 7-1 Drawer Assembly



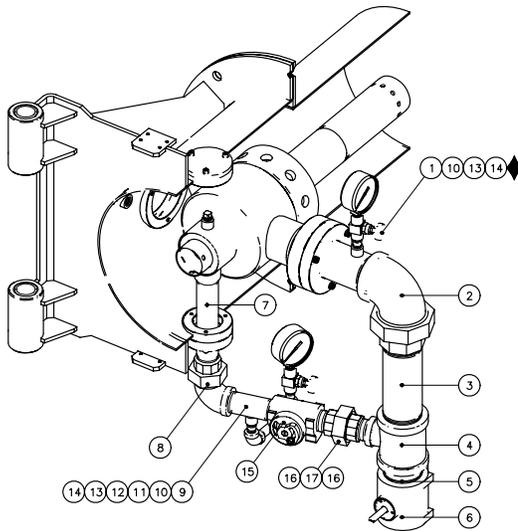
INVERTED APP'S.  
GAS PIPING W/STABILIZER GAS  
(TOP ENTRY)



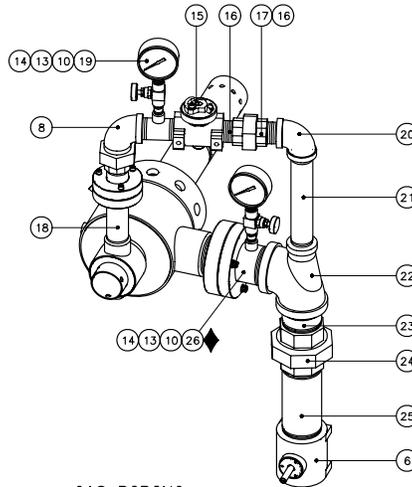
GAS PILOT PIPING DETAIL

◆ APPLY A UNIFORM COATING OF ANTI-SEIZE  
I.C. P/N #876-00158 TO DESIGNATED THREADED  
CONNECTIONS.

APPLY A UNIFORM COATING OF THREAD COMPOUND  
I.C. P/N #919-00140 TO ALL THREADED  
CONNECTIONS, EXCEPT WHERE NOTED OTHERWISE.



GAS PIPING  
W/STABILIZER GAS  
(BOTTOM ENTRY)

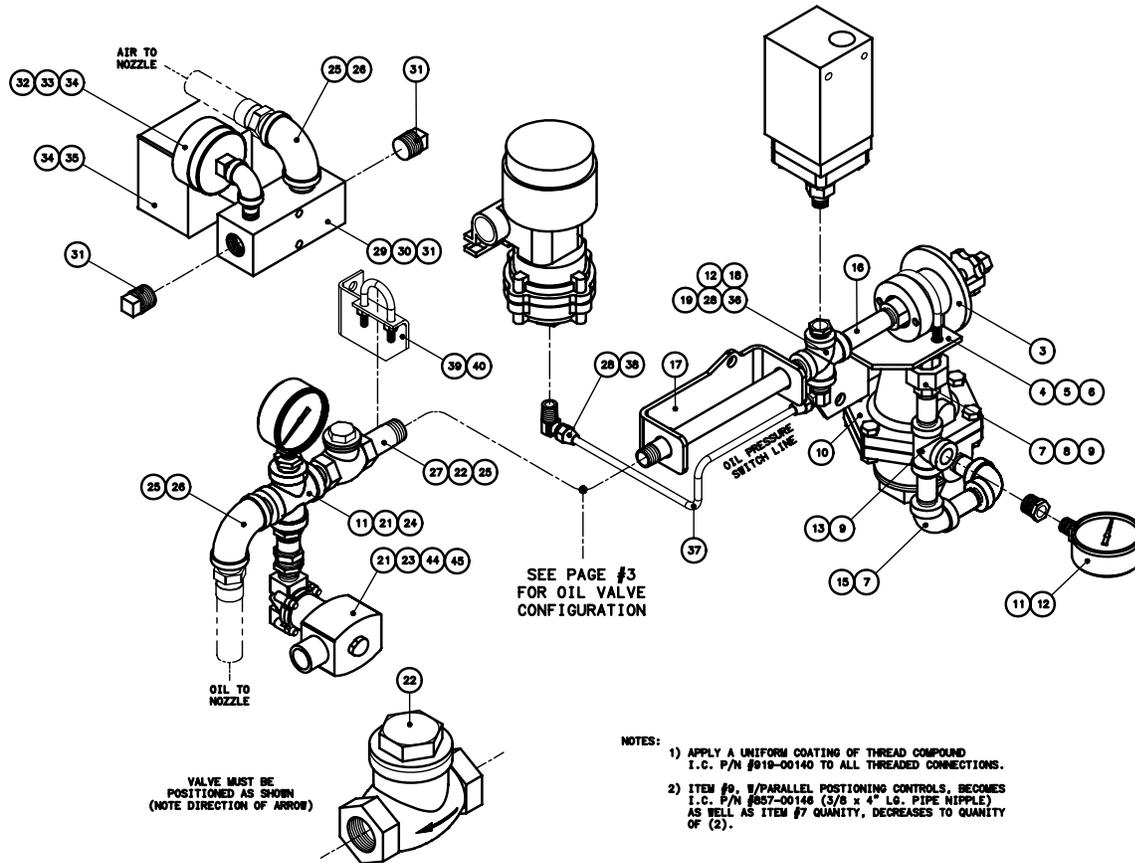


GAS PIPING  
W/STABILIZER GAS  
(TOP ENTRY)

ITEM	QTY.	PART NO.	DESCRIPTION
1	1	900-00580	PIPE WELDMT, OUTER GAS
2	1	859-00360	ELBOW, UNION, PIPE, 2" x 90°
3	1	857-00758	NIPPLE, PIPE, 2" x 6-1/2" LG.
4	1	847-00312	TEE, REDUCING, 2" x 2" x 1"
5	2	857-00204	NIPPLE, PIPE, 2" x CLOSE
6	1	940-01257	VALVE, BUTTERFLY, 2" NPT (REDUCED PORT)
7	1	857-00648	NIPPLE, PIPE, 1" x 7" LG.
8	1	859-00362	ELBOW, UNION, PIPE, 1" x 90°
9	1	900-00607	PIPE WELDMT, STABILIZER GAS
10	2	857-00128	NIPPLE, PIPE, 1/4" x 1-1/4" LG.
11	2	859-00078	ELBOW, PIPE, 1/4" x 90°
12	1	857-00132	NIPPLE, PIPE, 1/4" x 3" LG.
13	2	941-00587	VALVE, NEEDLE, 1/4" FPT
14	2	850-00355	GAUGE, 0-5 PSI
15	1	940-01592	VALVE, BUTTERFLY, 1" NPT (MANUAL)
16	2	857-00175	NIPPLE, PIPE, 1" x CLOSE
17	1	858-00218	UNION, PIPE, 1"
18	2	857-00628	NIPPLE, PIPE, 1" x 6-1/2" LG.

ITEM	QTY.	PART NO.	DESCRIPTION
19	1	900-00582	PIPE WELDMT, STABILIZER GAS
20	1	859-00082	ELBOW, PIPE, 1" x 90°
21	1	857-00796	NIPPLE, PIPE, 1" x 7-1/2" LG.
22	1	847-00825	TEE, REDUCING, 2" x 1" x 2"
23	1	857-00205	NIPPLE, PIPE, 2" x 2-1/2" LG.
24	1	858-00221	UNION, PIPE, 2"
25	1	857-00211	NIPPLE, PIPE, 2" x 6" LG.
26	1	900-00608	PIPE WELDMT, OUTER GAS
27	1	857-00177	NIPPLE, PIPE, 1" x 2-1/2" LG.
28	1	900-00579	PIPE WELDMT, STABILIZER GAS
29	1	900-00549	PIPE, ORIFICE, CONNECTION
30	1	158-00071	PLUG, ORIFICE
31	1	845-00317	F.F., 3/8" ODC. x 3/8" FPT. x 90°
32	2	845-00043	NUT, FLARE, 3/8"
33	1	847-00415	BUSHING, REDUCING, 1/4" x 1/8" PIPE
34	1	939-00305	TUBING, ALUMINUM, 3/8" OD.
35	1	845-00046	F.F., 3/8" ODC. x 3/8" MPT. X STR.

Figure 7-2 Gas Piping

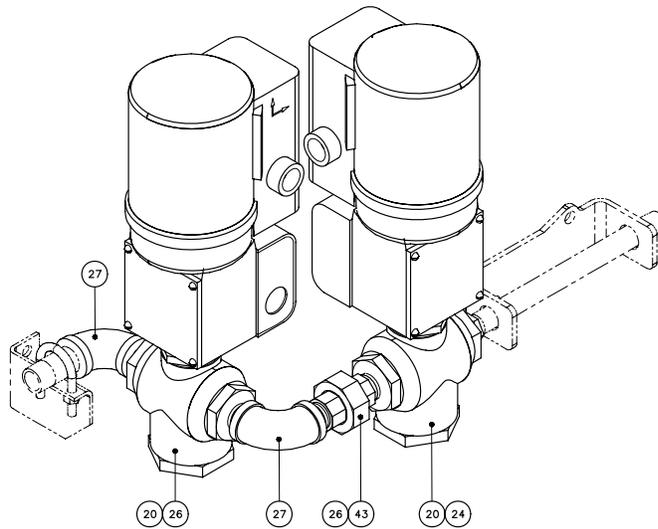


- NOTES:
- 1) APPLY A UNIFORM COATING OF THREAD COMPOUND I.C. P/N #019-00140 TO ALL THREADED CONNECTIONS.
  - 2) ITEM #9, 8/PARALLEL POSITIONING CONTROLS, BECOMES I.C. P/N #657-00146 (3/8" x 4" LG. PIPE NIPPLE) AS WELL AS ITEM #7 QUANTITY, DECREASES TO QUANTITY OF (2).

ITEM	QTY.	PART NO.	DESCRIPTION
1	2	861-00266	HOSE, FLEX, 1/2" NPT S.S. BRAIDED
2	2	845-00489	PLUG, QUICK DISCONNECT, 1/2" NPT (FEMALE)
3	1	940-01436	VALVE, METERING, 3/8" NPT
4	1	008-02099	BRACKET, HOLD DOWN
5	1	007-00237	U-BOLT, 5/16-18 x 1-3/4" x 2-11/16"
6	2	869-00206	NUT, HEX, SPINLOCK, 5/16-1/8 UNC.
7	2	857-00141	NIPPLE, PIPE, 3/8" x 1-1/2" LG.
8	2	858-00215	UNION, PIPE, 3/8"
9	3	857-00142	NIPPLE, PIPE, 3/8" x 2" LG.
10	1	918-00740A	REGULATOR, PRESSURE, OIL, 3/8" NPT
11	2	850-00003	GAUGE, PRESSURE, 1/4" NPT
12	2	847-00417	BUSHING, REDUCING, PIPE, 3/8" x 1/4"
13	1	859-00023	TEE, PIPE, 3/8" x 3/8" x 3/8"
14	2	857-00143	NIPPLE, PIPE, 3/8" x 2-1/2" LG.
15	3	859-00079	ELBOW, PIPE, 3/8" x 90°
16	1	857-00144	NIPPLE, PIPE, 3/8" x 3" LG.
17	1	008-02110	BRACKET, MOUNTING, OIL PIPING
18	1	859-00261	CROSS, PIPE, 3/8"
19	1	858-00102	PLUG, PIPE, 3/8"
20	2	SEE NEXT PAGE	VALVE, OIL
21	4	857-00139	NIPPLE, PIPE, CLOSE, 3/8"
22	1	940-01169	VALVE, CHECK, HORIZONTAL, 1/2" NPT
23	3	847-00420	BUSHING, REDUCING, PIPE, 1/2" x 3/8"

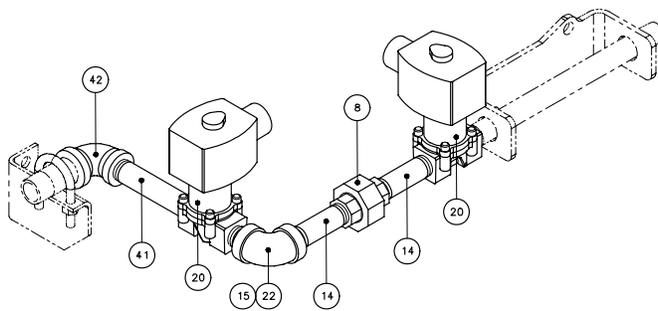
ITEM	QTY.	PART NO.	DESCRIPTION
24	1	859-00262	CROSS PIPE, 1/2"
25	6	857-00151	NIPPLE, PIPE, CLOSE, 1/2"
26	4	859-00080	ELBOW, PIPE, 1/2" x 90°
27	1	857-00154	NIPPLE, PIPE, 1/2" x 2" LG.
28	2	845-00008	NUT, FLARE, 1/4" ODC.
29	2	847-00419	BUSHING, REDUCING, PIPE, 1/2" x 1/4"
30	1	106-00111	BLOCK, MANIFOLD
31	3	858-00103	PLUG, PIPE, 1/2"
32	1	850-00391A	GAUGE, PRESSURE, 1/4" NPT
33	1	859-00078	ELBOW, PIPE, 1/4" x 90°
34	2	857-00128	NIPPLE, PIPE, 1/4" x 1-1/4" LG.
35	1	858-00019	COUPLING, PIPE, FULL, 1/4"
36	1	845-00391	F.F., 1/4" ODC. x 3/8" MPT. x 90°
37	1	939-00025	TUBING, COPPER, 1/4" O.D.
38	1	845-00009	F.F., 1/4" ODC. x 1/4" MPT. x 90°
39	1	008-02147	BRACKET, SUPPORT, OIL PIPING
40	1	007-00196	U-BOLT, 1/4-20 UNC
41	1	857-00145	NIPPLE, PIPE, 3/8" x 3-1/2" LG.
42	1	847-00545	ELBOW, REDUCING, 1/2" x 3/8"
43	1	858-00216	UNION, PIPE, 1/2" NPT
44	1	940-01686	BUSHING, CHECK VALVE
45	1	940-01520	VALVE

Figure 7-3 Oil Piping



ITEM	QTY.	PART NO.	DESCRIPTION
20	2	940-01520	VALVE, SOLENOID, 3/8" NPT
	2	940-01190	VALVE, MOTORIZED, 1/2" NPT

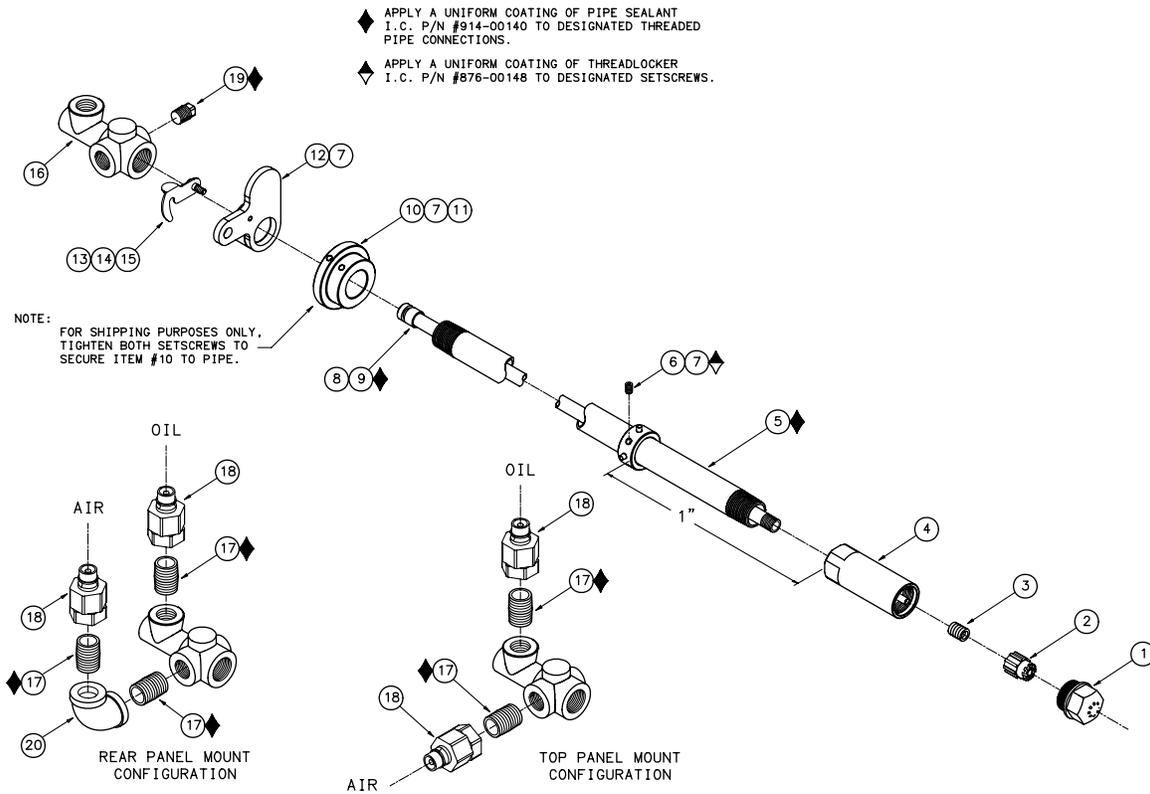
OIL PIPING W/MOTORIZED VALVES



OIL PIPING W/SOLENOID VALVES

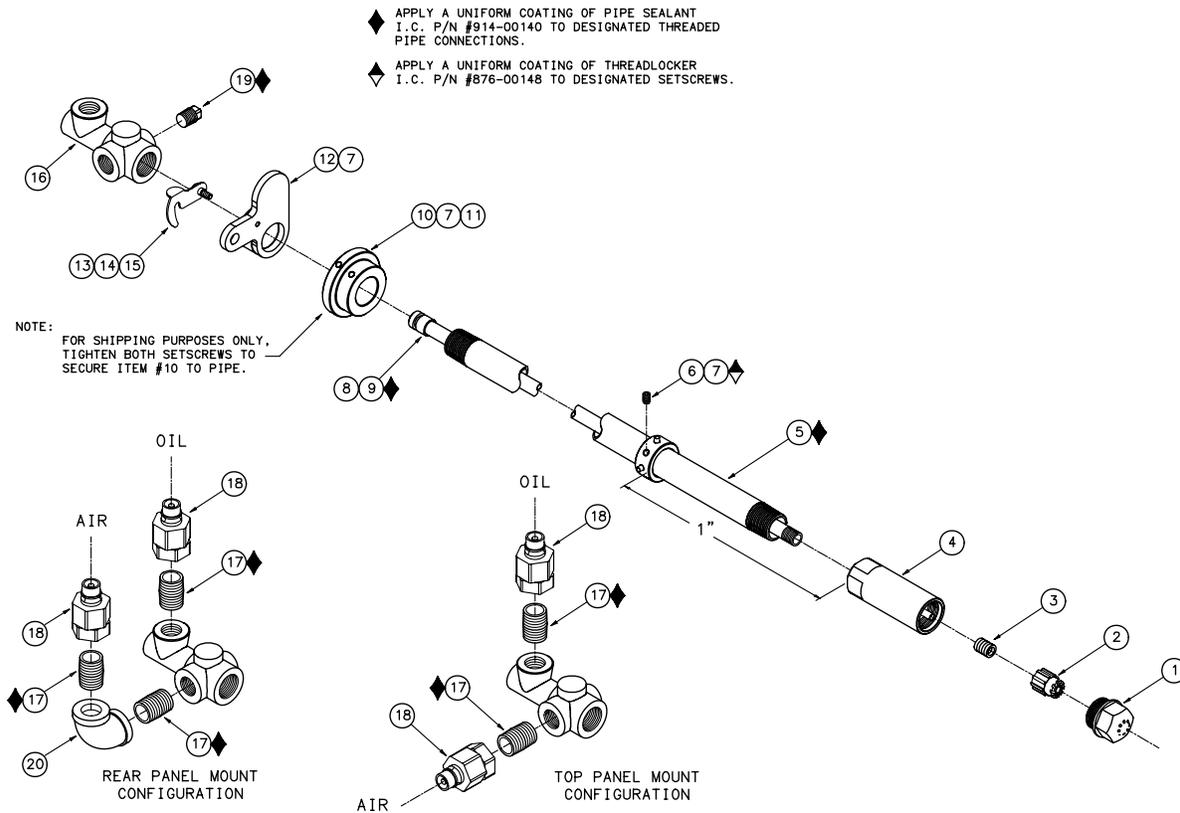
- NOTES:
- 1) APPLY A UNIFORM COATING OF THREAD COMPOUND I.C. P/N #919-00140 TO ALL THREADED CONNECTIONS.
  - 2) ITEM #9, W/PARALLEL POSITIONING CONTROLS, BECOMES I.C. P/N #857-00146 (3/8 x 4" LG. PIPE NIPPLE) AS WELL AS ITEM #7 QUANTITY, DECREASES TO QUANTITY OF (2).

**Figure 7-4 Oil Valves**



ITEM	QTY.	PART NO.	DESCRIPTION
1	1	048-00311	NOZZLE TIP, OIL
2	1	109-00014	SWIRLER, OIL
3	1	082-00033	SPRING, COMPRESSION
4	1	277-00047A	BODY ASSEMBLY, NOZZLE
5	1	900-00600	PIPE, 3/4" x 51" LG. SCH. #40 #304 S.S. (T.B.E.)
6	1	018-00227	COLLAR ASSEMBLY, CENTERING
7	5	860-00039	SET SCREW, 1/4-20 UNC x 3/8" LG. KNURLED PT.
8	1	090-00929	TUBE ASSEMBLY
9	1	853-00613	O-RING
10	1	860-00044	SET SCREW, 1/4-20 UNC x 3/4" LG. KNURLED PT.
11	1	010-00405	BUSHING, PIPE, OIL GUN
12	1	011-00159	STOP WELDMENT, SWITCH
13	2	952-00302	WASHER, SHIM
14	1	866-00008A	HOOK, FASTENER
15	1	860-00321	BOLT, SHOULDER, #10-24 UNC
16	1	106-00101	MANIFOLD, AIR/OIL INLET
17	3	857-00151	NIPPLE, CLOSE, 1/2" NPT
18	2	845-00490	PLUG, 1/2" QUICK DISCONNECT (MALE END)
19	1	858-00101	PLUG, PIPE, 1/4" NPT
20	1	859-00080	ELBOW, 90° x 1/2" NPT

Figure 7-5 Oil Gun 1



ITEM	QTY.	PART NO.	DESCRIPTION
1	1	048-00311	NOZZLE TIP, OIL
2	1	109-00014	SWIRLER, OIL
3	1	082-00033	SPRING, COMPRESSION
4	1	277-00047A	BODY ASSEMBLY, NOZZLE
5	1	900-00601	PIPE, 3/4" x 54" LG. SCH. #40 #304 S.S. (T.B.E.)
6	1	018-00227	COLLAR ASSEMBLY, CENTERING
7	5	860-00039	SET SCREW, 1/4-20 UNC x 3/8" LG. KNURLED PT.
8	1	090-00941	TUBE ASSEMBLY
9	1	853-00613	O-RING
10	1	860-00044	SET SCREW, 1/4-20 UNC x 3/4" LG. KNURLED PT.
11	1	010-00405	BUSHING, PIPE, OIL GUN
12	1	011-00159	STOP WELDMENT, SWITCH
13	2	952-00302	WASHER, SHIM
14	1	866-00008A	HOOK, FASTENER
15	1	860-00321	BOLT, SHOULDER, #10-24 UNC
16	1	106-00101	MANIFOLD, AIR/OIL INLET
17	3	857-00151	NIPPLE, CLOSE, 1/2" NPT
18	2	845-00490	PLUG, 1/2" QUICK DISCONNECT (MALE END)
19	1	858-00101	PLUG, PIPE, 1/4" NPT
20	1	859-00080	ELBOW, 90° x 1/2" NPT

Figure 7-6 Oil Gun 2

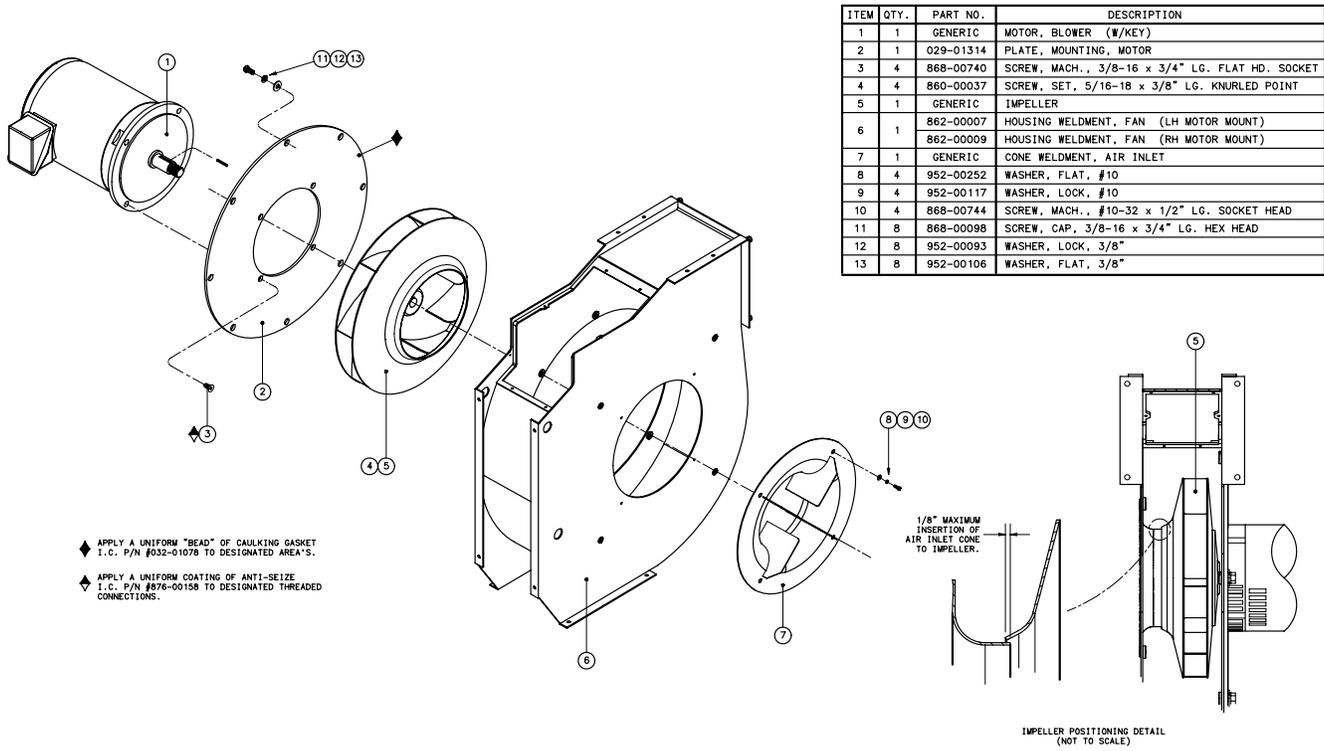
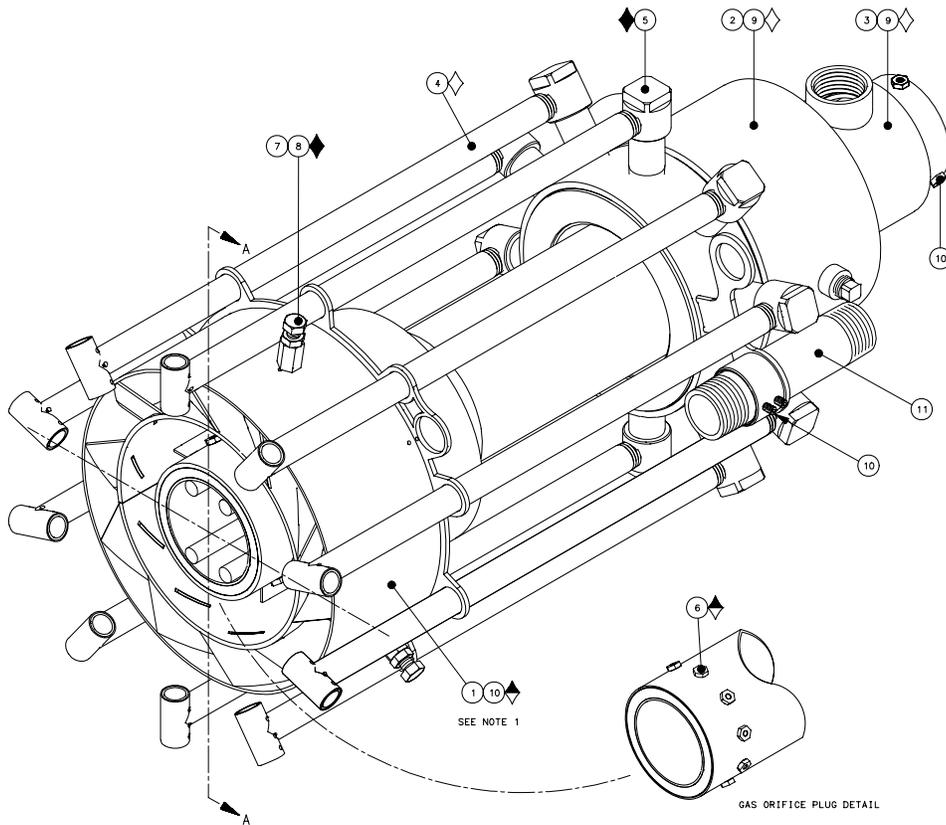


Figure 7-7 Air Handling Assembly

NTH SIZE 4



NOTES

- 1 UPON APPLYING THREADLOCKER TO EACH SETSCREW, TIGHTEN SETSCREWS UNTIL CONTACT IS MADE WITH ITEM #3 (INSIDE OF GROOVE). BACK EACH SETSCREW OUT 1/4 TURN. THIS WILL ENSURE ROTATIONAL ADJUSTMENT, BUT LIMIT LINEAR MOVEMENT.
- 2 \*NTH 090\* LOW GAS PRESSURE APPLICATION. NOZZLES TO BE POSITIONED SO THAT THE "RETRO" HOLE IS AIMED AT THE MIDDLE OF THE VANE OPENING & BETWEEN VANES.
- 3 \*NTH 120\* SWIRLER TO BE IN LINE WITH INNER MANIFOLD WITHIN ±.06.

◆ APPLY A UNIFORM COATING OF ANTI-SEIZE I.C. P/N #876-00158 TO DESIGNATED THREADED CONNECTIONS.

◆ APPLY A UNIFORM COATING OF THREADLOCKER I.C. P/N #876-00148 TO DESIGNATED COMPONENTS.

◆ APPLY A UNIFORM COATING OF SEALANT/THREADLOCKER I.C. P/N #876-00157 TO DESIGNATED THREADED CONNECTIONS.

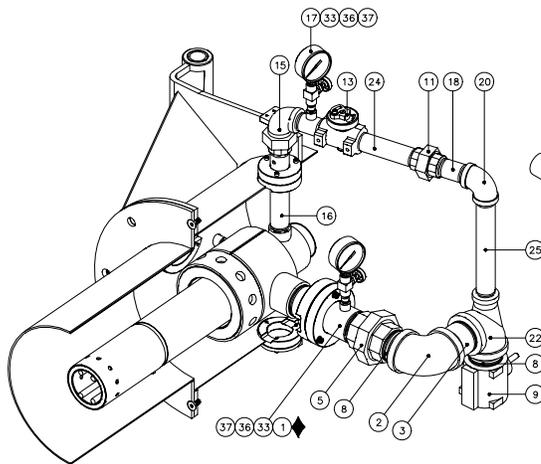
SEE NOTE 1

GAS ORIFICE PLUG DETAIL

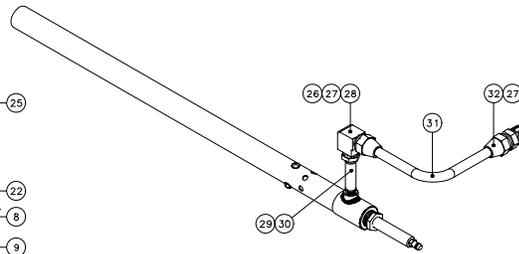
ITEM	QTY.	PART NO.	DESCRIPTION
1	1	GENERIC	SWIRLER WELDMENT, AIR
2	1	GENERIC	MANIFOLD WELDMENT, OUTER GAS
3	1	GENERIC	MANIFOLD WELDMENT, STABILIZER GAS
4	12	GENERIC	NOZZLE, GAS
5	12	GENERIC	COUPLING, GAS NOZZLE
6	12	GENERIC	PLUG, GAS ORIFICE
7	3	868-00737A	CAPSCREW, 5/16-18 UNC x 1" LG. (SS)
8	3	869-00216	NUT, 5/16-18 UNC, JAM (SS)
9	2	858-00101	PLUG, 1/4" NPT PIPE
10	7	860-00312	SETSCREW, #10-32 UNF x 5/16" LG. (SS)
11	1	GENERIC	TUBE, SCANNER

BURNER MODEL	DRAWER ASSY.
NTH 070	581-00014
NTH 080	581-00001
NTH 084	581-00010
NTH 090	581-00002
*NTH 090	581-00053
NTH 100	581-00002
NTH 105	581-00011
NTH 110	581-00003
NTH 120	581-00003
*NTH 120	581-00057

Figure 7-8 Drawer Assembly



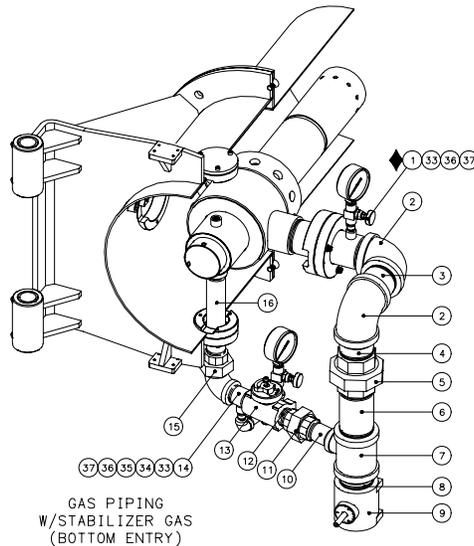
INVERTED APP'S.  
GAS PIPING W/STABILIZER GAS  
(TOP ENTRY)



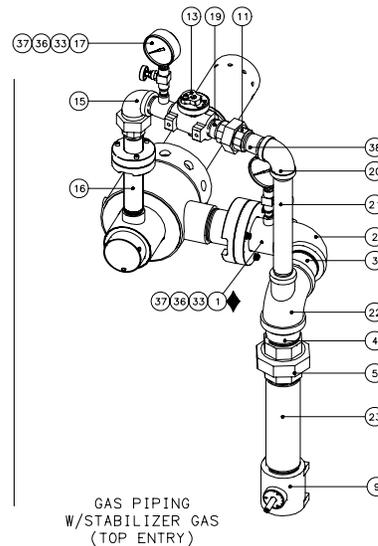
GAS PILOT PIPING DETAIL

◆ APPLY A UNIFORM COATING OF ANTI-SEIZE  
I.C. P/N #876-00158 TO DESIGNATED THREADED  
CONNECTIONS.

APPLY A UNIFORM COATING OF THREAD COMPOUND  
I.C. P/N #919-00140 TO ALL THREADED  
CONNECTIONS, EXCEPT WHERE NOTED OTHERWISE.



GAS PIPING  
W/STABILIZER GAS  
(BOTTOM ENTRY)

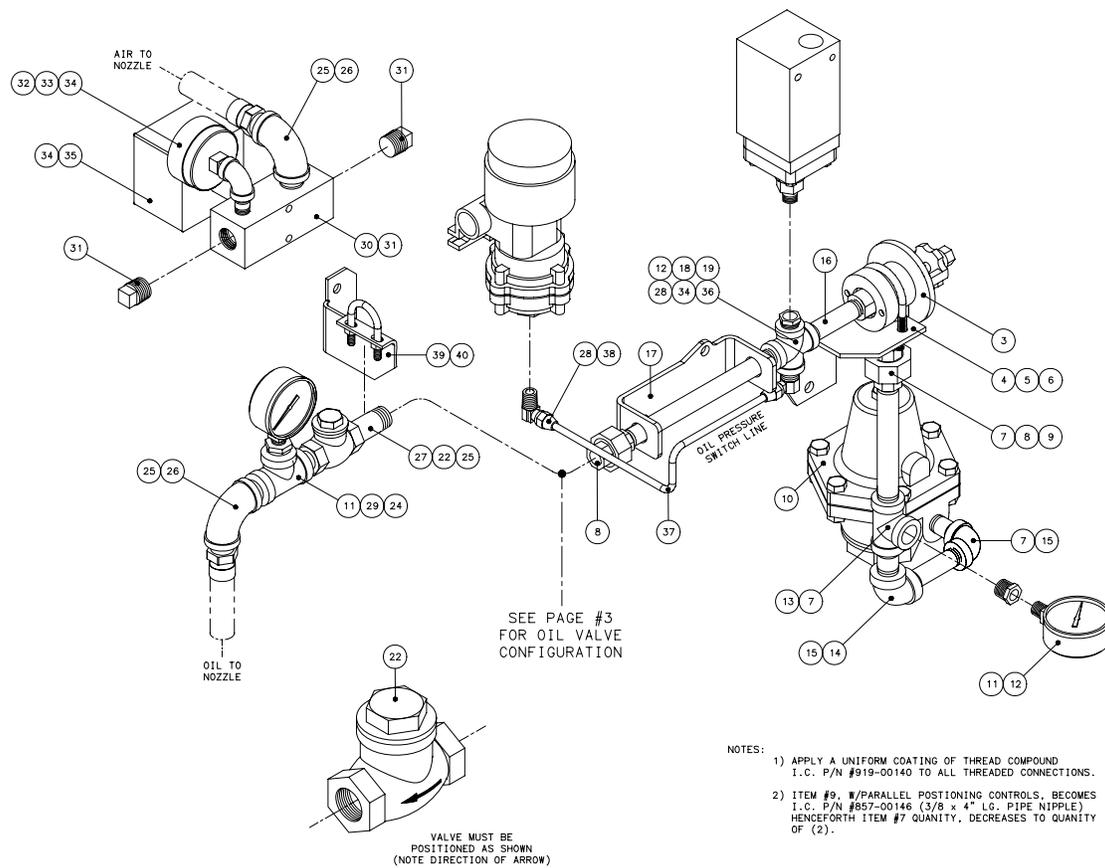


GAS PIPING  
W/STABILIZER GAS  
(TOP ENTRY)

ITEM	QTY.	PART NO.	DESCRIPTION
1	1	900-00580	PIPE WELDMENT, OUTER GAS
2	2	859-00085	ELBOW, PIPE, 2" x 90°
3	1	857-00206	NIPPLE, PIPE, 2" x 3" LG.
4	1	857-00205	NIPPLE, PIPE, 2" x 2-1/2" LG.
5	1	858-00221	UNION, PIPE, 2"
6	1	900-00077	PIPE, 2" x 4-3/4" LG. (T.B.E.)
7	1	847-00312	TEE, REDUCING, 2" x 2" x 1"
8	1	857-00204	NIPPLE, PIPE, 2" x CLOSE
9	1	940-01257	VALVE, BUTTERFLY, 2" REDUCED PORT
10	1	900-00076	PIPE, 1" x 2-3/4" LG. (T.B.E.)
11	1	858-00218	UNION, PIPE, 1"
12	1	857-00175	NIPPLE, PIPE, 1" x CLOSE
13	1	940-01592	VALVE, BUTTERFLY, 1" GAS
14	1	900-00579	PIPE WELDMENT, STABILIZER GAS
15	1	859-00362	ELBOW, UNION, PIPE, 1" x 90°
16	1	900-00078	PIPE, 1" x 7-11/16" LG. (T.B.E.)
17	1	900-00582	PIPE WELDMENT, STABILIZER GAS
18	1	857-00008	NIPPLE, PIPE, 1" x 3" LG.

ITEM	QTY.	PART NO.	DESCRIPTION
19	1	857-00010	NIPPLE, PIPE, 1" x 2" LG.
20	1	859-00082	ELBOW, PIPE, 1" x 90°
21	1	857-00759	NIPPLE, PIPE, 1" x 9-1/2" LG.
22	1	847-00825	TEE, REDUCING, 2" x 1" x 2"
23	1	857-00072	NIPPLE, PIPE, 2" x 9" LG.
24	1	857-00182	NIPPLE, PIPE, 1" x 5-1/2" LG.
25	1	857-00703	NIPPLE, PIPE, 1" x 9" LG.
26	1	845-00317	F.F., 3/8" ODC. x 3/8" FPT. x 90°
27	2	845-00043	NUT, FLARE, 3/8"
28	1	847-00415	BUSHING, REDUCING, 1/4" x 1/8" PIPE
29	1	900-00549	PIPE, ORIFICE, CONNECTION
30	1	158-00071	PLUG, ORIFICE
31	1	939-00305	TUBING, ALUMINUM, 3/8" OD.
32	1	845-00046	F.F., 3/8" ODC. x 3/8" MPT. X STR.
33	2	857-00128	NIPPLE, PIPE, 1/4" x 1-1/4" LG.
34	2	859-00078	ELBOW, PIPE, 1/4" x 90°
35	1	857-00132	NIPPLE, PIPE, 1/4" x 3" LG.
36	2	941-00587	VALVE, NEEDLE, 1/4" x 3" LG.
37	2	850-00355	GAUGE, 0-5 PSI
38	1	857-00177	NIPPLE, PIPE, 1" x 2-1/2" LG.

Figure 7-9 Gas Piping

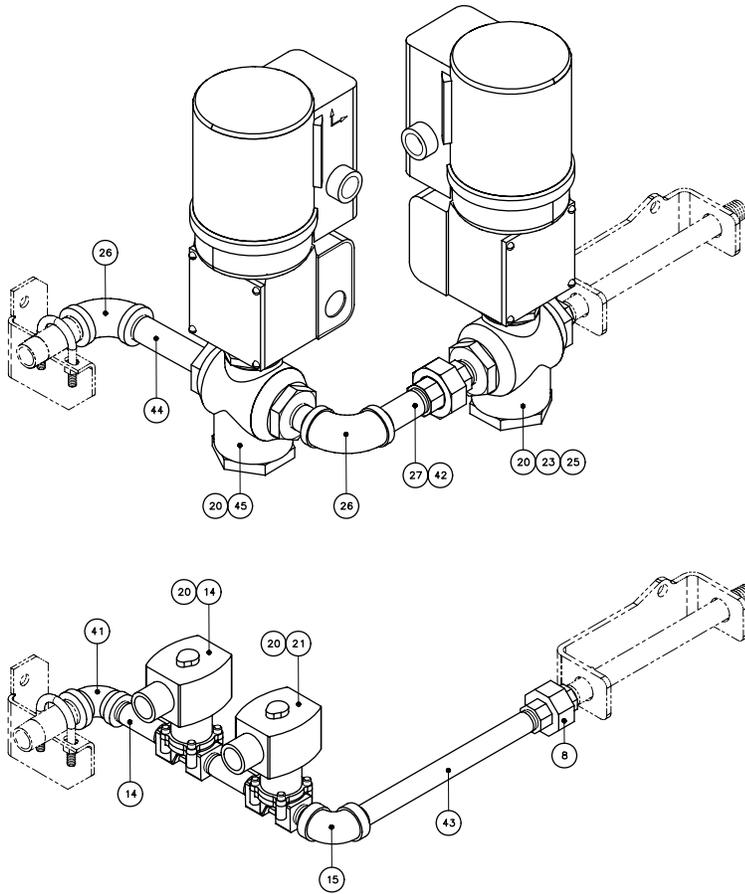


- NOTES:
- 1) APPLY A UNIFORM COATING OF THREAD COMPOUND I.C. P/N #919-00140 TO ALL THREADED CONNECTIONS.
  - 2) ITEM #9, W/PARALLEL POSITIONING CONTROLS, BECOMES I.C. P/N #857-00146 (3/8" x 4" LG. PIPE NIPPLE) HENCEFORTH ITEM #7 QUANTITY, DECREASES TO QUANTITY OF (2).

ITEM	QTY.	PART NO.	DESCRIPTION
1	2	861-00266	HOSE, FLEX, 1/2" NPT S.S. BRAIDED
2	2	845-00489	PLUG, QUICK DISCONNECT, 1/2" NPT (FEMALE)
3	1	940-01436	VALVE, METERING, 3/8" NPT
4	1	008-02099	BRACKET, HOLD DOWN
5	1	007-00237	U-BOLT, 5/16-18 x 1-3/4" x 2-11/16"
6	2	869-00206	NUT, HEX, SPINLOCK, 5/16-1/8 UNC.
7	3	857-00141	NIPPLE, PIPE, 3/8" x 1-1/2" LG.
8	2	858-00215	UNION, PIPE, 3/8"
9	1	857-00148	NIPPLE, PIPE, 3/8" x 5" LG.
10	1	918-00740A	REGULATOR, PRESSURE, OIL, 3/8" NPT
11	2	850-00003	GAUGE, PRESSURE, 1/4" NPT
12	2	847-00417	BUSHING, REDUCING, PIPE, 3/8" x 1/4"
13	1	859-00023	TEE, PIPE, 3/8" x 3/8" x 3/8"
14	3	857-00143	NIPPLE, PIPE, 3/8" x 2-1/2" LG.
15	3	859-00079	ELBOW, PIPE, 3/8" x 90°
16	1	857-00145	NIPPLE, PIPE, 3/8" x 3-1/2" LG.
17	1	008-02110	BRACKET, MOUNTING, OIL PIPING
18	1	859-00261	CROSS, PIPE, 3/8"
19	1	858-00102	PLUG, PIPE, 3/8"
20	2	SEE NEXT PAGE	VALVE, OIL
21	1	857-00139	NIPPLE, PIPE, CLOSE, 3/8"
22	1	940-01169	VALVE, CHECK, HORIZONTAL, 1/2" NPT
23	1	847-00420	BUSHING, REDUCING, PIPE, 1/2" x 3/8"

24	1	859-00024	TEE, PIPE, 1/2"
25	4	857-00151	NIPPLE, PIPE, CLOSE, 1/2"
26	4	859-00080	ELBOW, PIPE, 1/2" x 90°
27	2	857-00155	NIPPLE, PIPE, 1/2" x 2-1/2" LG.
28	2	845-00008	NUT, FLARE, 1/4" ODC.
29	1	847-00419	BUSHING, REDUCING, PIPE, 1/2" x 1/4"
30	1	106-00111	BLOCK, MANIFOLD
31	3	858-00103	PLUG, PIPE, 1/2"
32	1	850-00391A	GAUGE, PRESSURE, 1/4" NPT
33	1	859-00078	ELBOW, PIPE, 1/4" x 90°
34	3	857-00128	NIPPLE, PIPE, 1/4" x 1-1/4" LG.
35	1	858-00019	COUPLING, PIPE, FULL, 1/4"
36	1	845-00391	F.F., 1/4" ODC. x 3/8" MPT. x 90°
37	1	939-00025	TUBING, COPPER, 1/4" O.D.
38	1	845-00009	F.F., 1/4" ODC. x 1/4" MPT. x 90°
39	1	008-02147	BRACKET, SUPPORT, OIL PIPING
40	1	007-00196	U-BOLT, 1/4-20 UNC
41	1	845-00545	ELBOW, REDUCING, 1/2" x 3/8"
42	1	858-00216	UNION, PIPE, 1/2" NPT
43	1	857-00676	NIPPLE, PIPE, 3/8" x 8" LG.
44	1	900-00015	PIPE, 1/2" SCH. #40 x 3-3/4" LG. T.B.E.
45	1	857-00153	NIPPLE, PIPE, 1/2" x 1-1/2" LG.

Figure 7-10 Oil Piping

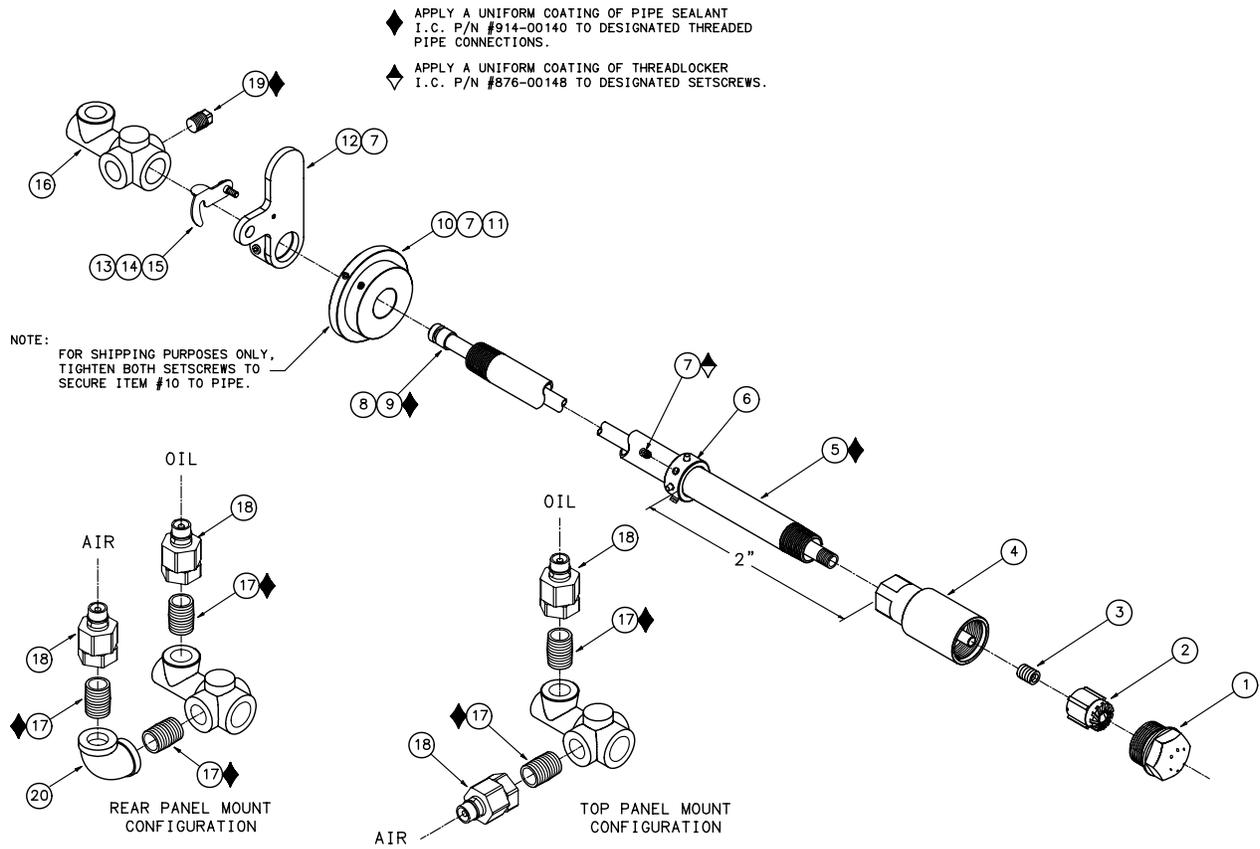


ITEM	QTY.	PART NO.	DESCRIPTION
21	2	940-01520	VALVE, SOLENOID, 3/8" NPT
	2	940-01190	VALVE, MOTORIZED, 1/2" NPT

OIL PIPING W/MOTORIZED VALVES

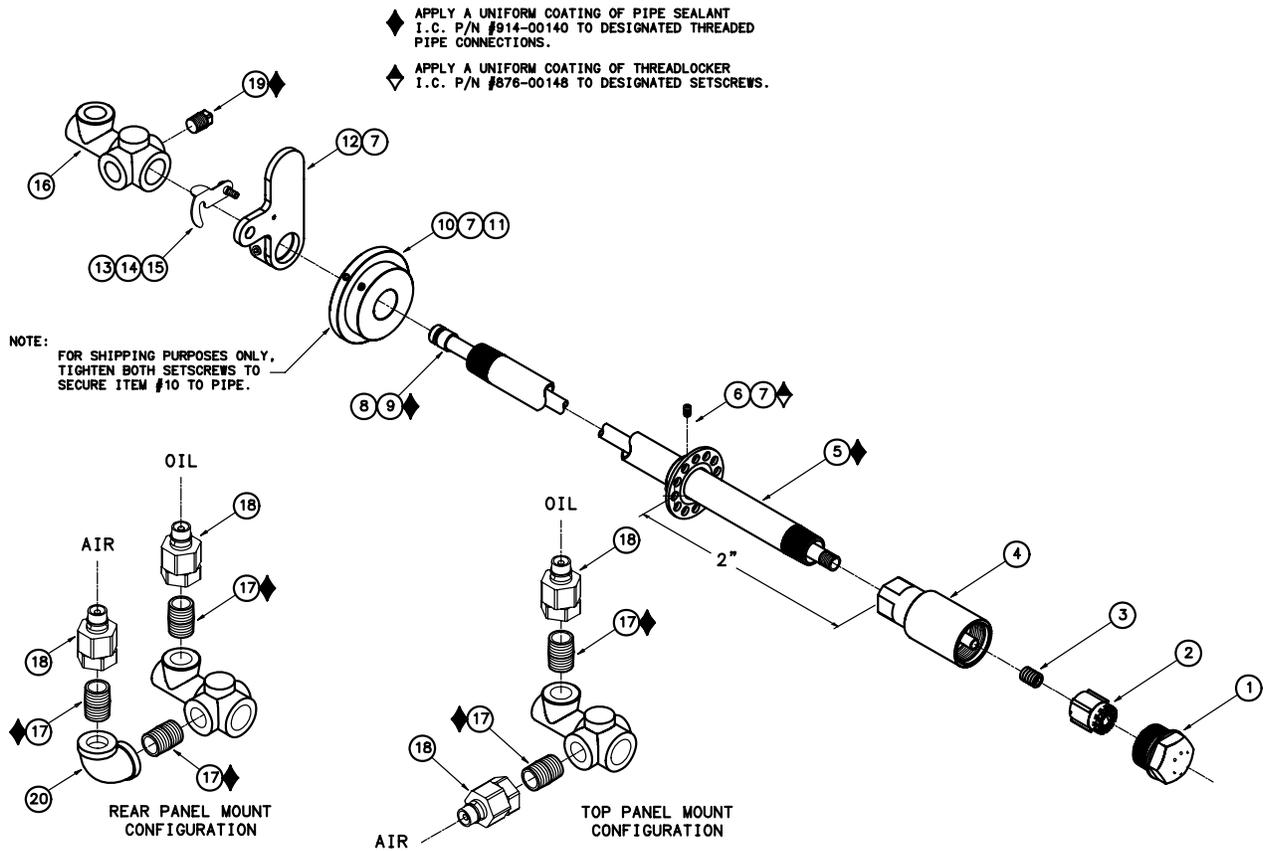
OIL PIPING W/SOLENOID VALVES

**Figure 7-11 Oil Valves**



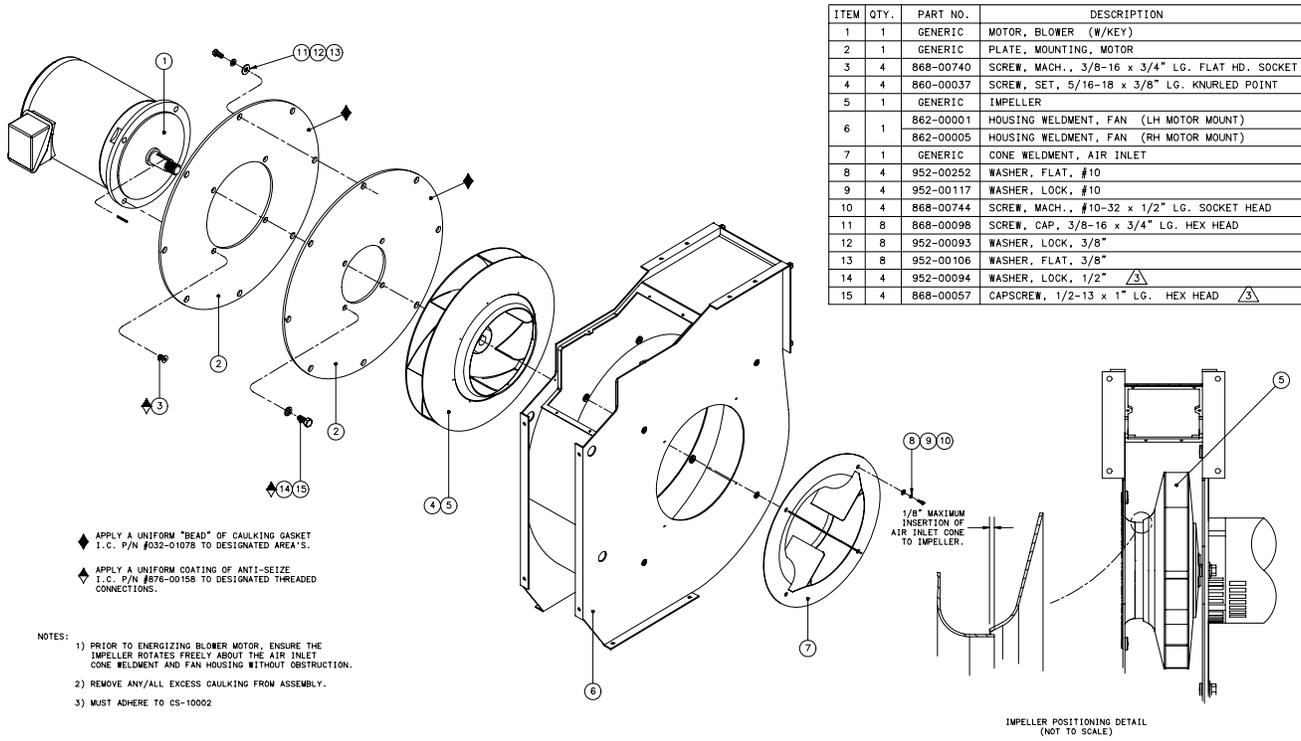
ITEM	QTY.	PART NO.	DESCRIPTION
1	1	048-00605A	NOZZLE TIP, OIL
2	1	109-00020	SWIRLER, OIL
3	1	082-00128	SPRING, COMPRESSION
4	1	277-00106	BODY ASSEMBLY, NOZZLE
5	1	900-00583	PIPE, 3/4" x 58" LG. SCH. #40 #304 S.S. (T.B.E.)
6	1	018-00227	COLLAR ASSEMBLY, CENTERING
7	5	860-00039	SET SCREW, 1/4-20 UNC x 3/8" LG. KNURLED PT.
8	1	090-00885	TUBE ASSEMBLY
9	1	853-00613	O-RING
10	1	860-00044	SET SCREW, 1/4-20 UNC x 3/4" LG. KNURLED PT.
11	1	010-00398	BUSHING, PIPE, OIL GUN
12	1	011-00158	STOP WELDMENT, SWITCH
13	2	952-00302	WASHER, SHIM
14	1	866-00008A	HOOK, FASTENER
15	1	860-00321	BOLT, SHOULDER, #10-24 UNC
16	1	106-00101	MANIFOLD, AIR/OIL INLET
17	3	857-00151	NIPPLE, CLOSE, 1/2" NPT
18	2	845-00490	PLUG, 1/2" QUICK DISCONNECT (MALE END)
19	1	858-00101	PLUG, PIPE, 1/4" NPT
20	1	859-00080	ELBOW, 90° x 1/2" NPT

Figure 7-12 Oil Gun 1



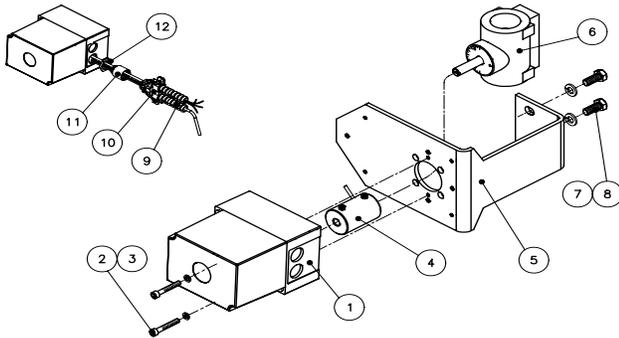
ITEM	QTY.	PART NO.	DESCRIPTION
1	1	048-00605A	NOZZLE TIP, OIL
2	1	109-00020	SWIRLER, OIL
3	1	082-00128	SPRING, COMPRESSION
4	1	277-00106	BODY ASSEMBLY, NOZZLE
5	1	900-00593	PIPE, 3/4" x 61" LG. SCH. #40 #304 S.S. (T.B.E.)
6	1	009-00464	BAFFLE WELDMENT
7	5	860-00039	SET SCREW, 1/4-20 UNC x 3/8" LG. KNURLED PT.
8	1	090-00917	TUBE ASSEMBLY
9	1	853-00613	O-RING
10	1	860-00044	SET SCREW, 1/4-20 UNC x 3/4" LG. KNURLED PT.
11	1	010-00398	BUSHING, PIPE, OIL GUN
12	1	011-00158	STOP WELDMENT, SWITCH
13	2	952-00302	WASHER, SHIM
14	1	866-00008A	HOOK, FASTENER
15	1	860-00321	BOLT, SHOULDER, #10-24 UNC
16	1	106-00101	MANIFOLD, AIR/OIL INLET
17	3	857-00151	NIPPLE, CLOSE, 1/2" NPT
18	2	845-00490	PLUG, 1/2" QUICK DISCONNECT (MALE END)
19	1	858-00101	PLUG, PIPE, 1/4" NPT
20	1	859-00080	ELBOW, 90° x 1/2" NPT

Figure 7-13 Oil Gun 2



ITEM	QTY.	PART NO.	DESCRIPTION
1	1	GENERIC	MOTOR, BLOWER (W/KEY)
2	1	GENERIC	PLATE, MOUNTING, MOTOR
3	4	868-00740	SCREW, MACH., 3/8-16 x 3/4" LG. FLAT HD. SOCKET
4	4	860-00037	SCREW, SET, 5/16-18 x 3/8" LG. KNURLED POINT
5	1	GENERIC	IMPELLER
6	1	862-00001	HOUSING WELDMENT, FAN (LH MOTOR MOUNT)
		862-00005	HOUSING WELDMENT, FAN (RH MOTOR MOUNT)
7	1	GENERIC	CONE WELDMENT, AIR INLET
8	4	952-00252	WASHER, FLAT, #10
9	4	952-00117	WASHER, LOCK, #10
10	4	868-00744	SCREW, MACH., #10-32 x 1/2" LG. SOCKET HEAD
11	8	868-00098	SCREW, CAP., 3/8-16 x 3/4" LG. HEX HEAD
12	8	952-00093	WASHER, LOCK, 3/8"
13	8	952-00106	WASHER, FLAT, 3/8"
14	4	952-00094	WASHER, LOCK, 1/2"
15	4	868-00057	CAPSCREW, 1/2-13 x 1" LG. HEX HEAD

### PARALLEL POSITIONING



ITEM	PART NO.	DESCRIPTION
1		ACTUATOR
2	TABLE 7-1	SCREW
3		WASHER
4		COUPLER, SHAFT
5	TABLE 7-2	BRACKET, MOUNTING
6		VALVE, BUTTERFLY
7		CAPSCREW, 5/16-18 x 3/4" LG., HEX. HEAD
8		WASHER, 5/16, LOCK
9	TABLE 7-3	CONDUIT, ELECTRICAL, FLEX, 3/8"
10		CONNECTOR, FLEX METAL, DUAL
11	869-00222	NUT, HEX, FEMALE ADAPTER
	869-00221	NUT, HEX, FEMALE ADAPTER
12	061-00006	NUT, HEX, CONNECTOR
	061-00005	NUT, HEX, CONNECTOR

\*Not required with Honeywell apps. Use 869-00222 and 061-00006 with Fireye and AutoFlame apps

**Figure 7-15 Gas Butterfly Valve with Actuator**

Honeywell			
Item	Qty	PN	Description
1	1	945-00150	Actuator (alt: CB labeled actuator 945-00216A)
2	1	868-00135	Capscrew
3	1	952-00092	Washer
4	1	819-00168	Coupler, Shaft

Siemens			
Item	Qty	PN	Description
1	1	945-00156	Actuator
2	4	868-00744	Screw, Machine
3	4	952-00117	Washer
4	1	819-00205	Coupler, Shaft

Fireye			
Item	Qty	PN	Description
1	1	945-00151	Actuator
2	2	868-00747	Screw, Machine
3	2	952-00117	Washer
4	1	819-00171	Coupler, Shaft

AutoFlame			
Item	Qty	PN	Description
1	1	945-00154	Actuator
2	2	868-00744	Screw, Machine
3	2	952-00117	Washer
4	1	819-00174	Coupler, Shaft

**Table 7-1 Actuators, Gas BF Valve**

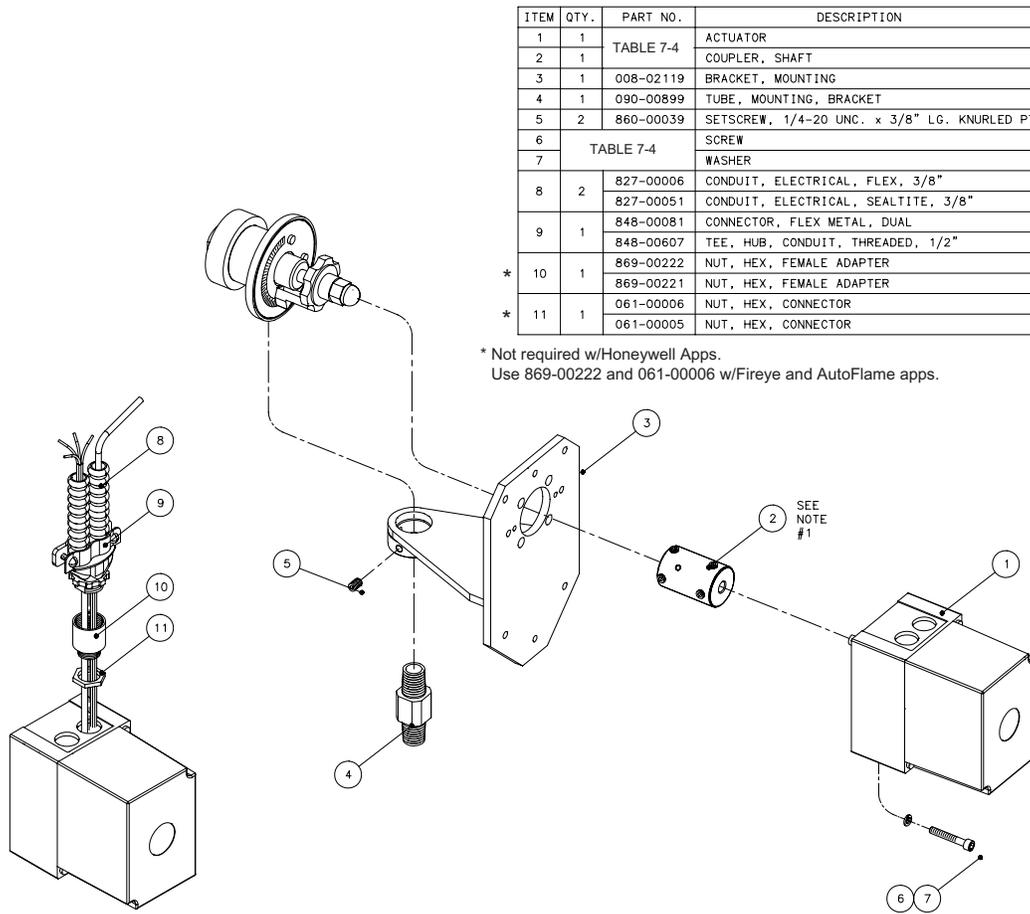
Item	Qty		PN						Description
	1"-3" Valves	4" Valve	1" Valve	1 1/2" Valve	2" Valve	2 1/2" Valve	3" Valve	4" Valve	
5	1	1	008-02120	008-02121	008-02122	008-02123	008-02124	008-02125	Bracket, Mounting
6	1	N/A	940-01559	940-01561	940-01563	940-01565	940-01567	N/A	Valve - Full Port
	1	1	940-01560	940-01562	940-01564	940-01566	940-01568	940-01569	Valve - Reduced Port
7	2	4	868-00032	868-00032	868-00032	868-00032	868-00032	868-00032	Capscrew
8	2	4	952-00114	952-00114	952-00114	952-00114	952-00114	952-00114	Washer

**Table 7-2 Gas Butterfly Valve and Mounting**

Standard Applications			
Item	Qty	PN	Description
9	2	827-00006	Conduit, Electrical, Flex
10	1	848-00081	Connector, Flex Metal, Dual

Sealtite Applications			
Item	Qty	PN	Description
9	2	827-00051	Conduit, Electrical, Sealtite
10	1	848-00607	Tee, Hub, Conduit
	1	848-00041	Nut, Hex, Connector
	1	857-00151	Nipple, Pipe

**Table 7-3 Gas Linkage Misc.**



ITEM	QTY.	PART NO.	DESCRIPTION
1	1		ACTUATOR
2	1	TABLE 7-4	COUPLER, SHAFT
3	1	008-02119	BRACKET, MOUNTING
4	1	090-00899	TUBE, MOUNTING, BRACKET
5	2	860-00039	SETScrew, 1/4-20 UNC. x 3/8" LG. KNURLED PT.
6			SCREW
7		TABLE 7-4	WASHER
8	2	827-00006	CONDUIT, ELECTRICAL, FLEX, 3/8"
		827-00051	CONDUIT, ELECTRICAL, SEALTITE, 3/8"
9	1	848-00081	CONNECTOR, FLEX METAL, DUAL
		848-00607	TEE, HUB, CONDUIT, THREADED, 1/2"
* 10	1	869-00222	NUT, HEX, FEMALE ADAPTER
		869-00221	NUT, HEX, FEMALE ADAPTER
* 11	1	061-00006	NUT, HEX, CONNECTOR
		061-00005	NUT, HEX, CONNECTOR

\* Not required w/Honeywell Apps.  
Use 869-00222 and 061-00006 w/Fireye and AutoFlame apps.

Figure 7-16 Oil Actuator

Siemens			
Item	Qty	PN	Description
1	1	945-00156	Actuator
2	1	819-00209	Coupler, Shaft
6	4	868-00744	Screw, Machine
7	4	952-00117	Washer

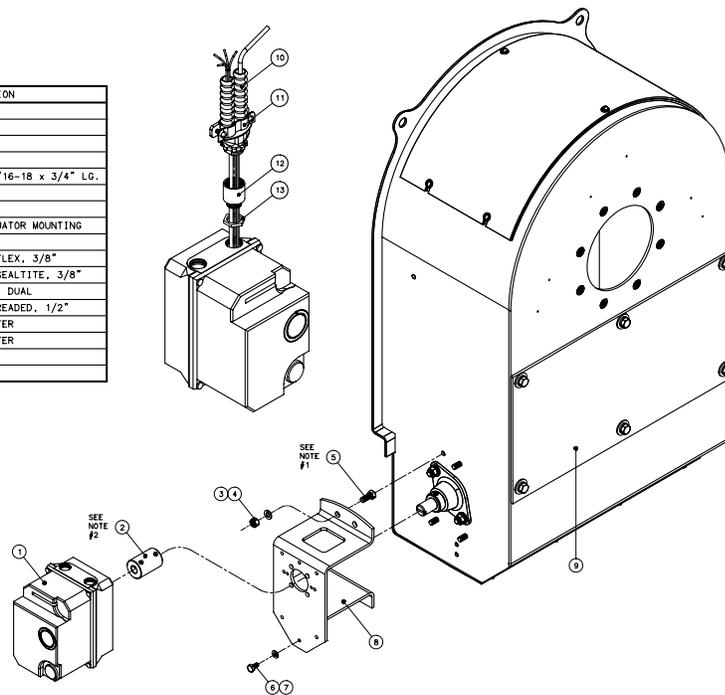
Fireye			
Item	Qty	PN	Description
1	1	945-00151	Actuator
2	1	819-00207	Coupler, Shaft
6	2	868-00747	Screw, Machine
7	2	952-00117	Washer

Honeywell			
Item	Qty	PN	Description
1	1	945-00150	Actuator (alt: CB labelled actuator 945-00216A)
2	1	819-00206	Coupler, Shaft
6	1	868-00135	Screw, Machine
7	1	952-00092	Washer

AutoFlame			
Item	Qty	PN	Description
1	1	945-00154	Actuator
2	1	819-00208	Coupler, Shaft
6	2	868-00744	Screw, Machine
7	2	952-00117	Washer

Table 7-4 Oil Valve Actuators

ITEM	QTY.	PART NO.	DESCRIPTION
1	1	TABLE 7-5	ACTUATOR
2	1	TABLE 7-5	COUPLER, SHAFT
3	4	952-00114	WASHER, LOCK, 5/16"
4	4	868-00202A	NUT, HEX, 5/16-18 UNC.
5	4	868-00032	CAPSCREW, HEX HEAD, 5/16-18 x 3/4" LG.
6	4	TABLE 7-5	SCREW
7	4	TABLE 7-5	WASHER
8	1	008-02085	BRACKET WELDMENT, ACTUATOR MOUNTING
9	1	TABLE 7-6	PLATE, COVER
10	2	TABLE 7-7	CONDUIT, ELECTRICAL, FLEX, 3/8"
		TABLE 7-7	CONDUIT, ELECTRICAL, SEALTITE, 3/8"
11	1	TABLE 7-7	CONNECTOR, FLEX METAL, DUAL
		TABLE 7-7	TEE, HUB, CONDUIT, THREADED, 1/2"
12	1	869-00222	NUT, HEX, FEMALE ADAPTER
		869-00221	NUT, HEX, FEMALE ADAPTER
		061-00006	NUT, HEX, CONNECTOR
13	1	061-00005	NUT, HEX, CONNECTOR



**Figure 7-17 Rotary Air Damper Box w/Actuator**

Siemens			
Item	Qty	PN	Description
1	1	945-00157	Actuator
2	1	819-00210	Coupler, Shaft
6	4	868-00744	Screw, Machine
7	4	952-00117	Washer

Fireye			
Item	Qty	PN	Description
1	1	945-00152	Actuator
2	1	819-00189	Coupler, Shaft
6	2	868-00747	Screw, Machine
7	2	952-00117	Washer

Honeywell			
Item	Qty	PN	Description
1	1	945-00150	Actuator (alt: CB labelled actuator 945-00216A)
2	1	819-00186	Coupler, Shaft
6	1	868-00135	Screw, Cap
7	1	952-00092	Washer

AutoFlame			
Item	Qty	PN	Description
1	1	945-00155	Actuator
2	1	819-00172	Coupler, Shaft
6	2	868-00744	Screw, Machine
7	2	952-00117	Washer

**Table 7-5 Air Damper Actuators**

Item 9	
Size	Part Number
2	059-02123
3	059-01777
4	059-01709

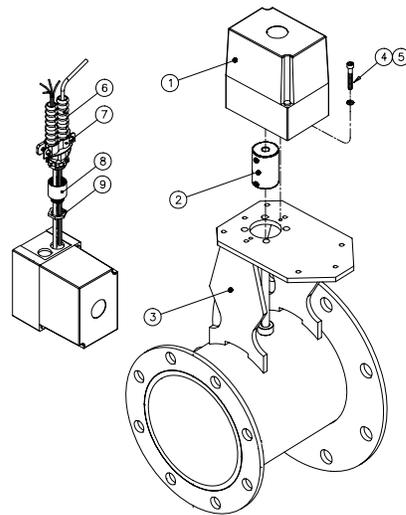
**Table 7-6 Damper Box Cover Plate**

Standard Applications			
Item	Qty	PN	Description
10	1	827-00006	Conduit, Electrical, Flex
11	1	848-00081	Connector, Flex Metal, Dual

**Table 7-7 Air Damper Linkage misc.**

Sealtite Applications			
Item	Qty	PN	Description
10	1	827-00051	Conduit, Electrical, Sealtite
11	1	848-00607	Tee, Hub, Conduit
	1	848-00041	Nut, Hex, Connector
	1	857-00151	Nipple, Close

ITEM	QTY.	PART NO.	DESCRIPTION
1	1		ACTUATOR
2	1		COUPLER, SHAFT
3	1	SEE TABLES	VALVE, F.G.R., SUB-WELDMENT
4	4		SCREW
5	4		WASHER
6	2	827-00006	CONDUIT, ELECTRICAL, FLEX, 3/8"
		827-00051	CONDUIT, ELECTRICAL, SEALTITE, 3/8"
		848-00081	CONNECTOR, FLEX METAL, DUAL
7	1	848-00607	TEE, HUB, CONDUIT, THREADED, 1/2"
8	1	869-00222	NUT, HEX, FEMALE ADAPTER
		869-00221	NUT, HEX, FEMALE ADAPTER
		061-00006	NUT, HEX, CONNECTOR
9	1	061-00005	NUT, HEX, CONNECTOR



**Figure 7-18 FGR Actuator Assembly**

Item	Qty	Description	Siemens	Fireye	Honeywell	AutoFlame
1	1	Actuator	945-00156	945-00151	945-00150	945-00154

**Table 7-8 FGR Actuator**

			4"-6" FGR Valves				8" FGR Valves			
Item	Qty	Description	Siemens	Fireye	Honeywell	AutoFlame	Siemens	Fireye	Honeywell	AutoFlame
2	1	Coupler, Shaft	819-00205	819-00171	819-00168	819-00174	819-00176	819-00176	819-00177	819-00177

**Table 7-9 Shaft Coupler**

			Left Side Mounting		Right Side Mounting		
Item	Qty	Description	4"	6"	4"	6"	8"
3	1	Weldment, Valve	194-00124	194-00122	194-00125	194-00123	194-00107

**Table 7-10 Valve Weldment**

			Siemens	
Item	Qty	Description	4"-6"	8"
4	4	Screw, Machine	868-00744	868-00772
5	4	Washer, Lock	952-00117	952-00301

Item	Qty	Description	Fireye
4	2	Screw, Machine	868-00747
5	2	Washer, Lock	952-00117

Item	Qty	Description	Honeywell
4	1	Screw, Machine	868-00135
5	1	Washer, Lock	952-00092

Item	Qty	Description	AutoFlame
4	2	Screw, Machine	868-00744
5	2	Washer, Lock	952-00117

Standard Applications			
Item	Qty	Description	PN
9	2	Conduit, Elec	827-00006
10	1	Connector	848-00081

Sealtite Applications			
Item	Qty	Description	PN
9	2	Conduit, Elec	827-00051
10	1	Tee, Hub, Conduit	848-00607
	1	Nut, Hex	848-00041
	1	Nipple, Pipe	857-00151

**Table 7-11 FGR Misc**



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