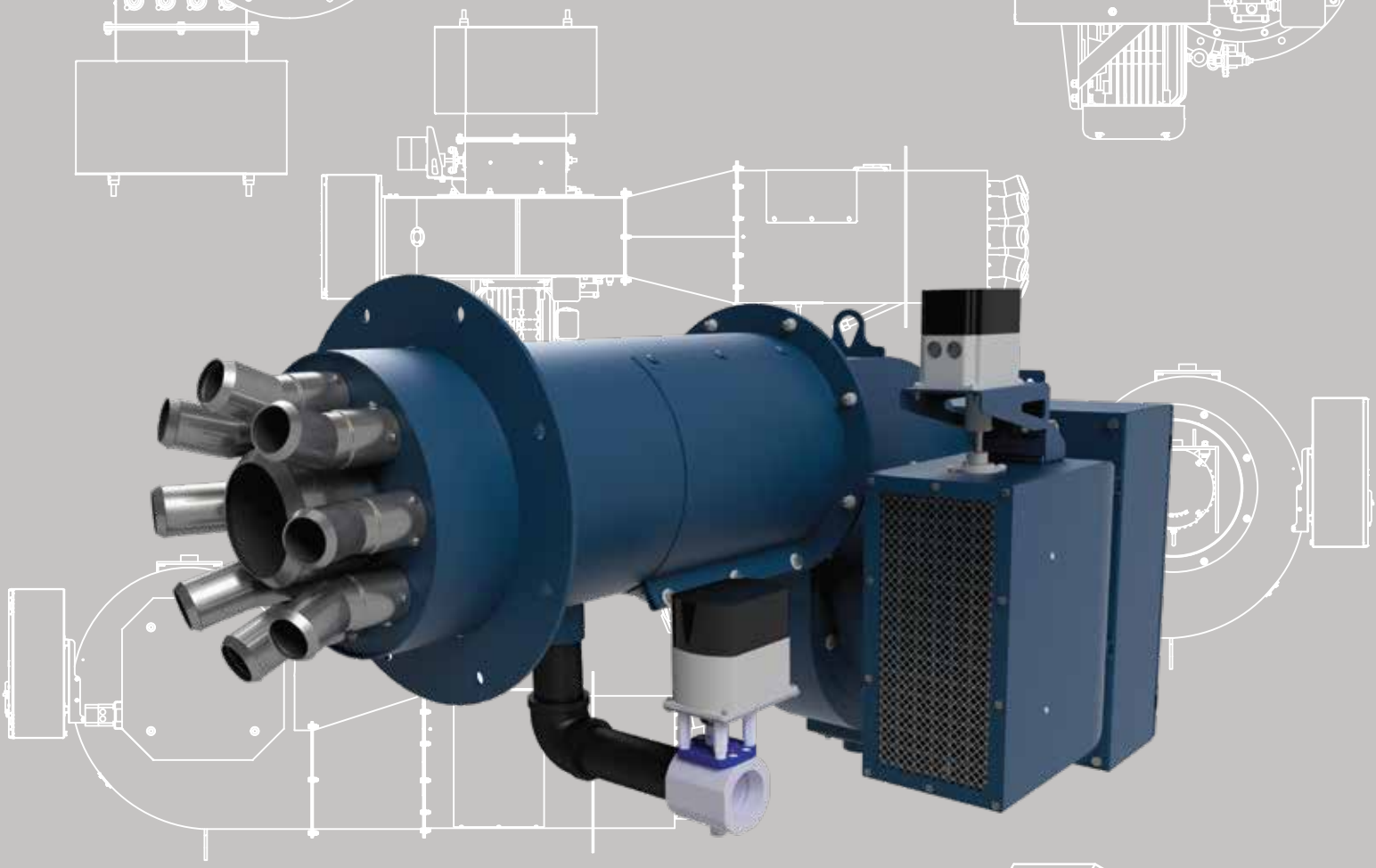
Power Flame Inc.®

AN ASTEC COMPANY



EVO® MANUAL

POWER FLAME MODEL EVO® BURNER

For use by Qualified Service Personnel Only

WARNING

The improper installation, adjustment, alteration, service, or maintenance of this equipment can result in fire, explosion, serious injury, or death. Refer to this manual. For assistance or additional information consult a qualified installer, service agency or the gas supplier.

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

ATTENTION!

All Personnel involved with the startup, maintenance, or adjustment of this burner must read and understand the entire contents of this manual prior to any startup or adjustment made to the burner and related components. Installation and service must be performed by a qualified installer, service agency or the gas supplier.

WHAT TO DO IF YOU SMELL GAS

1. Do not try to light any appliance
2. Do not touch any electrical switch
3. Do not use any phone in your building
4. Immediately call your gas supplier from a neighbor's phone
5. Follow the gas supplier's instructions
6. If you cannot reach your gas supplier, call the fire department

1. GENERAL PRODUCT INFORMATION 1

1.1 Principle of Operation 1
1.2 Unpacking and Handling 1
1.3 Warranty and Spare Parts Information 1
1.4 General Components Information 2

2. INSTALLATION 6

2.1 Gas Supply Piping 6
2.2 Combustion Air Requirements 7
2.3 Burner Mounting: General 7
2.4 Combustion Chamber: General 9
2.5 Extreme Temperature Operation: General 9

3. START UP PROCEDURES 10

3.1 Burner Start Up and Service Test Equipment Required 10
3.2 General Start-Up All Fuels 10
3.3 Burner Start-Up Sequence Instructions: Gas 11

4. TROUBLESHOOTING 15

4.1 Gas Pilot Ignition Adjustment 15
4.2 Gas Pilot Flood Test 15
4.3 Trouble Shooting Suggestions: general 16
4.4 Trouble Shooting Suggestions: Gas 16

5. MAINTENANCE 18

5.1 General Information 18
5.2 Periodic Check List 19

6. BURNER START UP INFORMATION & TEST DATA 20

1. GENERAL PRODUCT INFORMATION

1.1 Principle of Operation

1.1.1 The Power Flame Model EVO® Burner, U.S. Patent #11,585,528, is a forced draft, partial premix/nozzle mix, staged gas burner designed for Sub 30 PPM NOx emissions without the use of Flue Gas Recirculation, while maintaining 3% O_2, when firing with typical Natural Gas fuel. The Model EVO® burner is listed and labeled by Underwriters Laboratories, Inc. up to EVO800. The combustion air is furnished by an integrally mounted combustion air fan. The Power Flame packaged combustion system can be operated under positive or negative furnace pressures with clean, efficient combustion in a wide range of combustion chamber conditions.

1.1.2 The Power Flame Model EVO® burner is a totally packaged and factory tested combustion system offering single unit responsibility. The package incorporates accurate control of the fuel-air ratio throughout the firing range with the resultant controlled flame patterns and clean combustion for maximum efficiency.

1.1.3 Combustion air flow is controlled by a multi-louvered damper assembly. Combustion air is supplied by an integral motor-driven blower, which discharges into the burner blast tube assembly.

1.1.4 The air-fuel ratio is established at the time of start-up and proven with combustion test equipment to provide the lowest practical oxygen and lowest NOx with a clean flame. Firetube applications typically have bent lean extensions as depicted in Figures 1a-1c while watertube applications typically have straight lean extensions.

1.1.5 A Flame Safeguard Controller programs the firing cycle. The operating cycle is sequenced to ensure normal and safe conditions before fuel can be introduced into the combustion chamber area. The complete firing cycle is supervised to ensure that ignition of main flame is properly established and maintained. Flame monitoring is provided by a scanner as required by code.

1.1.6 The limit circuit includes the operating limit control to maintain set operating pressure or temperature, as well as a high limit control to guard against excessive pressure or temperature. Low water and other similar safety controls can be interlocked into the burner control system to satisfy specific job and/or code requirements.

1.1.7 The control circuit is normally 120 volts. A control circuit transformer may be furnished to provide the 120 volts control circuit for polyphase motor voltage applications.

1.1.8 The pre-wired Control Panel is mounted and wired as an integral part of the burner in accordance with recommendations of Underwriters Laboratories, Inc. and The National Electrical Code. Components are wired to numbered terminal strips. Panel and burners are factory fire tested before shipment. Comprehensive wiring and gas and/or oil piping diagrams are furnished with each burner in accordance with individual job or application requirements. Wall mounted or free standing control panels are also available.

1.1.9 Power Flame Model EVO® burners are available with control systems to comply with the requirements of Factory Mutual, Industrial Risk Insurers and any special state, municipal, local and utility company codes, including New York City Department of Buildings (MEA), NYC Department of Environmental Protection, Commonwealth of Massachusetts, State of Connecticut Fire Marshall, Illinois School Code and others.

1.2 Unpacking and Handling

1.2.1 Power Flame Model EVO® burners are usually shipped as a unit with an integrally mounted, pre-wired control panel. Gas train components may be pre-piped as an option or shipped loose for field mounting.

1.2.2 Uncrate the burner carefully and check all parts received against the computer generated Burner Specification Sheets supplied by Power Flame. Components not mounted on the burner (shipped loose) are designated with an L in the right hand column on the sheets. Claims on shortages or damage must be immediately filled with the carrier.

1.3 Warranty and Spare Parts Information

1.3.1 Please refer to the Power Flame Terms and Conditions for our warranty policy.

1.3.2 Should a component fail, contact Power Flame Inc. or our Representative in your area and advise them of the Serial Number of your burner. The burner as-built included with the installers packet includes a Bill of

Material, wiring and piping diagrams, and a Recommended Spare Parts List. An on-hand supply of spare parts is highly recommended. All communications with the factory will be handled more efficiently if the burner is identified by the burner model, serial and job numbers. This information is stamped onto the burner nameplate that is attached to the integral control panel (or to the burner, when remote control panels are supplied).

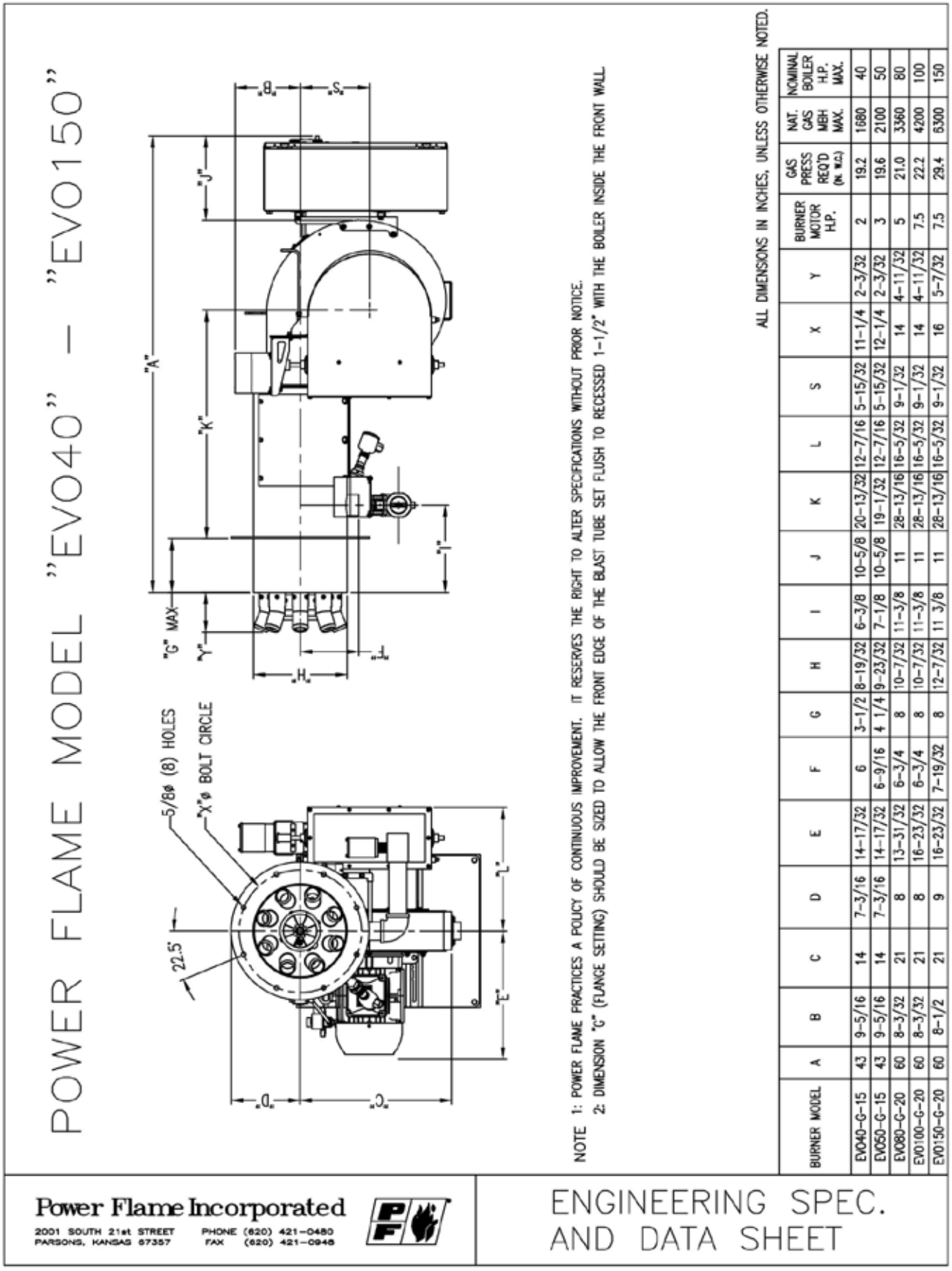
1.4 General Components Information

1.4.1 The contents of this manual are general in nature due to the wide variety of equipment specifications, insurance requirements, and state, local and other applicable codes.

1.4.2 The computer generated Burner Specification Sheets, shipped with the burner, represent the As-Built version of your specific Power Flame combustion system. Part numbers and component descriptions will match those components supplied. A duplicate set of Burner Specification Sheets is available through Power Flame's Customer Service Department or through the secured area of our website.

1.4.3 **The components and arrangements shown are typical for a Model EVO® natural gas burner. In some cases, the type of components and/or their arrangement may vary from this depiction. Power Flame practices a policy of continuous product improvement. It reserves the right to alter specifications without prior notice.** For specifics on your system, refer to the technical information supplied with the burner.

1.4.4 **Any part of the burner and associated equipment including gas trains and control panels shall not be used as a step to climb on during service work. Warranty will be void if evidence is found.**



BURNER MODEL	A	B	C	D	E	F	G	H	I	J	K	L	S	X	Y	BURNER MOTOR H.P.	GAS PRESS REQ'D (IN W.C.)	NAT. GAS MBH MAX.	NOMINAL BOILER H.P. MAX.
EVO40-G-15	43	9-5/16	14	7-3/16	14-17/32	6	3-1/2	8-19/32	6-3/8	10-5/8	20-13/32	12-7/16	5-15/32	11-1/4	2-3/32	2	19.2	1680	40
EVO50-G-15	43	9-5/16	14	7-3/16	14-17/32	6-9/16	4 1/4	9-23/32	7-1/8	10-5/8	19-1/32	12-7/16	5-15/32	12-1/4	2-3/32	3	19.6	2100	50
EVO80-G-20	60	8-3/32	21	8	13-31/32	6-3/4	8	10-7/32	11-3/8	11	28-13/16	16-5/32	9-1/32	14	4-11/32	5	21.0	3360	80
EVO100-G-20	60	8-3/32	21	8	16-23/32	6-3/4	8	10-7/32	11-3/8	11	28-13/16	16-5/32	9-1/32	14	4-11/32	7.5	22.2	4200	100
EVO150-G-20	60	8-1/2	21	9	16-23/32	7-19/32	8	12-7/32	11 3/8	11	28-13/16	16-5/32	9-1/32	16	5-7/32	7.5	29.4	6300	150

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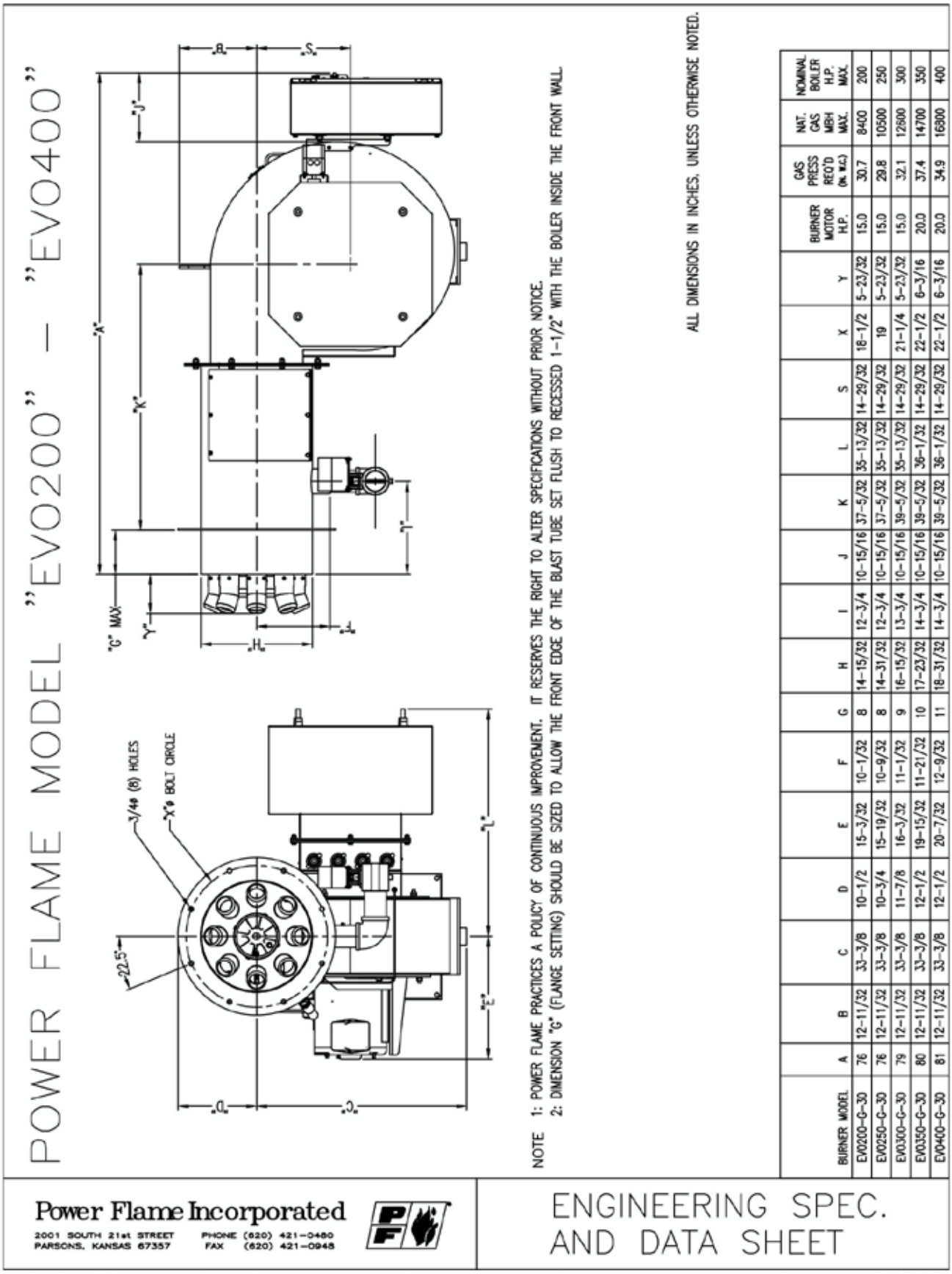
ENGINEERING SPEC. AND DATA SHEET

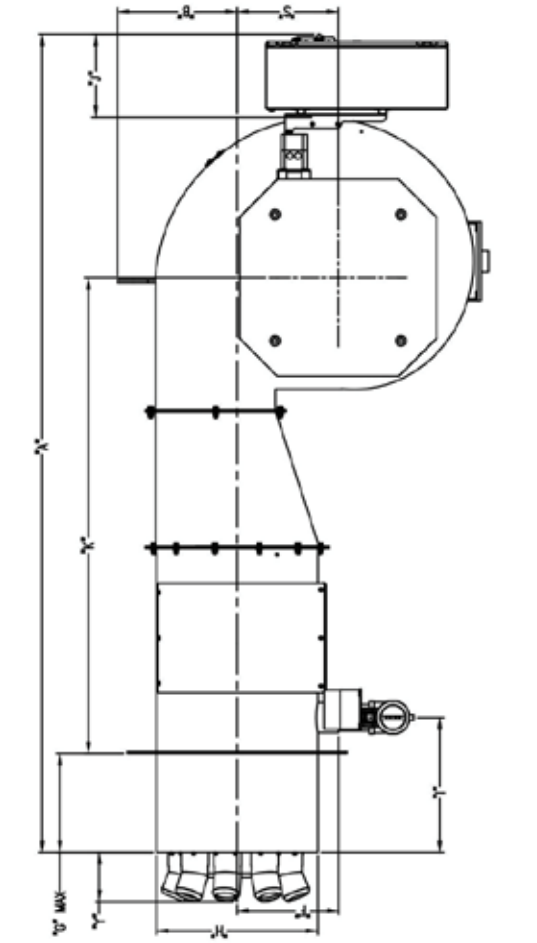
Figure 1a: Model EVO® Dimensions, size 40-150



BURNER MODEL	A	B	C	D	E	F	G	H	I	J	K	L	S	X	Y	BURNER MOTOR H.P.	GAS PRESS REQ'D (IN. W.C.)	NAT. GAS MBH MAX.	NOMINAL BOILER H.P. MAX.
EVO200-G-30	76	12-11/32	33-3/8	10-1/2	15-3/32	10-1/32	8	14-15/32	12-3/4	10-15/16	37-5/32	35-13/32	14-29/32	18-1/2	5-23/32	15.0	30.7	8400	200
EVO250-G-30	76	12-11/32	33-3/8	10-3/4	15-19/32	10-9/32	8	14-31/32	12-3/4	10-15/16	37-5/32	35-13/32	14-29/32	19	5-23/32	15.0	29.8	10500	250
EVO300-G-30	79	12-11/32	33-3/8	11-7/8	16-3/32	11-1/32	9	16-15/32	13-3/4	10-15/16	39-5/32	35-13/32	14-29/32	21-1/4	5-23/32	15.0	32.1	12600	300
EVO350-G-30	80	12-11/32	33-3/8	12-1/2	19-15/32	11-21/32	10	17-23/32	14-3/4	10-15/16	39-5/32	36-1/32	14-29/32	22-1/2	6-3/16	20.0	37.4	14700	350
EVO400-G-30	81	12-11/32	33-3/8	12-1/2	20-7/32	12-9/32	11	18-31/32	14-3/4	10-15/16	39-5/32	36-1/32	14-29/32	22-1/2	6-3/16	20.0	34.9	16800	400

Figure 1b: Model EVO® Dimensions, size 200-400

POWER FLAME MODEL "EVO500" – "EVO1000"



NOTE 1: POWER FLAME PRACTICES A POLICY OF CONTINUOUS IMPROVEMENT. IT RESERVES THE RIGHT TO ALTER SPECIFICATIONS WITHOUT PRIOR NOTICE.
2: DIMENSION "G" (FLANGE SETTING) SHOULD BE SIZED TO ALLOW THE FRONT EDGE OF THE BLAST TUBE SET FLUSH TO RECESSED 1-1/2" WITH THE BOILER INSIDE THE FRONT WALL.

ALL DIMENSIONS IN INCHES, UNLESS OTHERWISE NOTED.

BURNER MODEL	A	B	C	D	E	F	G	H	I	J	K	L	S	X	Y	BURNER MOTOR H.P.	GAS PRESS REQ'D (IN W.C.)	NAT. GAS MBH MAX.	NOMINAL BOILER H.P. MAX.
EVO500-G-30	107-7/8	15-3/4	33-1/4	14-1/2	21-3/32	13-13/32	13	21-7/32	17-3/4	11-1/32	62-3/4	36-13/32	13-5/16	26	6-19/32	25.0	41.9	21000	500
EVO600-G-30	118-9/16	16-3/4	32-1/4	16	21-3/32	14-13/32	14	23-7/32	18-3/4	11-1/32	62-1/2	36-13/32	12-5/16	29	6-19/32	25.0	52.1	25200	600
EVO700-G-30	116	17-5/8	33-3/16	16-1/2	26-23/32	15-9/32	15-1/4	24-31/32	20	10-15/16	68-3/16	36-3/4	12-1/8	31	7-3/32	30.0	64.9	29400	700
EVO800-G-30	118 3/4	15-13/16	33-3/16	17-1/2	24-13/16	16-5/32	17	26-23/32	21-3/4	10-15/16	69-3/16	36-3/4	12-1/16	33	7-3/32	40.0	77.3	33600	800
EVO900-G-30	123 5/16	29-3/4	31-3/4	18	28-7/8	16-29/32	20-1/2	28-7/32	25-1/4	10-15/16	65-3/16	36-3/4	10-5/8	34	7-3/4	40.0	85.4	37800	900
EVO1000-G-30	128 7/8	31-5/8	34-5/16	19	28-1/8	17-21/32	21-1/2	29-25/32	26-1/4	10-15/16	74-9/16	36-3/4	11-13/16	36	8-3/4	50.0	99.6	42000	1000

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ENGINEERING SPEC.
AND DATA SHEET

Figure 1c: Model EVO® Dimensions, size 500-1000

2. INSTALLATION

2.1 Gas Supply Piping

2.1.1 The installer should contact the local gas utility for information related to available supply pressures, limitations on allowable pressures in the building, general piping requirements and applicable codes, restrictions and regulations. Considerations of these types, as well as written permits and other state, city and local codes should be discussed with and approved by the appropriate governing bodies.

2.1.2 Gas piping should be sized to provide the required pressure at the burner train inlet manual shutoff cock, when operating at the maximum desired fuel input.

2.1.3 All gas piping should be appropriately pressure tested to ensure leak free operation. It is recommended that a dirt pocket or trap be piped into the gas supply system just ahead of the burner train inlet manual shutoff cock.

2.1.4 When testing with pressures higher than the maximum pressure ratings of the gas train components, be sure to isolate these components and test their piping for gas leaks with correct pressures only.

2.1.5 Refer to Table 1 and 2 for information relating to the sizing of gas supply piping. These charts are based on the general flow characteristics of commercially produced black carbon steel pipe. If in doubt regarding flow capabilities of a chosen line size, the next largest size is recommended. Use correction factors (multiplier) at right for other specific gravities and pressure drops.

2.1.6 Refer to Figure 2 for the typical gas piping schematic to meet U.L. requirements in the EVO® burner firing ranges.

Capacity of Pipes – Natural Gas (CFH)

With Pressure Drop of 0.3" w.c. and Specific Gravity of 0.60

Pipe Length (Feet)	Pipe Size – Inches (IPS)						
	1	1-1/4	1-1/2	2	2-1/2	3	4
10	520	1050	1600	3050	4800	8500	17500
20	350	730	1100	2100	3300	5900	12000
30	285	590	890	1650	2700	4700	9700
40	245	500	760	1450	2300	4100	8300
50	215	440	670	1270	2000	3600	7400
60	195	400	610	1150	1850	3250	6800
70	180	370	560	1050	1700	3000	6200
80	170	350	530	990	1600	2800	5800
90	160	320	490	930	1500	2600	5400
100	150	305	460	870	1400	2500	5100
125	130	275	410	780	1250	2200	4500
150	120	250	380	710	1130	2000	4100
175	110	225	350	650	1050	1850	3800
200	100	210	320	610	980	1700	3500

Correction Factors

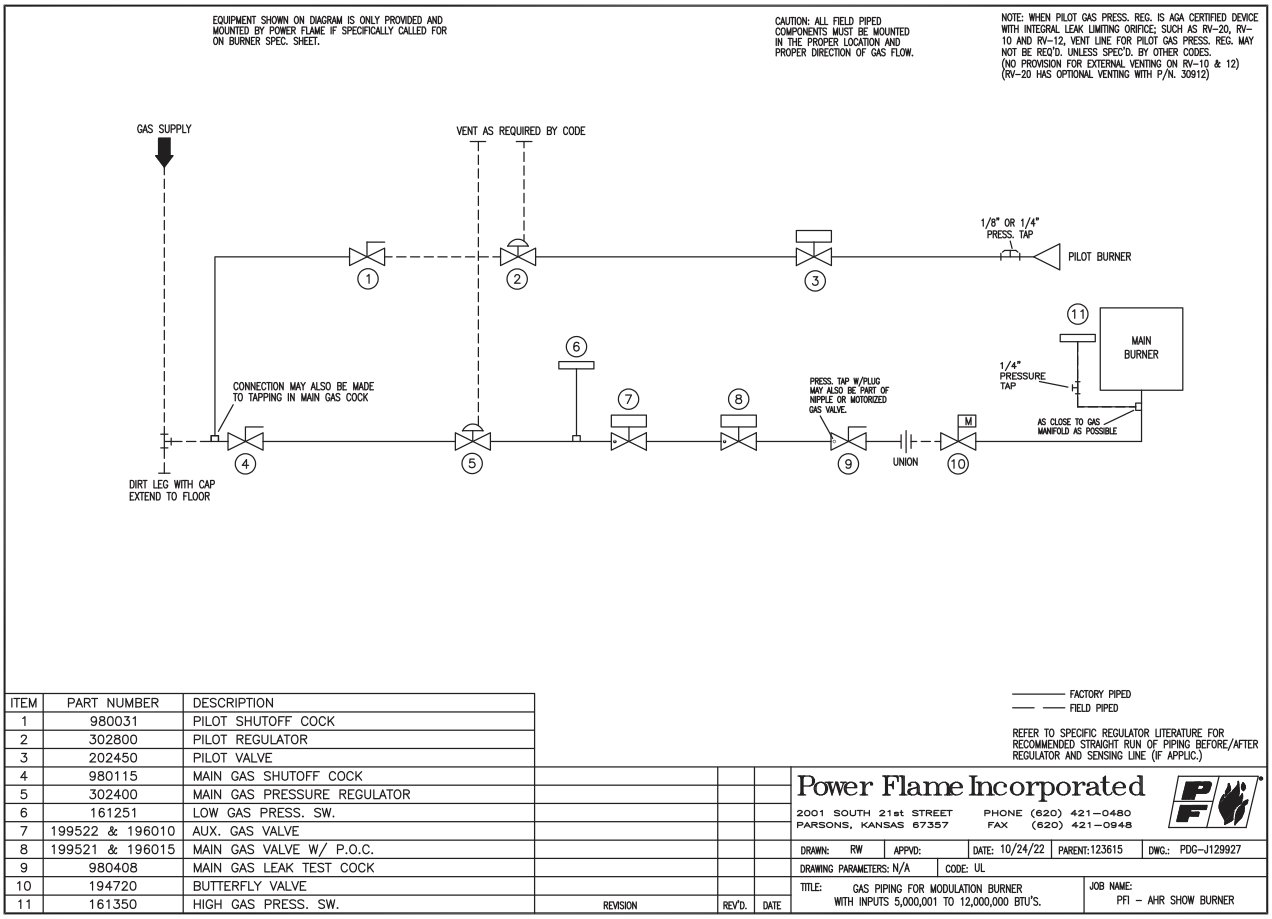
Specific Gravity other than 0.60		Specific Drop other than 0.3" w.c.	
Specific Gravity	Multiplier	Pressure drop (" w.c.)	Multiplier
0.5	1.1	0.1	0.577
0.6	1	0.2	0.815
0.7	0.926	0.3	1
0.8	0.867	0.4	1.16
0.9	0.817	0.6	1.42
1	0.775	0.8	1.64
Propane - Air		1	1.83
1.1	0.74	2	2.58
Propane		3	3.16
1.55	0.662	4	3.65
Butane		6	4.47
2	0.547	8	5.15

Note: Use multiplier at right for other specific gravities and pressure drops

Table 1: Capacity of pipes and correction factors

	Pipe Size (IPS)						
	1	1-1/4	1-1/2	2	2-1/2	3	4
Std tee through side	5.5	7.5	9	12	14	17	22
Std. E11	2.7	3.7	4.3	5.5	6.5	8	12
45° E11	1.2	1.6	2	2.5	3	3.7	5
Plug Cock	3	4	5.5	7.5	9	12	16

Table 2: Equivalent Length of Fittings in Feet



ITEM	PART NUMBER	DESCRIPTION
1	980031	PILOT SHUTOFF COCK
2	302800	PILOT REGULATOR
3	202450	PILOT VALVE
4	980115	MAIN GAS SHUTOFF COCK
5	302400	MAIN GAS PRESSURE REGULATOR
6	161251	LOW GAS PRESS. SW.
7	199522 & 196010	AUX. GAS VALVE
8	199521 & 196015	MAIN GAS VALVE W/ P.O.C.
9	980408	MAIN GAS LEAK TEST COCK
10	194720	BUTTERFLY VALVE
11	161350	HIGH GAS PRESS. SW.

Figure 2: Typical Gas Piping Schematic for Model EVO® Burner

2.2 Combustion Air Requirements

2.2.1 Fresh air required to support combustion, as well as to provide adequate location ventilation, must be supplied. All types of fuel require approximately 10 cubic feet of standard air (sea level at 60°F) per 1000 BTU's firing rate, for theoretical perfect combustion. In actual practice, a certain amount of excess air is required to ensure complete combustion, but this can vary substantially with specific job conditions.

2.2.2 Additional air is lost from the boiler room through barometric dampers, draft diverters, and similar venting devices. It is generally accepted that ½ square inch of free air opening (for each gas or oil burner in the room) per 1000 BTU/hr firing rate will be adequate. Under no circumstances should a boiler room be under negative pressure. Jurisdictional authority relating to combustion air and boiler room ventilation requirements vary widely. In order to achieve compliance, the controlling authorities should be consulted.

2.3 Burner Mounting: General

2.3.1 Provisions should be made to provide adequate space around the burner and associated equipment to allow for ease of inspection, maintenance, and service.

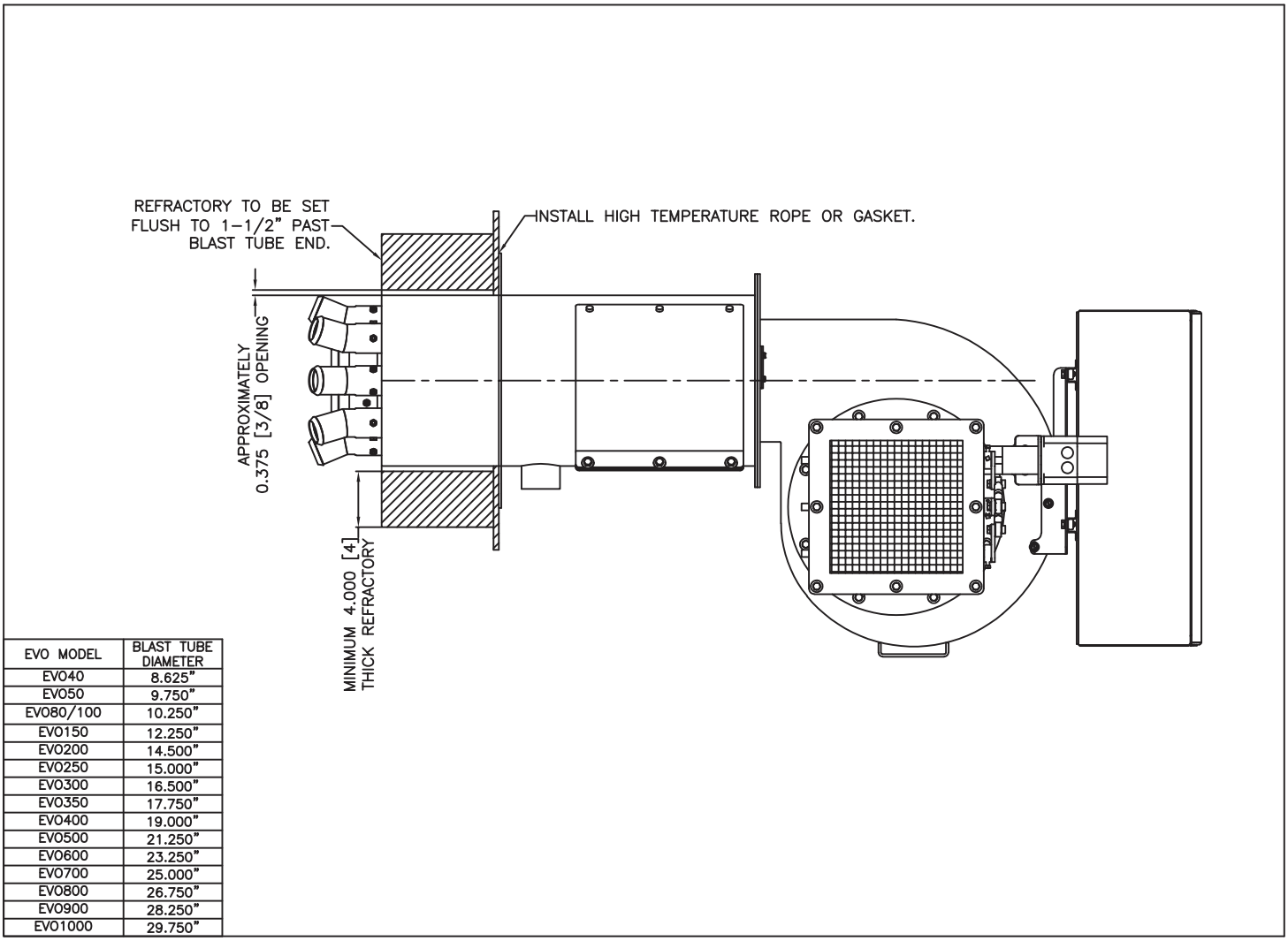
2.3.2 Observe codes for the minimum clearances to combustible materials.

2.3.3 Provide a suitable burner front plate, consisting of a steel plate of ample thickness to support the weight of the burner to hold it firmly in alignment with the heat exchanger.

2.3.4 The burner mounting flange must be securely attached to the heat exchanger front plate with suitable gasket or non-asbestos, high temperature rope packing to prevent any products of combustion from escaping from the combustion chamber through the burner-boiler mounting flanges. The burner assembly **must** be supported at the base of the housing to prevent undue strain on the front plate. (A mounting pedestal may be furnished for this purpose.)

2.3.5 The front edge of the blast tube needs to be set flush to 1 ½" recessed from the inside front wall of the heat exchanger. See Figure 3.

2.3.6 All burners are set through refractory with sleeve to allow field removal. The unlined space between sleeve and burner blast tube shall be filled in with non-asbestos high-temperature rope or KA-O-Wool.



EVO MODEL	BLAST TUBE DIAMETER
EV040	8.625"
EV050	9.750"
EV080/100	10.250"
EV0150	12.250"
EV0200	14.500"
EV0250	15.000"
EV0300	16.500"
EV0350	17.750"
EV0400	19.000"
EV0500	21.250"
EV0600	23.250"
EV0700	25.000"
EV0800	26.750"
EV0900	28.250"
EV01000	29.750"

Figure 3. EVO® Mounting Position

2.4 Combustion Chamber: General

2.4.1 All possible points of air infiltration or ex-filtration must be sealed. If the unit is to be fired under positive combustion chamber conditions, extreme care must be taken to ensure that a 100% seal is maintained. The Model EVO® burner is designed to provide all the air required for complete and efficient combustion. Entry or loss of air from sources other than the firing unit will decrease its' overall combustion and operational efficiency.

2.4.2 Table 3 below lists the minimum recommended firetube dimensions for the EVO® burner.

BHP	Min. Inside Diameter
40	*16"*
50	*18"*
80	*20"*
100	*22"*
150	*24"*
200	*28"*
250	*34"*
300	*34"*
350	*34"*
400	*38"*
500	*38"*
600	*42"*
700	*45"*
800	*45"*
900	*50"*
1000	*50"*

Table 3: Scotch Marine Boiler Minimum Furnace Tube Inside Diameter

2.5 Extreme Temperature Operation: General

2.5.1 When a burner is operating in an environment with combustion air as low at -40 F, it is strongly recommended that a combustion air preheater be installed to raise the combustion air temperature to at least 35 F. While the burner can operate with low temperature combustion air, there is a potential of ice buildup on the air damper, blower wheel, linkage, etc that can lead to failure of operation.

2.5.2 If the entire burner and control panel are outside in an environment that can reach -40 F, it is strongly recommended to install electrical heat tracing on natural gas piping, safety shutoff valves, and to use components rated for the environmental conditions. Also, it is recommended to install a heater in the control panel as well as insulating the flame scanner. Low temperature components are available at time of order as well as parts orders.

2.5.3 If the burner is in a hot environment, temperature ratings of each component need to be verified and an A/C unit may be required for the burner control panel.

3. START UP PROCEDURES

3.1 Burner Start Up and Service Test Equipment Required

3.1.1 The following test equipment is required to ensure proper start up and adjustment of burner equipment to obtain maximum efficiency and reliability of operation.

3.1.2 Equipment required:

For any fuel:

- O_2 analyzer (Required)
- NOx analyzer (Required)
- Stack thermometer
- Draft gauge or inclined manometer
- Combination volt/ammeter
- DC Micro-ammeter or DC Voltmeter, as required by Flame Safeguard programmer

For gas:

- CO indicator
- U-Tube manometers 0-16" W.C. or larger
- Calibrated pressure gauges 0-100" W.C. and 0-5 PSIG (Higher pressure ranges may be necessary depending upon gas inlet supply pressure)

3.2 General Start-Up All Fuels

3.2.1 A thoroughly qualified burner technician must be employed to provide the initial burner start up, as well as any subsequent servicing of the burner and related controls.

3.2.2 A representative of the owner and/or the person or persons responsible for operating and maintaining the unit should be present during the initial start up. A service representative may also be required by the local utility on gas-fired equipment. Instructions regarding the proper care and maintenance of the unit should be outlined with these people present.

3.2.3 Before initiating start up, the start up technician should thoroughly study and become completely familiar with the exact sequence of operation and all other details of the specific flame safeguard control system being used. This information will be found in bulletins printed and supplied by the control manufacturer. A copy of this bulletin is supplied with the burner.

3.2.4 Make a general inspection of the equipment room to ensure that the installation is complete. Check piping, controls, wiring and etc.

3.2.5 Close main and checking gas cocks.

3.2.6 Tighten all screws on terminal blocks in control cabinet in case some may have loosened in shipment.

3.2.7 Check fuses in main panel (if supplied) and in burner control cabinet. Check wiring to the burner control cabinet for compliance with the wiring diagram and local codes. Determine that voltage supply is correct to motor starter line connections and to control circuit line connections. If a control circuit transformer is supplied, make certain its primary voltage matches the line voltage being supplied.

3.2.8 Check breaching and stack to ensure that they are open and unobstructed.

3.2.9 Check blower rotation by momentarily making contact of the motor starters. Proper rotation is imprinted on the fan housing.

3.2.10 Check operating controls, limit controls, low water cut-off, flame safeguard control reset, high and low gas pressure switches (if used), low fire interlock switch (if used) and all other applicable interlocks. All contacts should be closed (an exception will be found on jobs using the low gas pressure switch; this switch should be open until the main gas cock is opened).

3.2.11 Do not repeatedly recycle the burner, as to allow any unburned fuel in the combustion chamber to collect. Allow 5 minutes between recycles.

3.2.12 Specific instructions relative to component sequencing are provided in the flame safeguard manufacturer's bulletin which is included with the documentation shipped with the burner.

3.2.13 Proper test equipment must be used in order to achieve maximum system operational reliability and fuel efficiencies. See previous page for a list of required equipment.

3.2.14 All fuel/air adjustments should be made to achieve required input rate, satisfactory combustion test values, flame stability and appearance.

3.2.15 Before firing gas, confirm the expected high fire manifold pressure as listed on the burner data plate. The manifold pressure shown will be the approximate manifold pressure at high fire. Specific adjustments to the burner such as changing the position of the diffuser, and/or changing the opening of the diffuser blades, will affect the ultimate manifold pressure.

3.2.16 Every new burner startup should employ the use of the Burner Start-Up Information and Test Data sheets on pages 20 and 21.

3.2.17 The gas system uses two electric gas shutoff valves to control the on/off flow of the gas. The gas flow is controlled by a butterfly type Gas Proportioning Valve. This fuel valve is controlled by an individual servo motor. The combustion air damper is also controlled by an individual servo motor, through appropriate sequencing – providing low fuel/air input for a smooth low fire start and a near infinite number of fuel/air positions between full low and high fire.

3.3 Burner Start-Up Sequence Instructions: Gas

3.3.1 Prior to burner start up – contact the local gas company to determine if any correction factors have to be applied to their indicated meter flow rates. This information is important as it relates to achieving specific heat exchanger BTU/HR inputs.

3.3.2 Refer to the gas piping diagram furnished with the burner. Check gas piping, controls and valves for leaks and compliance with codes.

3.3.3 Close main checking and pilot gas cocks. Install one gas pressure gauge (0-100" W. C.) to gas manifold pressure port. See Figure 2 for pressure sensing locations. Install a second gas pressure gauge to read gas supply pressure between the main gas cock and the inlet to the main gas pressure regulator (use a 0-5 PSI gauge or as appropriate). If there is no tapping in this location, install a tee at the point where the pilot gas supply is connected to the main gas line. Slowly open the main gas cock in order to determine that the incoming gas pressure is within the specified limits of the main and pilot gas pressure regulators, automatic fuel valves and gas pressure switches.

3.3.4 Disconnect pilot line at inlet to the pilot gas pressure regulator and purge air from the pilot gas line. Purging of gas lines must be done in accordance with NFPA 54 of the National Fire Protection Association's National Fuel Gas Code. After the air is purged from the gas supply system, close the pilot cock and reconnect the pilot line. Leave the pilot cock closed.

3.3.5 Install required system measuring devices: a) appropriate flame signal meter to the flame safeguard control; b) manometer (or 0-10" W. C. gauge) in the pilot test tee port; c) stack thermometer and O_2 sample line to the breaching; and d) draft gauge to the combustion chamber test point.

3.3.6 It is strongly recommended that an automatic gas valve bubble leak test be performed in accordance with the gas valve manufacturer's instructions on every new installation and periodically afterwards in order to ensure that the valve is functioning according to the manufacturer's specifications. It is also suggested that the test be conducted during a normal pre-purge burner operation. This test will reveal any problems that relate to incorrect wiring of the automatic gas valve that could cause premature energizing of the valve.

3.3.7 Verify the position of each servo. After the initial spanning of the servos the fuel valve should be at or near zero with the air dampers closed to 1/8" open. With both pilot and leak test gas cocks closed, open the main gas cock (to allow the low gas pressure switch, if supplied, to make its circuit). With the control switch in the OFF position, apply power to the burner through the main burner disconnect switch. Switch the burner panel On/Off switch to the ON position momentarily to determine that the blower rotation is correct.

3.3.8 Re-start the burner. With the pilot gas cock closed, the burner will go through a blower pre-purge period, after which the gas pilot ignition transformer will be energized, although no pilot will be established. (At no time should there be any flame signal reading, nor should the main gas valve attempt to open.) At the end of the pilot trial for ignition and blower purge period, the flame safeguard control should shut the system down in a safety lockout mode, requiring manual reset of the flame safeguard control to restart the burner.

3.3.9 Wait three minutes, reset the flame safeguard control safety switch (restarting the burner) and open the pilot gas cock. When the blower pre-purge period ends and the burner is energized – if the flame safeguard control has a test/run switch – flip the switch to the test position while the pilot is on and make adjustments

as required. The typical pilot pressure is 2" to 6" W.C. but can be higher depending on site conditions. See page 15 for pilot ignition adjustments, and Figure 4 below for pilot position. Recycle the burner several times to make certain pilot operation is reliable.

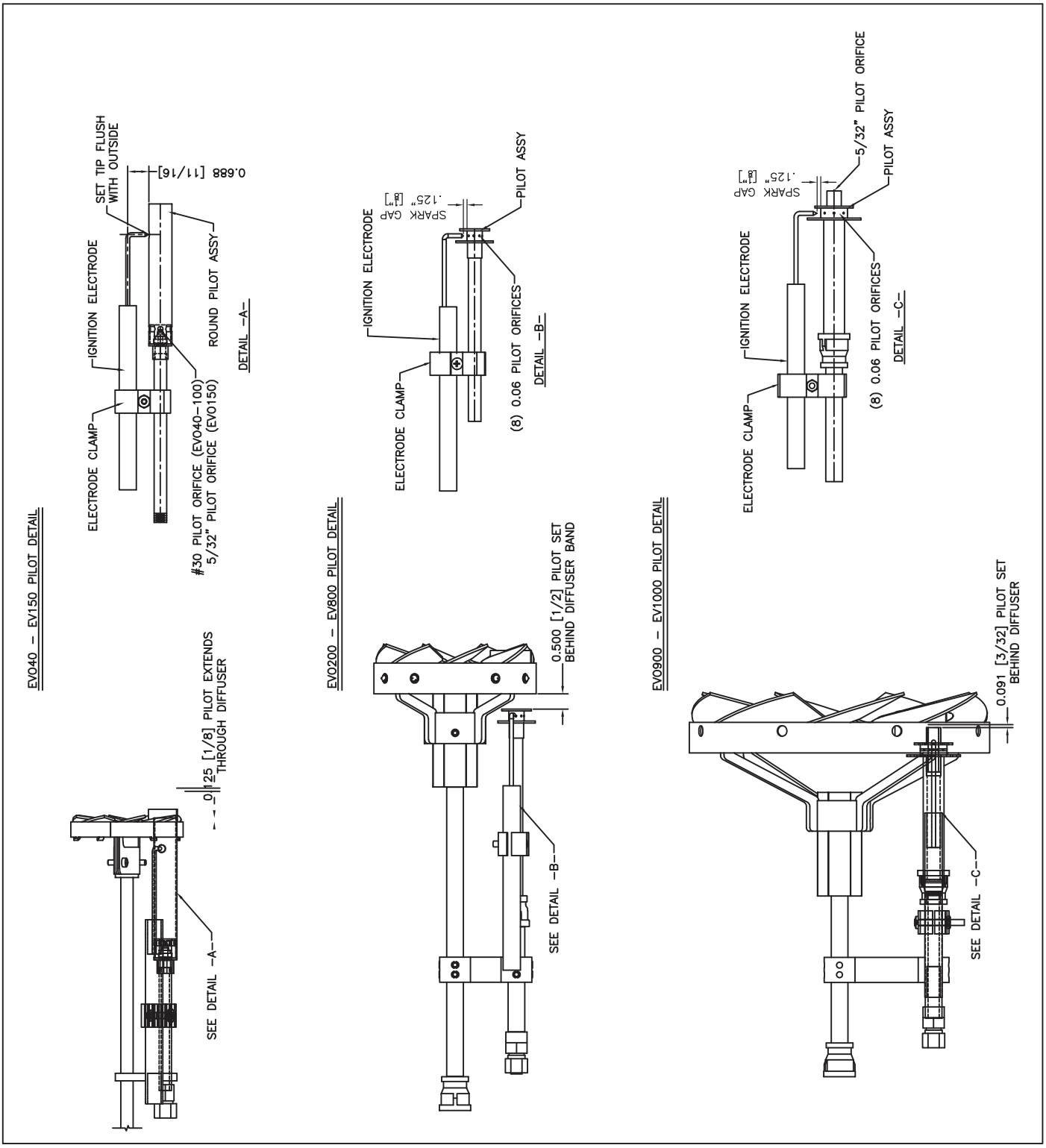


Figure 4. EVO® Pilot Position

3.3.10 With pilot adjustments completed, reset the switch to the Run position, which will allow the sequence to proceed to the automatic gas valve energizing position.

3.3.11 When the main automatic gas valve begins to open, slowly open the checking gas cock to light off the main flame. The main flame should light immediately. If not, it may be necessary to eliminate air from the main gas line and/or adjust main gas pressure regulator flow rates.

3.3.12 Adjust the burner as necessary to provide smooth ignition of the main flame. If the flame signal drops significantly when the main automatic gas valve opens, slightly increase the pilot gas pressure to attain a stable flame signal value.

3.3.13 Refer to paragraph 3.3.20 and 3.3.21 carefully for recommended limit control and other control devices operational checkout.

3.3.14 Initial adjustments should be made at the low fire position.

3.3.15 With the burner in the low fire position, adjust air and fuel servos to good fuel/air ratio low fire settings (3 – 5% O_2 and little or no CO). Operate the burner at low fire until the water is warm in the boiler.

3.3.16 At any point during commissioning, if the NOx level cannot be achieved it may be necessary to adjust the opening of the diffuser. This is accomplished by shutting down the burner and removing the diffuser to open or close the blades. However, as long as the burner maintains stability it is recommended that the commissioning continue since the regulator may need adjusted at high fire.

3.3.17 Slowly increase the firing rate by adjusting each servo to obtain the desired emissions level while maintaining stable combustion values (3 - 5% O_2 and little or no CO).

3.3.18 Continue to slowly increase the rate to high fire position. It will be necessary to reach the high fire position to determine the final gas regulator setting. Results should range in the area of 3% to 5% O_2 with little or no CO. The servo settings should be noted to obtain high fire reference points. Refer to Table 4 below for high fire net manifold pressures. These approximate manifold pressures do not include the furnace pressure, which will need to be added to these values.

EVO40	18.5”
EVO50	18.5”
EVO80	18.5”
EVO100	18.5”
EVO150	19.5”
EVO200	14.2”
EVO250	19.9”
EVO300	16.6”
EVO350	17.5”
EVO400	20.3”
EVO500	21.1”
EVO600	24.1”
EVO700	26.0”
EVO800	28.0”
EVO900	29.0”
EVO1000	30.0”

Table 4. Approximate High Fire Net Manifold Pressures

3.3.19 Determine that the required gas input rate is being achieved by clocking the gas flow at the gas meter. The gas utility may need to be consulted to determine if any correction factors have to be applied to the indicated meter flow rates.

3.3.20 Limit control check should be made as follows:

1) Permit the burner to run until the limit control settings have been reached.
2) The burner should turn off when the set temperature or pressure has been reached. Set the controls so that the burner will go to the low fire position before the operating limit control turns the burner off.
3) After a differential pressure or temperature drop, the burner should re-start automatically.
4) With the unit running normally, open the blow down valve and remove water to the point below the Low Water Cut Off setting. The burner should turn off and re-start automatically when the proper

water level is re-established. (If a manual reset type Low Water Cut Off is used, it will have to be reset).

3.3.21 Set and check operation of Low and High Gas Pressure Switches. See gas pressure switch manufacturer's instructions for detailed procedures. For initial start up, once the burner's normal operational gas pressure has been set, adjust the low and high gas pressure switches as follows:

1) Low Gas Pressure Switch: with the burner running, slowly close the main gas train manual shutoff cock and adjust the switch to open its circuit when the pressure falls approximately 25% below its normal value. The burner will shut down. Open the manual gas shutoff cock to the full open position and manually reset the Low Gas Pressure Switch. The burner will re-start.
2) High Gas Pressure Switch: with the burner running, adjust the switch to a point where the switch opens its circuit. The burner will shut down. Manually reset the switch and readjust the cutout point to be made at the normal operating pressure, but to open as the pressure increases to approximately 25% above normal.

3.3.22 Check all burner and heat exchanger controls and operating devices.

3.3.23 Check Blower Combustion Air Flow Switch:

1) Shut burner power off.
2) Disconnect both wires at the air flow switch and temporarily clip them together. Make sure that they cannot ground against anything, since they will be powered with 110 volts during the test.
3) Put a continuity meter across the common and normally open terminals on the air switch.
4) Close the gas train checking cock.
5) Start the blower motor. The meter should read electrical continuity as soon as the blower starts.
6) Disconnect the wire which energizes the coil of the motor relay (starter), or open the main power disconnect switch to the burner. Within 3 to 4 seconds after the blower motor is de-energized, the meter should indicate an open air flow switch circuit (no continuity).
7) If the switch does not open in 3 to 4 seconds, readjust accordingly. Turn the air flow switch adjustment screw clockwise to shorten cut-off response time and counter-clock-wise to lengthen cut-off response time.
8) Turn the burner power off. Remove the shorting clip from the two disconnected wires and cap them with a wire nut, let them hang loose (they will be powered with 110 volts, so don't let them ground out).
9) Open the gas train checking cock. Turn the burner on. With the wires disconnected, the burner should go into a purge cycle, although neither the ignition nor the main fuel valve circuits will be energized. If they do energize, there is a wiring problem. Correct as required.
10) Turn power off. Reconnect the air flow switch wires to the air flow switch terminals. Place burner back into normal operation.

3.3.24 The Owner's Operating Instructions, at the end of this manual, should be posted in a clearly visible location close to the burner.

3.3.25 If the burner operation is abnormal, refer to Section 4, Troubleshooting, as well as troubleshooting information included in the flame safeguard manufacturer's bulletin shipped with the burner. It is also strongly suggested that all test procedures outlined in the flame safeguard control manufacturer's bulletin be conducted.

3.3.26 Complete the Burner Start-up Information and Test Data sheets on pages 20 and 21.

4. TROUBLESHOOTING

4.1 Gas Pilot Ignition Adjustment

Excessive gas pressure and insufficient air may be the most common causes of pilot ignition failure. Gas pressure should be read at the test tee on the pilot gas supply pipe with a manometer or 0 – 16" W.C. gauge. Look for stability of gas pressures at all times. Some job conditions or heat exchangers may require larger air damper openings or different gas pressures than recommended. For dependable pilot ignition, always use air damper setting to provide the MOST air and LOWEST pilot gas pressure settings allowable for good pilot signal at all times.

1) Remove pilot assembly and check for proper orifice size and spark gap. The spark gap between the electrode and outside radius of the gas pilot assembly is detailed in Figure 4, on page 12.
2) Close checking cock (main test cock). Start up burner and flip run/test switch to test. Observe pilot signal with DC voltmeter or micro-ammeter and reduce pilot gas pressure to a point where the signal is erratic or reduced substantially from initial reading.
3) Raise the pilot gas pressure to the point where the signal is again stable. Remove scanner and use a mirror to view the pilot flame through the scanner pipe (a live flame from cigarette lighter or butane torch may be needed to keep scanner actuated). Be sure to get full coverage of scanner pipe by pilot flame. Replace scanner.
4) Release check switch and observe meter as main gas valve opens and the air damper moves. If there is a drop in signal as this happens, increase pilot pressure slightly until signal is steady at all times.

4.1.1 Refer to the next section, Gas Pilot Flood Test, as another means of determining proper pilot fuel/air mixture.

4.2 Gas Pilot Flood Test

4.2.1 Many pilot problems are caused by a poor mixture of gas and air at the point of ignition (ignition spark gap). The cause of this poor mixture condition is usually excessive gas flow or insufficient air (air dampers are closed too far).

4.2.2 Once the pilot is adjusted and felt to be correct – it is suggested that the following test be accomplished to further verify that the pilot will be reliable.

1) Turn the burner off and shut the main leak test cock in the main gas train. (This valve should always be closed when making pilot adjustments.)
2) Take steps to keep the fuel air linkage in the pilot light off position. If the flame safeguard control has a run/test switch, it can be placed in the test position. If the flame safeguard control does not have the run/test switch, it may be necessary to disconnect the power wire to the motorized gas valve.
3) Install a 0 to 16" W.C. gas pressure gauge or a manometer in the pilot test tee fitting. Plug an appropriate flame signal meter into the flame safeguard control.
4) Disconnect the high tension ignition lead-wire at the ignition transformer secondary terminal. Either hold onto the insulated portion or let the free ignition wire hang loose, so that it is not able to come into contact with the bare ignition terminal on the transformer.
5) Start the burner and let it go through the pre-purge period. As soon as the pilot ignition circuit is energized (listen for the sound of the solenoid valve opening or watch the pilot gas pressure gauge), let about 3 or 4 seconds lapse and then CAREFULLY (the ignition transformer is putting out 6000 volts) touch the ignition leadwire to the transformer terminal secondary. If the pilot fuel/air mixture and ignition electrode are adjusted correctly, the pilot will light instantly and the flame signal reading will be steady and of the correct value. If the pilot does not light instantly, then readjust the pilot gas pressure and/or the air dampers and/or the ignition electrode setting according to the information provided in this manual.

6) Turn the burner off. Re-connect the ignition leadwire to the ignition transformer secondary terminal. Set the check switch in the flame safeguard control for automatic operation. Re-connect any wires that have been disconnected to hold the motorized gas valve in the pilot position. Open the checking gas cock, turn the burner on and verify that the pilot lights and proves instantly, providing good, smooth ignition of the main gas flame.
7) If Gas Pilot Flood Test is successful, it is not always a guarantee of correct pilot air/fuel mixture, but a failure will almost always indicate an excessively rich mixture.

4.3 Trouble Shooting Suggestions: General

4.3.1 Burner Fails to Start

1) Defective On/Off or fuel transfer switch: replace.
2) Control circuit has an open control contact. Check limits, low water cutoff, proof of closure switch and others as applicable.
3) Bad fuse or switch open on in-coming power source. Correct as required.
4) Motor overloads tripped. Reset and correct cause for trip out.
5) Flame safeguard control safety switch tripped out. Reset and determine cause for apparent flame failure.
6) Loose connections or faulty wiring. Tighten all terminal screws and consult wiring diagram furnished with the burner.
7) Flame safeguard control starting circuit blocked due to flame relay being energized. Possible defective scanner: replace. Possible defective amplifier: replace. Scanner actually sighting flame due to leaking fuel valve: correct unwanted flame cause. Defective flame safeguard control: replace.
8) Defective blower motor. Repair or replace.

4.3.2 Occasional Lockouts For No Apparent Reason

1) Gas pilot ignition failure. Refer to pilot adjustment section and readjust to make certain that the ignition is instant and that flame signal readings are stable and above minimum values. Use a manometer or 0 to 16” W.C. gas pressure gauge on pilot test tee to make certain that pressure is as recommended.
2) Gas pilot ignition. Verify that there are no cracks in the porcelain and that transformer end and electrode end plug in connections are tight.
3) Loose or broken wires. Check all wire nut connections and tighten all terminal screw connections in panel and elsewhere as appropriate.
4) Ensure that when main flame lights, the air flow switch is not so critically set as to allow occasional momentary opening of the air switch contacts.
5) Occasional low voltage supply. Have local utility correct. Make certain that the burner control circuit transformer (if supplied) is correct for the voltage being supplied.
6) Occasional low gas supply pressure. Have utility correct.

4.4 Trouble Shooting Suggestions: Gas

4.4.1 Burner Motor Runs, but Pilot Does Not Light

1) Gas supply to burner shut off – make sure all manual gas supply valves are open. Automatic high pressure valve at meter such as Sentry type tripped shut due to high gas pressure – reset valve and correct cause for trip out.
2) Pilot solenoid valve not opening – listen and feel for valve actuation. Solenoid valve not being powered – check electrical circuitry. Replace coil or entire valve if coil is burned out.
3) Defective gas pilot regulator – replace.
4) Gas pressure too high or too low at pilot. Readjust as required.

5) Defective ignition transformer – replace. Incorrect ignition electrode settings – refer to gas pilot adjustments for correct settings.
6) Defective flame safeguard control or plug in purge timing card. Replace as required.
7) Air flow switch not making circuit – check out electrically and correct pressure adjustment on switch, if required. Defective air flow switch – replace. Air switch negative pressure sensing tube out of position – reposition as necessary.

4.4.2 Burner Motor Runs and Pilot Lights, but Main Gas Flame Is Not Established

1) Main shutoff or test cock closed. Check to make certain fully open.
2) Pilot flame signal reading too low to pull in flame safeguard relay. Refer to gas pilot settings section and readjust as required.
3) Defective automatic main or auxiliary gas shut off valves. Check electrical circuitry to valves. Replace valves or correct circuitry as required.
4) Defective flame safeguard control or plug in amplifier. Check and replace as required.
5) Butterfly valve set incorrectly on modulating burner. Readjust as required.
6) Main gas pressure regulator atmospheric vent line obstructed. Correct.
7) Defective main gas pressure regulator – replace. Misadjusted main gas pressure regulator – readjust to meet required operational values.

4.4.3 Carbon Monoxide Readings on Gas Firing

1) Flame impingement on cold heat transfer surfaces caused by excessive firing rate. Reduce firing rate to correct input volume.
2) Flame impingement on cold combustion chamber surfaces due to undersized combustion chamber. Refer to chamber size charts and/or contact factory for additional information.
3) Incorrect gas/air ratios. Readjust burner to correct CO_2 / O_2 levels, reducing CO formation to appropriate level.

4.4.4 Gas High Fire Input Cannot Be Achieved

1) Gas company pressure regulator or meter operating incorrectly, not allowing required gas pressure at burner train inlet. Have gas company correct.
2) Gas cock upstream of train inlet not fully open. Check and correct.
3) Gas line obstructed. Check and correct.
4) Gas train main and/or leak test cocks not fully open. Check and correct.
5) Gas supply line between gas company regulator and burner inlet too small. Check supply pressure at meter, determine pressure drop and increase line size as required, or raise supply pressure to compensate for small line. Do not raise pressure so high that under static (no flow) conditions the pressure exceeds the maximum allowable pressure to the gas train components on the burner.
6) Burner gas train components sized too small for supply pressure. Increase component size as appropriate.
7) Automatic gas valve not opening fully due to defective operation. Replace gas valve.
8) Butterfly valve not fully opened. Readjust.
9) Defective main gas pressure regulator. Replace
10) Incorrect spring in main gas pressure regulator. Replace as required.
11) Main gas pressure regulator vent line obstructed. Check and correct.
12) Normally open vent valve (if supplied) not closing when automatic gas valves open. Check to see if valve is fully closed when automatic valves are open. Replace vent valve, if not closing fully.

5. MAINTENANCE

5.1 General Information

5.1.1 Only qualified service technicians should make mechanical or electrical adjustments to the burner and/or associated control equipment.

5.1.2 Preventive maintenance can usually be performed by building maintenance personnel.

5.1.3 Always follow the information provided in the Owner Operating Instructions at the end of this manual. These should be conspicuously posted in the burner room at the time of the initial burner installation and startup.

5.1.4 Always turn the power supply off to the burner and close manual fuel valves as appropriate for routine maintenance.

5.1.5 Make sure that combustion and ventilation fresh air sources to the burner room remain clean and open.

5.1.6 Periodically check all electrical connections and make sure the flame safeguard control chassis is firmly connected to its wiring base.

5.1.7 Refer to manufacturer's product bulletins supplied with the burner for maintenance on the flame safeguard control and other components.

5.1.8 Refer to heat exchanger manufacturer's instructions for general inspection procedures and for specific testing and inspection of all liquid level controls, pressure/temperature relief and other applicable items.

5.1.9 If you have any questions about the procedures listed above or questions relating to components or devices on your unit not specifically covered in the above, contact Product Support at (620) 820-8301 for assistance.

5.2 Periodic Check List

Item	Frequency	Checked By	Remarks
Gages, monitors and indicators	Daily	Operator	Make visual inspection and record readings in log
Firing rate control	Weekly	Operator	Verify heat exchanger manufacture's settings
	Semiannually	Service Technician	Verify heat exchanger manufacture's settings
	Annually	Service Technician	Check with combustion test
Flue, vent, stack or outlet damper	Monthly	Operator	Make visual inspection of linkage check for proper operation
Combustion air	Monthly	Operator	Check that all sources remain clean and open
Ignition System	Weekly	Operator	Make visual inspection Check flame signal strength (see Combustion Safety Controls)
Flue, vent, stack or outlet damper	Monthly	Operator	Make visual inspection of linkage Check for proper operation
Pilot and main gas or oil valve	Weekly	Operator	Open limit switch-make aural and visual check Check valve position indicators Check fuel meters if so fitted
	Annually	Service Technician	Perform leakage tests (refer to valve manufacturer's instructions)
Flame failure	Weekly	Operator	Close manual fuel supply for (1) pilot and (2) main fuels and check safety shutdown timing and log
Flame signal strength	Weekly	Operator	If flame signal meter installed, read and log for both pilot and main flames Notify service organization if readings are very high, very low, or fluctuating (Refer to flame safeguard manufacturer's instructions)
Pilot turndown tests	As required/annually	Service Technician	Required after any adjustments to flame scanner mount or pilot burner (Refer to flame safeguard manufacturer's instruction)
Pilot signal	As required/annually	Service Technician	Verify that the scanner does not pick up the spark or the glow from the refractory
High limit safety control	Annually	Service Technician	Refer to heat exchanger manufacturer's instructions
Operating control	Annually	Service Technician	Refer to heat exchanger manufacturer's Instructions
Draft, fan, air pressure,and damper	Monthly	Operator	Refer to this manual and control manufacturer's instructions
High & low gas pressure interlocks	Monthly	Operator	Refer to instructions in this manual
Low oil pressure interlocks	Monthly	Operator	Refer to instructions in this manual
Fuel valve interlock switch	Annually	Service Technician	Refer to valve manufacturer's instructions
Purge switch	Annually	Service Technician	Refer to fuel/air control motor manufacturer's instructions
Low fire start interlock	Annually	Service Technician	Refer to fuel/air control motor manufacturer's instructions
Automatic changeover control (dual fuel)	Annually	Service Technician	Under supervision of gas utility
Remove oil drawer assembly	Annually	Service Technician	Remove and clean
Blower motor and blower wheel	Annually	Service Technician	Remove and clean as necessary
Gas pilot assembly	Annually	Service Technician	Remove and clean as necessary
Air compressor	Monthly	Operator	Check oil level and fill as required

6. BURNER START UP INFORMATION & TEST DATA

The following information shall be recorded for each burner start up

Power Flame model No._____ Job No._____ Serial No._____

Installation Name_____

Start Up Contractors Name_____

Name of Technician Performing Start Up_____

Phone_____ Start Up Date_____

Type of Gas: *Natural Gas*_____ *LP*_____ *Other* _____

Gas Firing					
Gas Pressure at Train Inlet	Burner Off		Flame signal	Pilot	
	Low Fire			Low Fire	
	High fire			High fire	
Stack Outlet Test Point Draft	Low fire		O2 (%)	Low fire	
	High Fire			High fire	
CO (ppm)	Low fire		Nox (ppm)	Low fire	
	High Fire			High fire	
Gas Pressure at Firing Head	Low fire		Combustion Efficiency (%)	Low fire	
	High Fire			High Fire	
Net Stack Temperature	Low fire		Input Rate BTU/HR	Low fire	
	High Fire			High Fire	
Over Fire Draft	Low fire		Power Supply	Volts	
	High Fire			Phase	
Gas Pressure at Pilot Test Tee				Hz	
Blower Motor Amps at High Fire			Control Circuit Volts		

Control Settings		
General	Operating control cut out setting	
	Operating control cut in setting	
	Limit control cut out setting	
	Limit control cut in setting	
Gas	Low gas pressure switch (")	
	High gas pressure switch (")	

Operation Checklist					
Checked for Proper Operation	Yes	No		Yes	No
Low water cut off			Fresh air damper switch		
High water cut off			Barometric Damper		
Flame safeguard control Ignition failure			Boiler room combustion air and ventilation provisions		
Flame safeguard control main flame failure			All gas lines checked for leaks		
Burner air flow switch			Gas lines and controls properly vented		
Induced draft fan controls			Other system components (specify)		
Over fire draft controls					

Notified_____of the following system deficiencies:_____

_____

_____

_____

_____

NOTES:

OWNER OPERATING INSTRUCTIONS

⚠ WARNING ⚠

Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Refer to the burner manual for assistance or additional information consult a qualified installer, service agency or the gas supplier.
Do not store or use gasoline or other flammable liquids and vapors in the vicinity of this or any other appliance.

START UP

Preparation for Start Up

1) Ensure that the system is in working order. If heat exchanger is a boiler, ensure that proper water level is available.
2) Turn the thermostat or operating control down to its lowest setting.
3) Check fuses and replace as necessary.
4) Depress the flame safeguard programming control reset button.

Start Up – Gas Burner

1) Manually open and close the main gas shut off cock, leak test cock and pilot cock to determine that they operate freely. Open all three cocks. (Reset low gas pressure switch if supplied).
2) Set the main power switch and burner panel control switch to the ON position. Wait 30 seconds and turn up thermostat or operating control to the desired setting.
3) The burner blower motor will start and after a suitable pre-purge period (this will vary with the type of flame safeguard control supplied – but will usually be minimum of 30 seconds to a maximum of 90 seconds) the burner pilot will light, after which the main flame will be established.
4) If the system does not respond properly, contact your qualified burner service company.
5) When burning gas on a combination gas/oil unit that has a blower motor driven oil pump, open all oil line valves. Oil must circulate through the oil pump, even when burning gas.

EXTENDED SHUT DOWN

1) Place main power switch and burner control panel switch in the OFF position.
2) Close all valves in gas lines.
3) Cover burner to protect it from dust and dampness.

FOR YOUR SAFETY

If you smell gas:

1) Open windows
2) Do not touch electrical switches
3) Extinguish any open flame 4) Call

you gas supplier immediately

IMPORTANT PRECAUTIONS

1) Never attempt to light burner with paper or other materials.
2) Never experiment with the burner.
3) Never change the fuel or air adjustments without consulting with the burner service company.
4) Never attempt to light the burner if combustion chamber contains any unburned fuel or gases.
5) Never throw waste paper, rags, garbage or other waste materials into the combustion chamber.
6) Never wash out heating equipment room without first covering the burner with waterproof material.

MAINTENANCE

Burner should be maintained and serviced by a qualified service agent. See service and maintenance section of the manual for suggestions on periodic maintenance and service.

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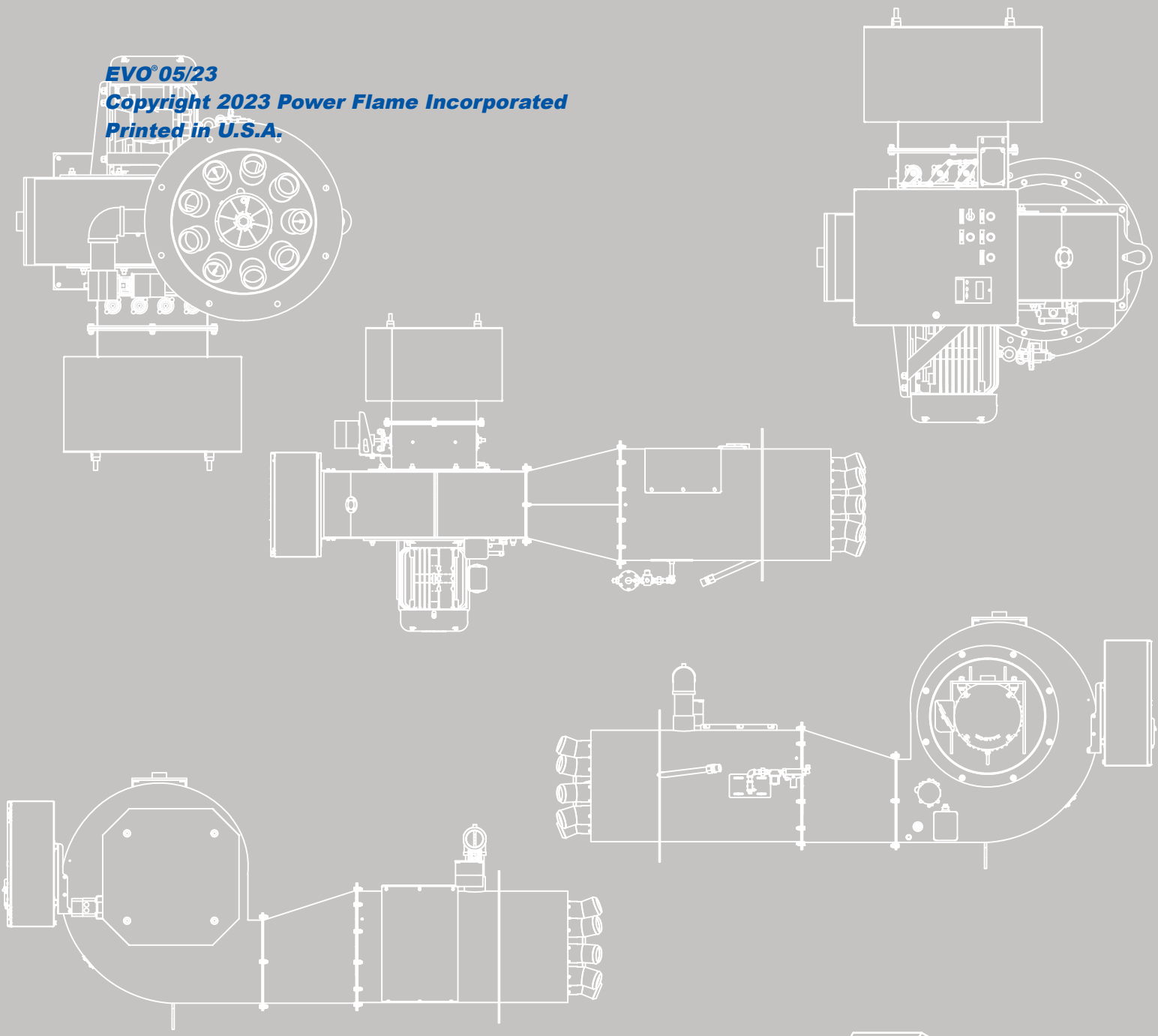
EVO® 05/23



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