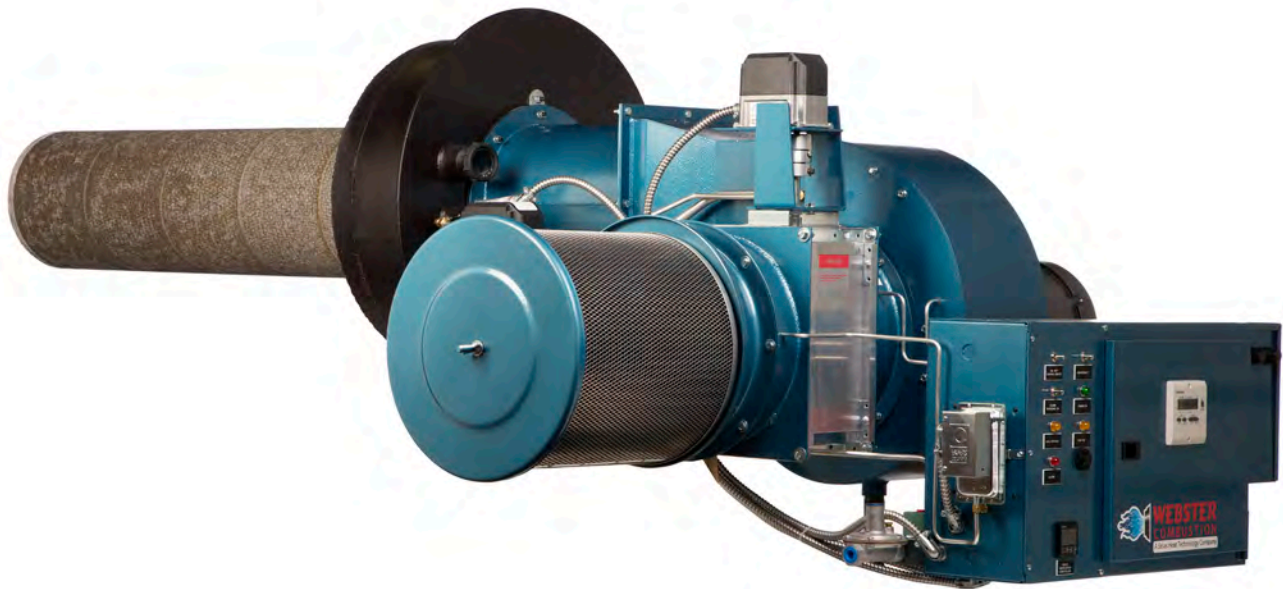




Webster Combustion Technology, L.L.C.  
619 Industrial Road, Winfield, KS 67156

## Installation, Startup, Operation and Maintenance Manual

# JBFX/HDFX Series Forced Draft Burners



Manual Part No. 950088  
[www.webstercombustion.com](http://www.webstercombustion.com)  
May, 2016



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## SAFETY PRECAUTIONS

Good safety practices must be used when working on burner equipment. The potential energy in the electrical supply, fuel and related equipment must be handled with extreme care to prevent equipment failures, injuries and potential death.

Throughout this manual, the following symbols are used to identify potential problems.

### WARNING

**This indicates a potential hazardous situation, which if not avoided, could result in personal injury or death.**

### CAUTION

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

The following general safety precautions apply to all equipment work.

### WARNING

**IF YOU SMELL GAS, OPEN WINDOW, EXTINGUISH ANY OPEN FLAMES, STAY AWAY FROM ELECTRICAL SWITCHES, EVACUATE THE BUILDING AND IMMEDIATELY CALL THE GAS COMPANY.**

**IN ACCORDANCE WITH OSHA STANDARDS, ALL EQUIPMENT, MACHINES AND PROCESSES SHALL BE LOCKED OUT PRIOR TO SERVICING.**

**IF THIS EQUIPMENT IS NOT INSTALLED, OPERATED AND MAINTAINED IN ACCORDANCE WITH THE MANUFACTURERS INSTRUCTIONS, THIS PRODUCT COULD EXPOSE YOU TO SUBSTANCES IN FUEL OR FROM FUEL COMBUSTION WHICH CAN CAUSE DEATH OR SERIOUS ILLNESS AND WHICH ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.**

**IMPROPER SERVICING OF THIS EQUIPMENT MAY CREATE A POTENTIAL HAZARD TO EQUIPMENT AND OPERATORS.**

**SERVICING MUST BE DONE BY FULLY TRAINED AND QUALIFIED PERSONNEL.**

**BEFORE DISCONNECTING OR OPENING UP A FUEL LINE AND BEFORE CLEANING OR REPLACING PARTS OF ANY KIND,**

- **TURN OFF THE MAIN MANUAL FUEL SHUTOFF VALVES INCLUDING THE PILOT COCK, IF APPLICABLE. IF A MULTIPLE FUEL BURNER, SHUT OFF ALL FUELS.**
- **TURN OFF ALL ELECTRICAL DISCONNECTS TO THE BURNER AND ANY OTHER EQUIPMENT OR SYSTEMS ELECTRICALLY INTERLOCKED WITH THE BURNER.**

Service Organization Information:

Company Name \_\_\_\_\_

Address \_\_\_\_\_

Phone Number \_\_\_\_\_

Date of Startup

\_\_\_\_\_

Lead Technician

\_\_\_\_\_

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## A. INTRODUCTION

This manual covers the Models JBFX and HDFX burners offered by Webster Combustion Technology, LLC. These burners can be used in a wide variety of Cast Iron, Firebox, Firetube, Flextube and other applications. They can fire natural gas or propane with several different operating systems.

### READ AND SAVE THESE INSTRUCTIONS FOR REFERENCE.

#### WARNING

**DO NOT ATTEMPT TO START, ADJUST OR MAINTAIN THIS BURNER WITHOUT PROPER TRAINING OR EXPERIENCE. FAILURE TO USE KNOWLEDGEABLE TECHNICIANS CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.**

The startup and maintenance of the JBFX and HDFX burners requires the skill of an experienced and properly trained burner technician. Inexperienced individuals should not attempt to start or adjust this burner.

Every attempt has been made to accurately reflect the burner construction, however, product upgrades and special order requirements may result in differences between the content of this manual and the actual equipment. These special components will be described in the information provided with the burner and should be used as the controlling document.

**NOTE: This manual must be readily available to all operators and maintained in legible condition.**

### 1. Nameplate Information

Each burner has a nameplate with important job details, similar to the nameplates shown in Figure A-1. The “X” in the model number refers to a low NOx burner.

**Figure A-1 Nameplate**

<b>MODEL NUMBER</b>		<b>SERIAL NUMBER</b>				
JBFX1G-47-10-LMV37-M.10-CSDI		U110539A-01				
<b>GAS INPUT RATING</b>						
	MBTU/HR	IN.WC				
MAXIMUM	1999	9.5				
MINIMUM	667	1.2				
FUEL	NATURAL GAS					
	VOLTS	AMPS	HERTZ	PHASE	HP	
CONTROL CIRCUIT	115	5.0	60	1		
BURNER MOTOR	208	4.1	60	3	1.0	

*The serial number represents the unique number for that burner and is a critical number that will be needed for any communications with Webster Combustion.*

*The input rates define the maximum and minimum inputs for that burner, given in MBH for gas.*

*The electrical ratings of the burner are given, with the voltage, current load, frequency and phase (this will either be single or 3-phase). For motors, the motor HP is listed.*

## 2. Ratings

The ratings for each specific burner are given on the nameplate. The general burner ratings are given in Specification Sheets that follow this section. The maximum inputs are given based on the type of fuel. Other conditions, like the supply gas pressure or the combination of fuels, emission requirements and control systems, may prevent the burner from reaching the lowest firing rate.

## 3. Product Offering

The JBFX/HDFX burner can fire natural gas, propane and digester gas.

This burner is a low emission burner capable of firing sub 20ppm NO<sub>x</sub> or sub 9ppm NO<sub>x</sub>, depending on the requirements of the particular burner application.

Figure A-2 lists the common variations and options available on this product. The minimum furnace conditions are given in Section C.

## 4. Your Complete Manual

In addition to this manual, there are several other documents that should be considered as part of the complete manual for the burner.

All of these documents are needed to support the installation and startup of the unit. These additional items include:

- a. The wiring diagram, which shows the limits and interconnection of the burner and vessel controls.
- b. The gas piping schematics, which show the components and their relative positions in the piping train.
- c. The unit material list which provides an overview of the burner requirements and a complete bill of material, including the part numbers and description for each item.
- d. The flame safeguard manual provides the operating sequence for the burner management system. This will be a critical document for troubleshooting any future problems.
- e. Catalog cuts of the major components. These provide details on the installation, adjustment and maintenance of the components used on the burner.

## 5. Service, Parts and other Information

Service and parts are available from your local Webster Representative. For a list of Webster Representatives, please call 620-221-7464, or visit the Webster web site:

**[www.webstercombustion.com](http://www.webstercombustion.com)**

# MODEL JBFX BURNER MODEL CONFIGURATION

## FIGURE A-2

**JBFX1G-40-07-RM7800L-M.25-M-UL/CSD-1**

BURNER SERIES	
JBF	JBF SERIES
HDF	HDF SERIES

"X" denotes Low NOx

BLOWER HOUSING SIZE
---------------------

FUELS	
G	Nat. Gas
LP	Propane
SG	Digester

Boiler Horsepower

BLOWER MOTOR HORSEPOWER	
03	1/3
05	1/2
07	3/4
10	1
15	1.5
20	2
30	3
50	5

FLAME SAFEGUARD VENDOR DESIGNATION	
RM7800L	Honeywell
M Mark	AutoFlame - mini mark
E110/EP170	Fireye
Nexus	Fireye
LMV3	Siemens
LMV5	Siemens

CODES AND LISTINGS
UL
ULc
CSD-1
FM
IRI
NFPA-85

GAS TRAIN VENDOR	
VGD	Siemens
VGG	Siemens
M	Maxon
Blank	All Others (ASCO) - (std)

GAS TRAIN SIZE	
.15	1 1/2 inches
.20	2 inches
.25	2 1/2 inches
.30	3 inches
.40	4 inches

GAS SYSTEM	
M	Modulation

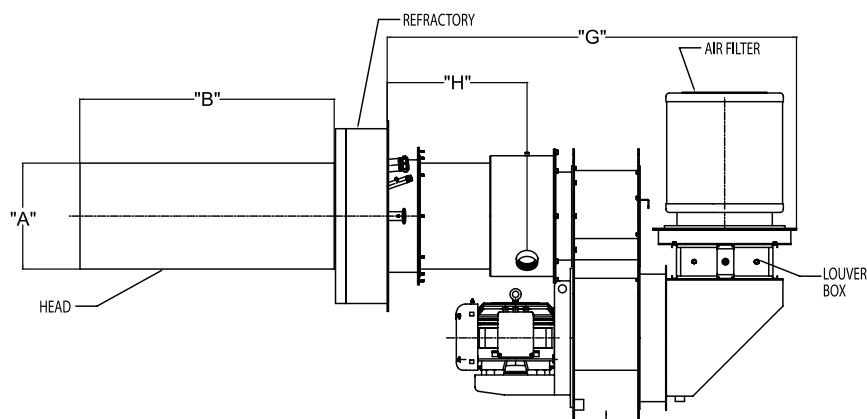
The above represents the common model designations.  
Contact the factory for other options and special applications.

## Model JBFX Series Typical Dimensions (Inches)

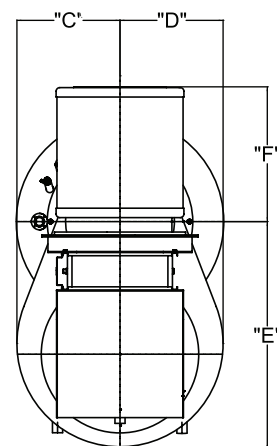
Burner Model Number	Input (MBH)	Motor HP	Std. Gas Train Size	Min. Req'd Gas Pres.	Dimensions							
					A	B	C	D	E	F	G	H
JBFX1-G10-03	420	1/3	1"	1 PSIG Min.	4	6	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G15-03	640	1/3	1"	Req'd Supply Pressure	4	9	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G20-05	850	1/2	1"		5.3	9	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G25-05	1060	1/2	1"		7.6	8	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G30-07	1280	3/4	1 1/4"		7.6	9.5	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G35-07	1490	3/4	1 1/4"		7.6	11	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G40-07	1700	3/4	1 1/4"		7.6	12.6	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G42-10	1790	1	1 1/4"		7.6	13.1	24.4	12.3	11.5	20	30.5	10.6
JBFX1-G47-10	2000	1	1 1/2"		7.6	14.8	24.4	12.3	11.5	20	30.5	10.6
JBFX2-G50-15	2130	1 1/2	1 1/2"		7.6	15.5	23.5	14.3	14.8	20	33.6	10.6
JBFX2-G60-15	2560	1 1/2	1 1/2"		7.6	19	23.5	14.3	14.8	20	33.6	10.6
JBFX2-G75-20	3200	2	2"		7.6	23.5	23.5	15.3	14.8	20	33.6	10.6
JBFX2-G90-30	3840	3	2"		9.5	23	23.5	15.3	14.8	20	39.6	11
JBFX3-G100-50	4260	5	2"		9.5	26	33.9	16	18.5	20	40.2	11
JBFX3-G125-50	5330	5	2 1/2"		9.5	31	33.9	16	18.5	20	40.2	11
JBFX3-G150-100	6400	10	2 1/2"		11	33	33.9	20	18.5	20	40.2	11
JBFX3-G200-100	8530	10	3"		11	44	36.5	20	18.5	20	40.2	11
HDFX5-G250-150	10,500	15	3"	2 PSIG	13	46	15.3	15.3	36	22.6	54	18
HDFX5-G300-150	12,600	15	3"	2 PSIG	15	48	15.3	15.3	36	22.6	54	18
HDFX7-G500-300	20,900	30	3"	4 PSIG	20	48	17.9	17.9	39.5	23.4	77.3	26.5

Note: HDFX burners are not currently U.L. listed.

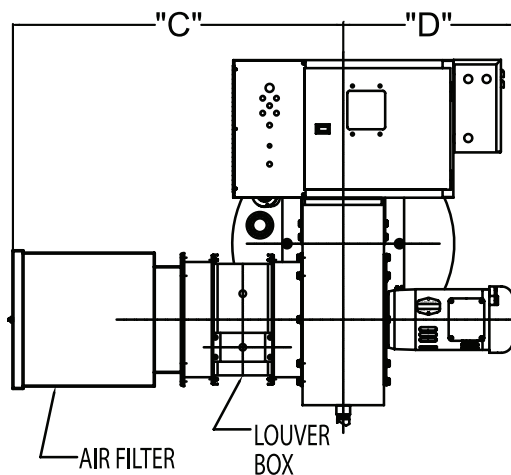
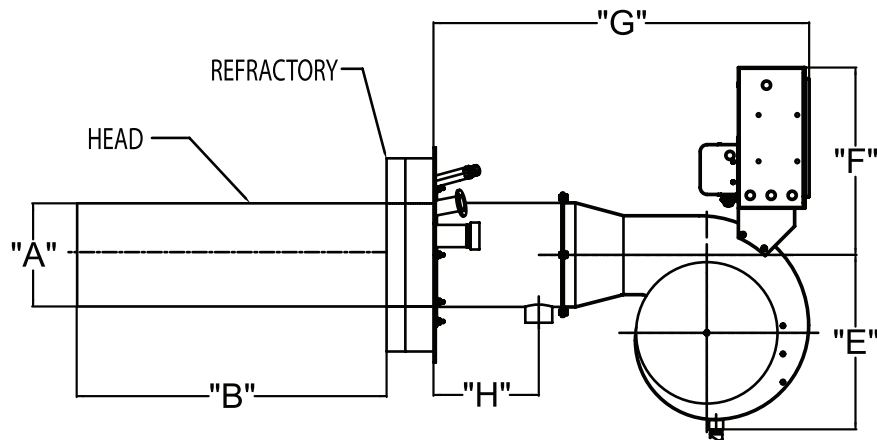
### HDFX Side View



### HDFX Back View



## JBFX Side View



## JBFX Back View

### Fuels Burned and Control Systems

- Natural Gas, Propane, Digester or Mixed Gases
- Modulating
- Control Circuit Requires 120 vac, 60 Hz, Single Phase Voltage Supply

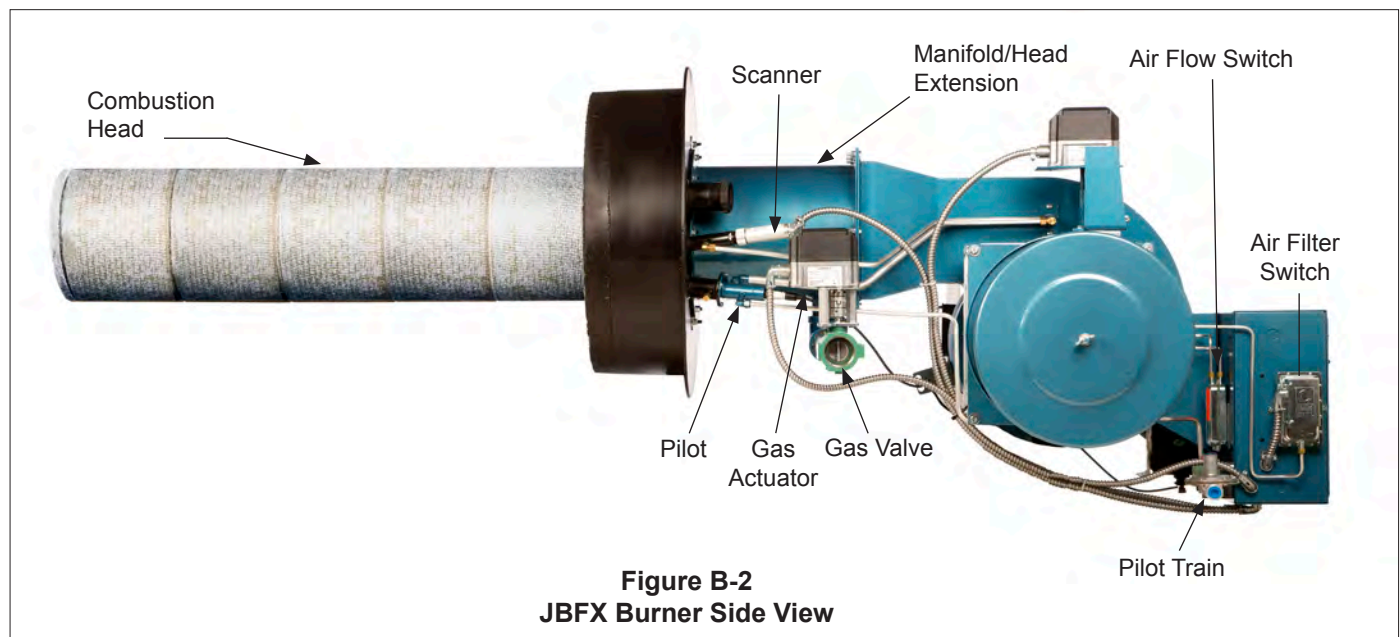
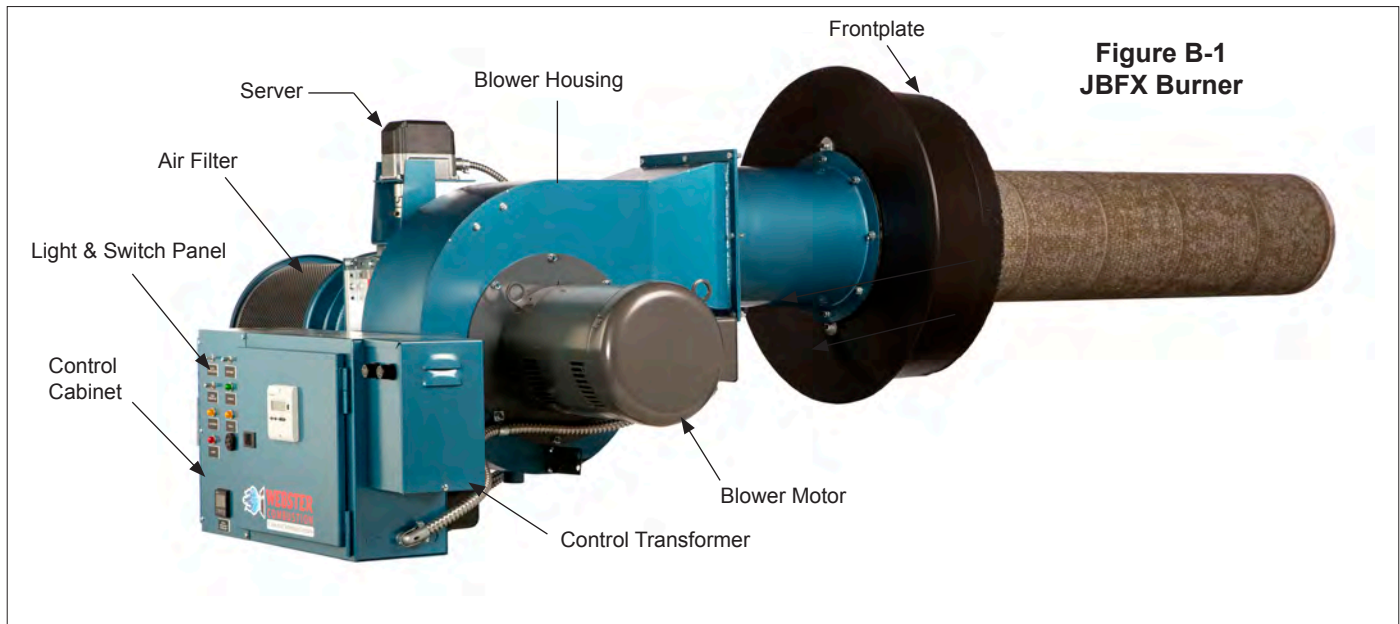
Model JBFX burners are listed by Underwriters Laboratories, Inc. (UL / ULC) and can be packaged to meet specific requirements of IRI, FM, GE GAP, NFPA, MIL spec. or other special insurance or local code requirements.

Model HAFX burners are not listed by Underwriters Laboratories Inc (UL/ULC) but can be packaged to meet specific requirements of IRI, FM, GE GAP, NFPA, MIL spec. or other special insurance or local code requirements.

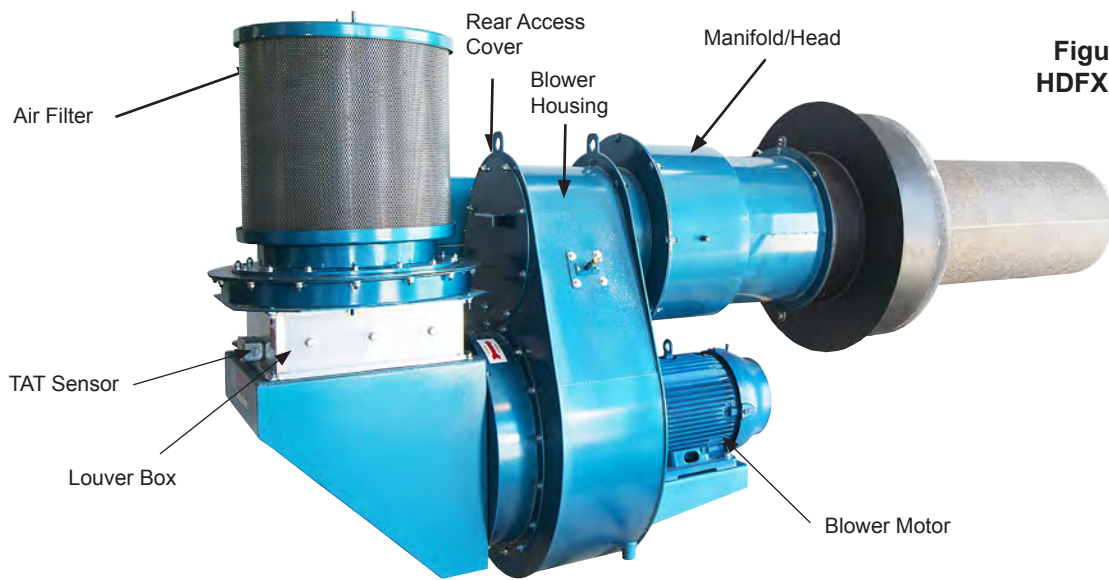


## B. COMPONENT IDENTIFICATION

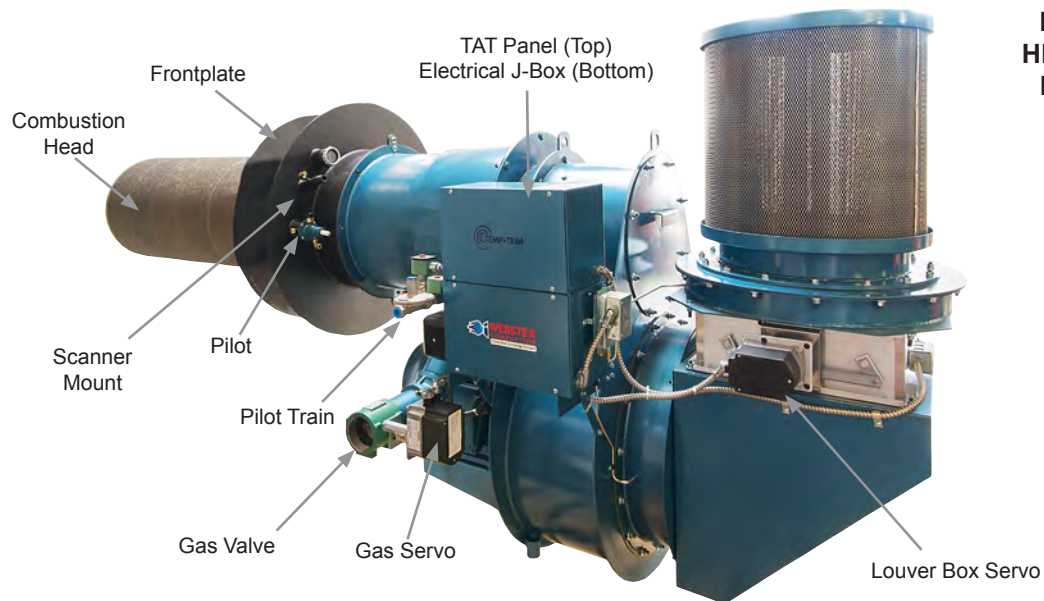
This section shows the different common components used in the JB burner line and should be helpful to identify parts described elsewhere in this manual.





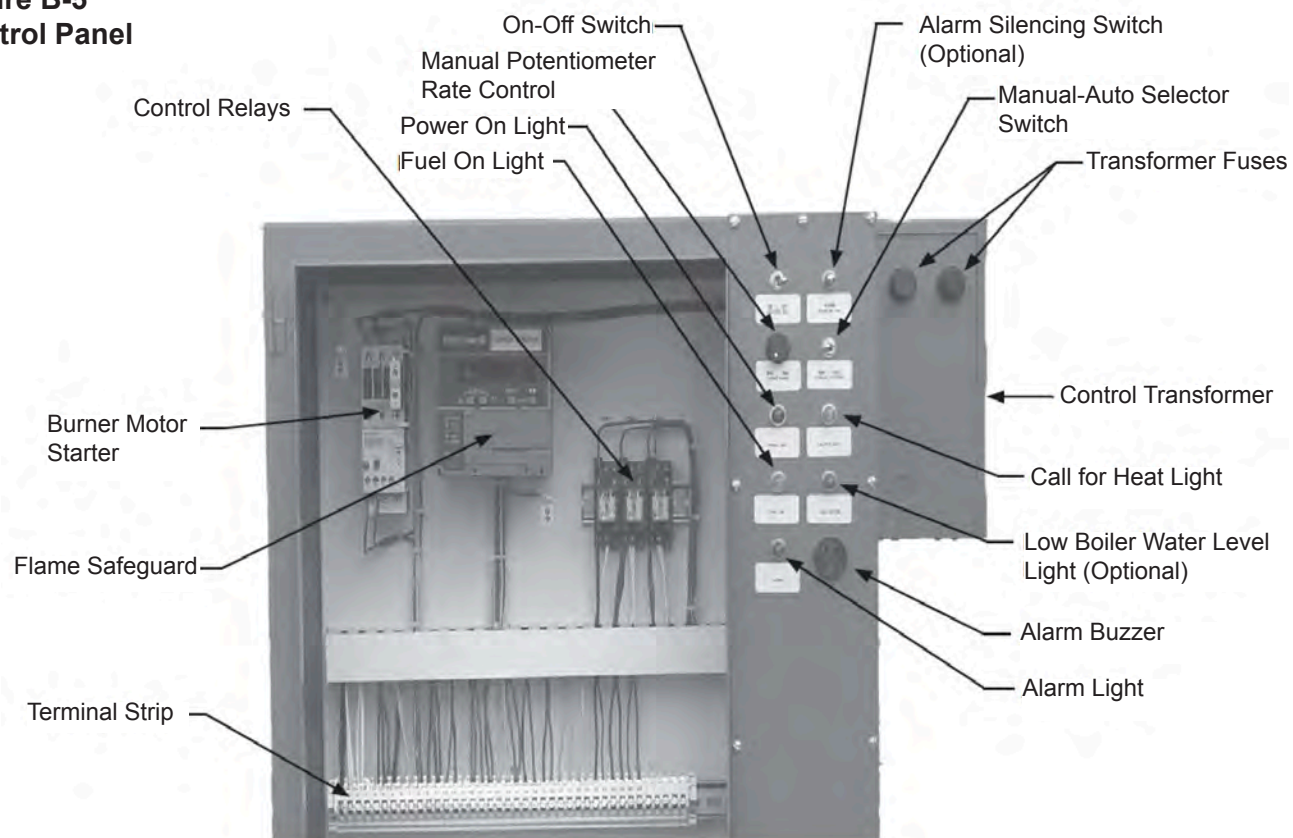


**Figure B-3  
HAFX Burner**



**Figure B-4  
HAFX Burner  
Back View**

**Figure B-5**  
**Control Panel**



## C. INSTALLATION

Prior to installing the burner, the site conditions and utilities need to be evaluated. This section provides some general questions that can help the review process. Inspect the burner for any undetected damage that may have occurred during shipment or by jobsite handling. Special attention should be given to the control panel and protruding parts such as linkages. Check linkages, air louver stops, wiring connections and fasteners for tightness. Also check head to ensure no damage has occurred to the metal fiber surface during shipment.

Verify that all ship loose (or separately shipped) items are on hand. This normally will be gas train components, mounting lugs and insulating rope. Also, front mounting plate with attached combustion head. The burner material list included with the instruction manual serves as a good checklist for this purpose.

1. Is there adequate outside ventilation to supply the needed air for safe combustion as required by your local regulatory agency?
2. If a burner mounting plate is required, is it available and does it meet specifications? (See Section E.)
3. Is 120-60-1 voltage available for the control circuit and is the correct voltage available for the blower motor?
4. Will the burner properly fit the boiler or heater with ample clearance on top, bottom and sides?
5. Will there be adequate gas pressure to assure the specified firing rate?
6. Is there adequate flue provisions to assure SAFE and proper venting of the burner?
7. All manuals should be reviewed and understood and stored in a convenient place.
8. Teflon tape should not be used on any field piping.

9. Rope gaskets should be used between vessel and mounting plate.

10. Gas piping should be flushed (cleaned) prior to use.

11. Check minimum straight lengths for gas pressure regulator and/or sensing line.

12. If multiple vessels connect to a single stack, are they sized and designed to maintain +/- 0.1" draft at the vessel outlet under all operating conditions.

13. Is stack designed to maintain +/- 0.1 at outlet during all operating conditions.

14. Is the burner mounting plate and burner head sealed with rope gasket? (See Figure B-2.)

15. Is there a drop leg in the gas supply to capture foreign material? (See Figure C-1.)

16. Is the piping between the gas train and burner done in a manner that will minimize the pressure drop?

17. Has all of the piping been pressure checked for leaks?

18. Is the combustion chamber of proper size?

Metal fiber burners must have at least 5" clearance between metal fiber head and furnace walls or tubes.

19. Inspect head carefully for damage to metal fiber surface prior to installation. If any damage is found, contact Webster before proceeding with installation.

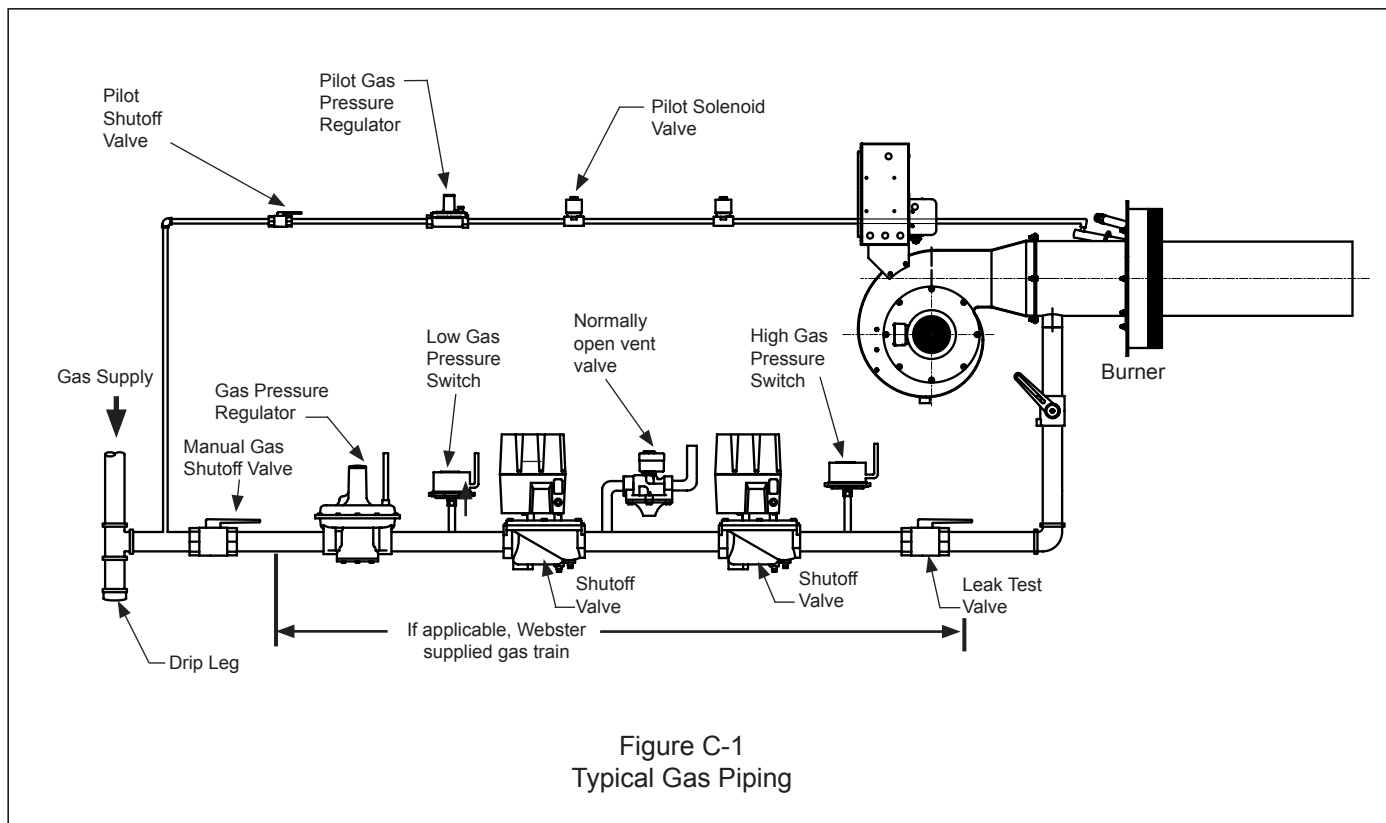
20. Smaller JBFX units are generally shipped as a complete assembly with head, frontplate and burner housing. Larger HDFX burners are shipped with head and refractory assembled as a single unit separate from the main burner housing.

21. Great care must be used when installing the head into the furnace opening. If the metal fiber surface of the head is damaged during installation, that can have adverse effects on the performance of the burner. If damage occurs, contact Webster.

22. Support burner adequately using coupling support points on the burner housing.

### WARNING

**DO NOT USE TEFLON TAPE OR COMPOUNDS CONTAINING TEFLON. THIS COULD DAMAGE THE VALVES CREATING AN UNSAFE OPERATION**



## D. SPECIAL INSTRUCTIONS FOR CANADIAN INSTALLATIONS

1. The installation of a burner shall be in accordance with the regulations of the provincial installation requirements, or in their absence, the following shall govern:

Gas Burners--CGAB149.1 and CGAB149.2

Authorities having jurisdiction should be consulted before installations are made.

2. All electrical wiring shall be done in accordance with the Canadian Electrical Code, Part I.

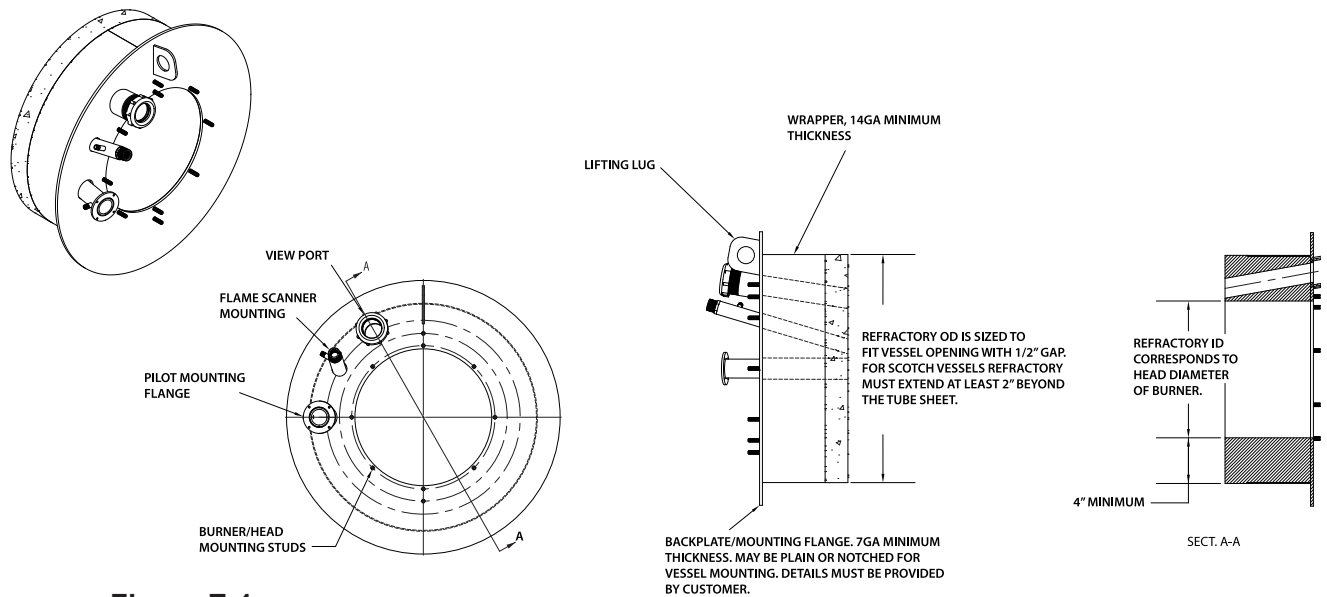
3. The installer shall identify (label) the main electrical power disconnect and the manual shut-off valve on the gas supply drop-line to the burner.

4. Gas burning equipment shall be connected to flues having sufficient draft at all times, to assure safe and proper operation of the burner.

## E. BURNER MOUNTING CRITERIA

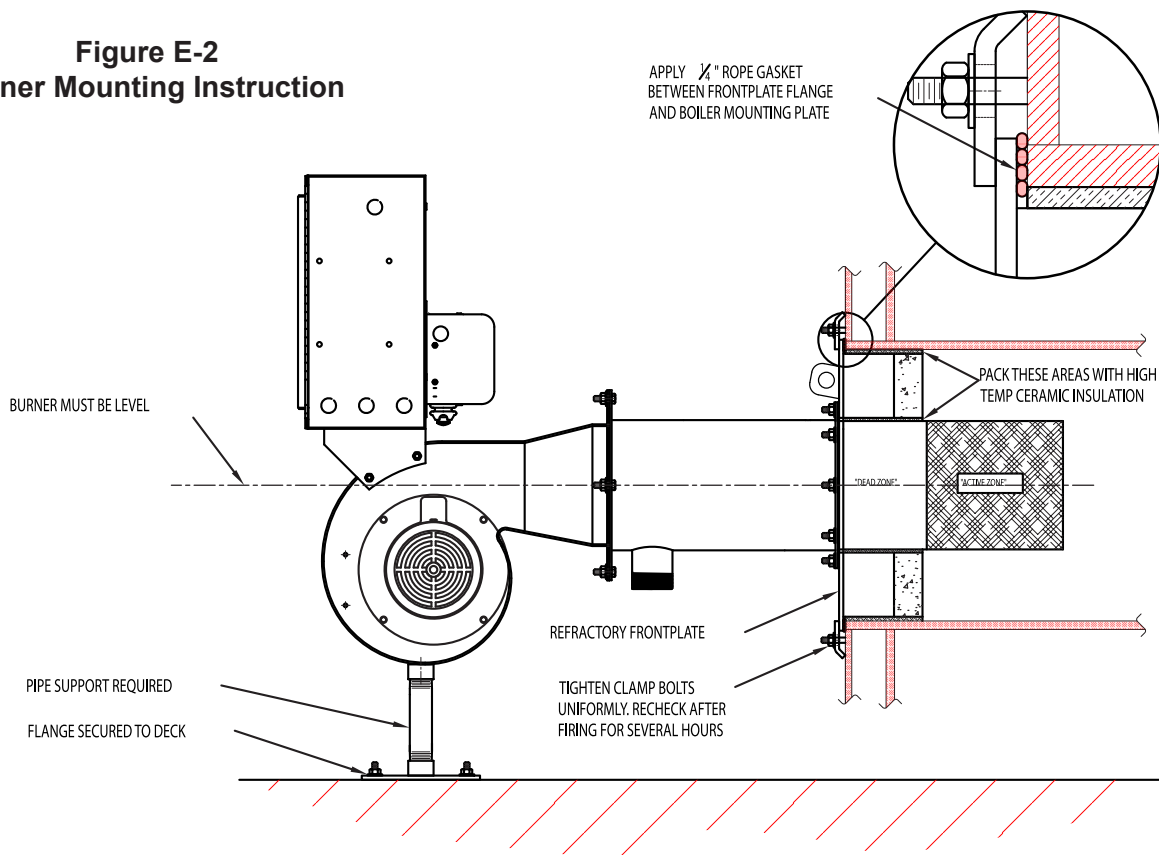
It is of vital importance that the burner be properly mounted to the boiler or appliance being fired. Improper mounting can cause leakage of the hot gases back around the burner head resulting in warpage and deterioration. The following illustrations show the proper way the burner must be installed to validate warranty conditions.

### TYPICAL METAL FIBER BURNER REFRACTORY FRONTPLATE



**Figure E-1**  
**Refractory Dimension**

### Figure E-2 Burner Mounting Instruction



## F. FUEL SYSTEMS

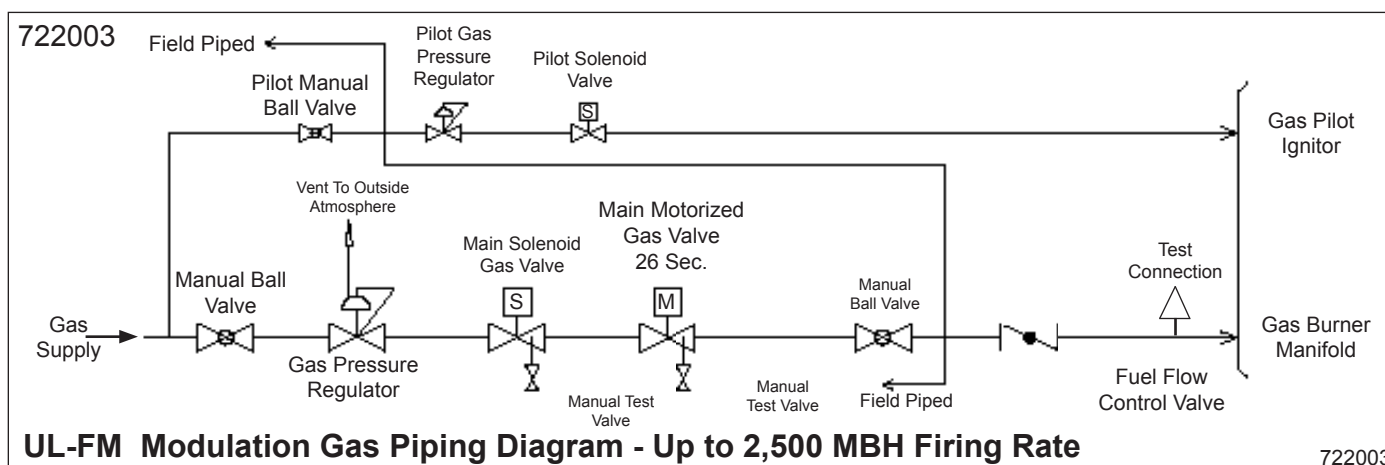
The JBFX and HAFX burner can be equipped with a wide range of fuel and operating systems to control the fuel, air, modulation and pilots. This section describes how these systems operate. Burner start-up is expected to be done by service personnel who are qualified in the basics of mechanical know-how. The following illustrations and information are supplied to identify the various fuels, air and ignition devices that have **Adjustment Features**. All adjustments can be done with common tools normally carried by burner and boiler service personnel.

**NOTE:** Refer to the bulletins included in the manufacturer's data section of the Burner Instruction Manual for items shown below.

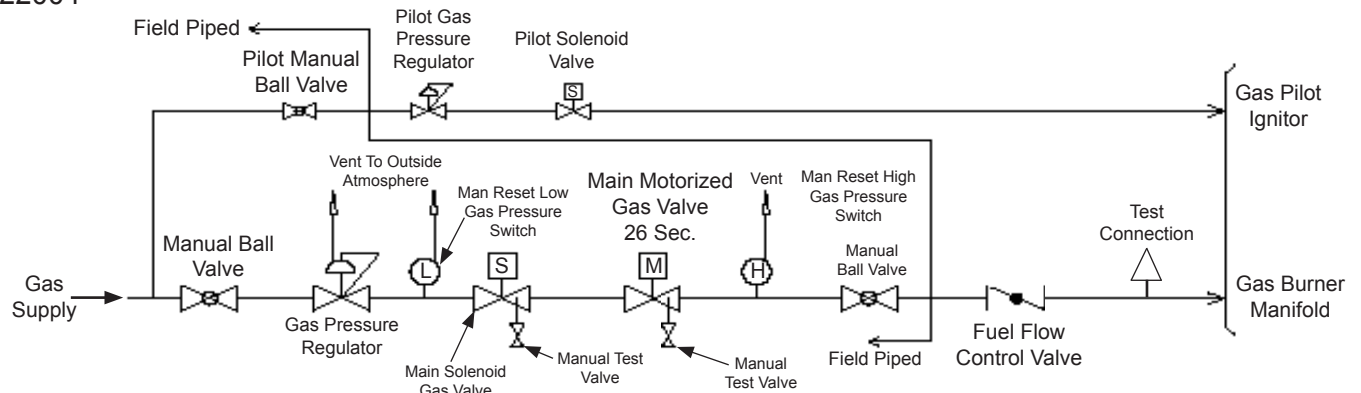
**Gas Systems – Illustrated Gas Trains by Capacity and Code:** The following illustrations show the Webster configuration for UL, FM and IRI as grouped by UL capacity ratings. Refer to the legend below for component part identification. These illustrations are not to be used for field erection and/or system design purposes.

UL Capacity Range BTU/Hr.	Operation Mode	Webster Designation	Code		Illustration
			UL / GE GAP	FM	
To 2,500,000	Modulating	M	X	X	722003
2,500,001 to 5,000,000	Modulating Modulating	M M	X	X	722004 722010
5,000,001 to 12,500,000	Modulating	M	X		722005
	Modulating	M		X	722011
12,500,001 and Up	Modulating	M	X		722082
	Modulating	M		X	722084

**NOTE:** Pressure Drops – Pressure drop through a given gas train will vary somewhat in relation to the individual items used, the specific gravity of the gas to be burned and the overall length.

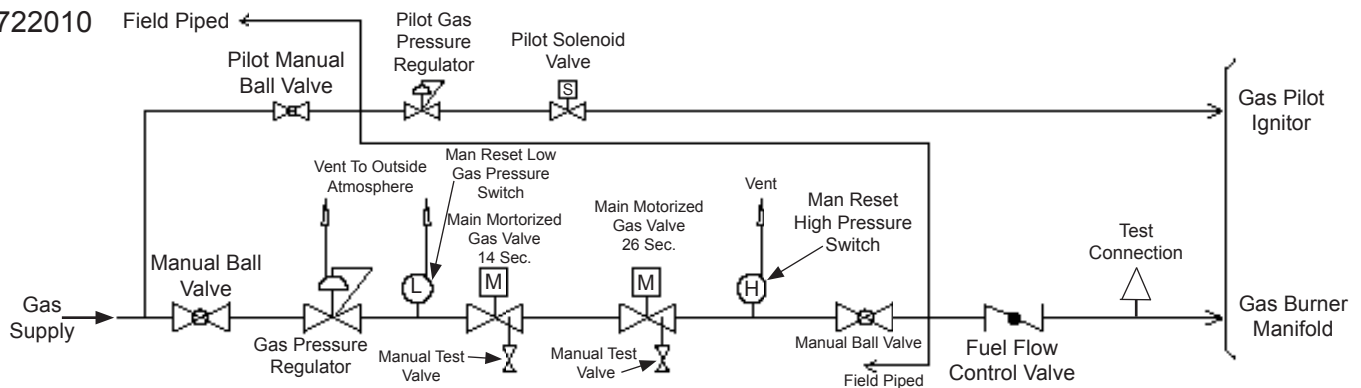


722004

**UL Modulation Gas Piping Diagram - 2,501 to 5,000 MBH Firing Rate**

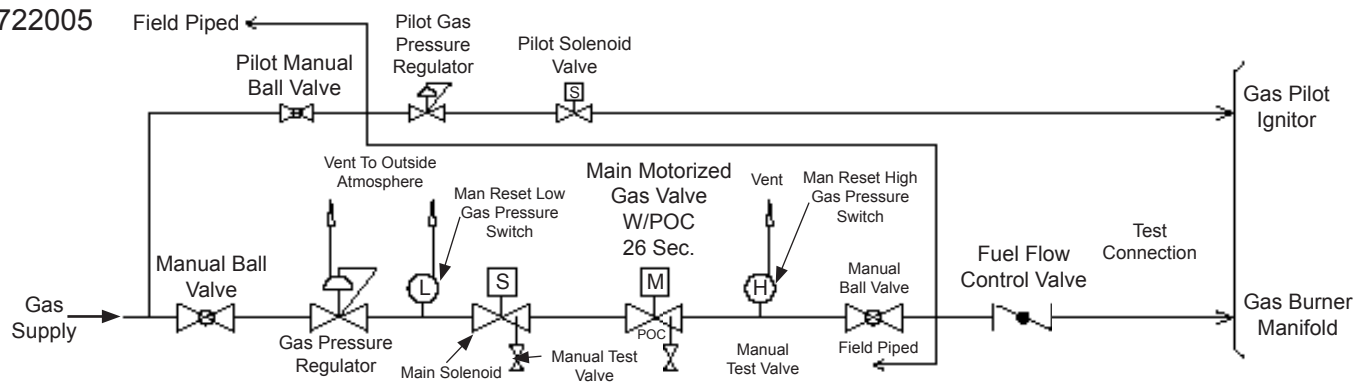
722004

722010

**FM Modulation Gas Piping Diagram - 2,501 to 5,000 MBH Firing Rate**

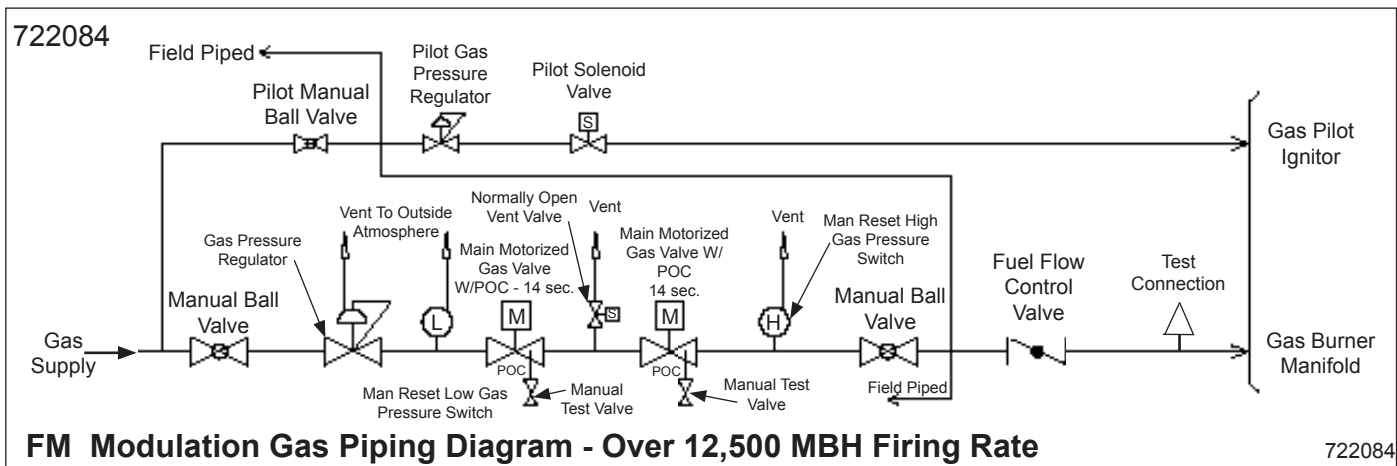
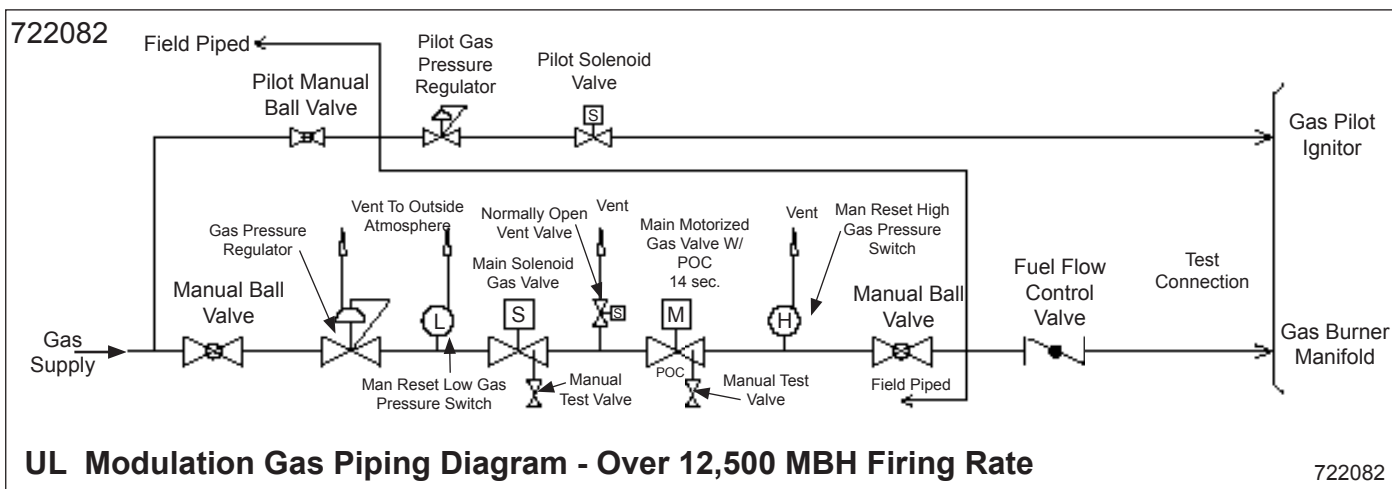
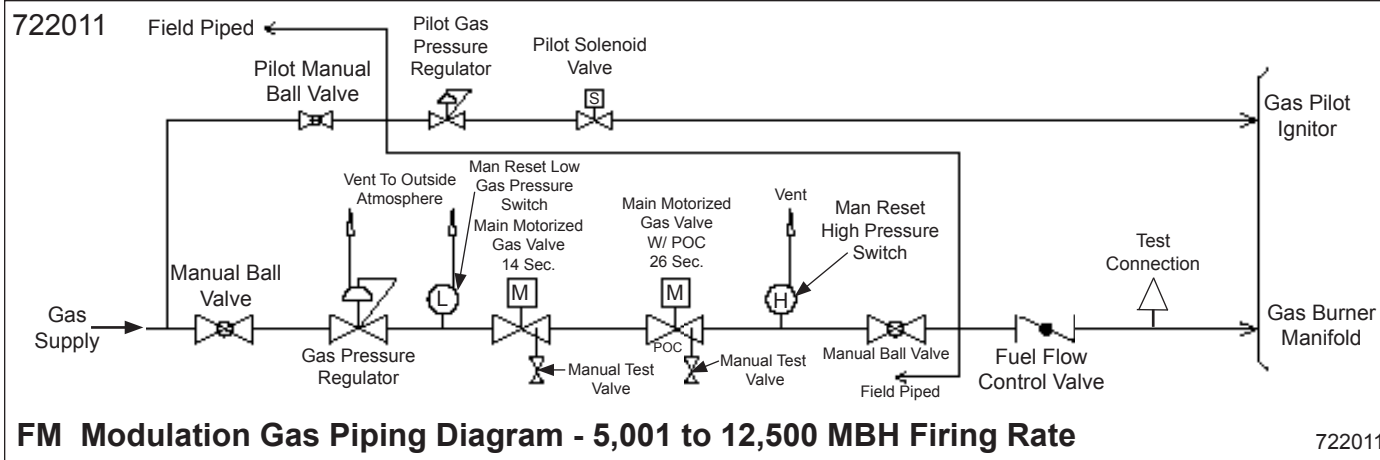
722010

722005

**UL Modulation Gas Piping Diagram - 5,001 to 12,500 MBH Firing Rate**

722005



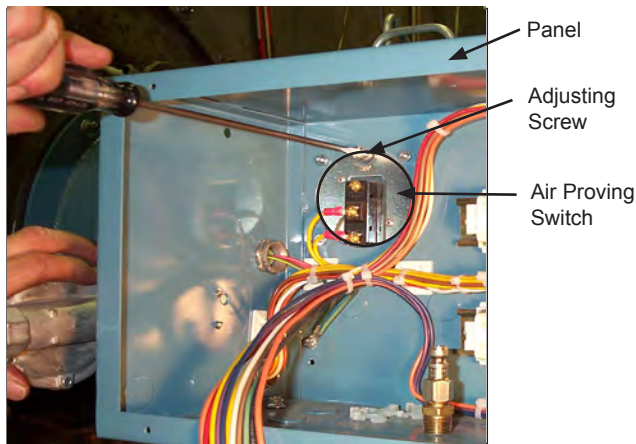


## G. INITIAL SETTINGS

1. The burner will be set at the factory for normal initial settings. These are only rough settings that must be adjusted at startup to match the furnace, fuel pressure and environment of the specific application. These general settings are covered in this chapter as a means of checking the burner (linkage and settings can move in shipment) or readjusting the burner if the settings are lost.

### 2. Air Proving Switch

The air proving switch has been adjusted at the factory for an initial setting. If the switch trips during initial start-up, first inspect the air sensing line tubing for kinks or burrs on the ends to make sure there are no obstructions. Also check to ensure the tubing connections going to the switch housing are tight, and double check the wiring going to the switch. If the tubing for the air sensing lines looks good and the wiring checks out, turn the adjustment screw CCW two full turns to reduce the trip pressure setting.



### 3. Air Filter Switch

The air filter switch has been adjusted at the factory for an initial setting. If the switch trips during initial startup, perform the same checks to the tubing & wiring as described for the Air Proving Switch. Also check to make sure there are no obstructions blocking airflow going into the filter element. If the tubing, wiring and filter element looks good, turn the adjusting screw on the switch CW in ¼ turn increments.

If the switch trips during normal burner operation the air filter element should be removed, inspected, cleaned and re-installed on burner. The filter element may be cleaned by using lukewarm water and mild detergent. Blow dry using compressed air from the inside out. Do not attempt to run burner without having the filter element in place as this may damage burner head.

### 4. Parallel Positioning Servos

JBFX and HAFX burners are equipped with a parallel positioning system (linkageless). The control valves can be positioned and operated using the fuel/air ratio controller. Refer to the burner controller system manual for specific details on how to adjust the servo position and set up fuel and air curves for your specific application. Fuel & Air curves are not put in at the factory unless customers specifically request a full factory firetest. Please be mindful that in the event curves were installed at the factory for the gas and air servos they will almost certainly require adjustment in the field as on site conditions cannot be perfectly duplicated at the factory. Refer to the instruction manual for details.

#### CAUTION

**ACTUATOR MOUNTINGS CAN BE BENT OR MOVED DURING SHIPMENT AND INSTALLATION. THEY MUST BE CHECKED PRIOR TO OPERATION AND ANY FAULTS CORRECTED. FAILURE TO CORRECT A MISALIGNED CONTROL WILL RESULT IN PREMATURE FAILURE.**

Metal Fiber burners are premix-type burners which require more excess air than conventional burners. For sub 9ppm NO<sub>x</sub> levels, this means the O<sub>2</sub> levels in the stack should be between 8-8.5% (about 55-60% excess air).

## H. IGNITION SYSTEMS

### 1. Gas Pilot Assembly

A crucial part of reliable burner operation is a dependable pilot, which must be properly adjusted and kept clean. A gas pilot is standard on all models of JBFX & HDFX burners. The pilot mounting tube is integral to the refractory frontplate. This tube is situated next to the pilot scanner and is angled in slightly toward the centerline of the burner head. The gas pilot assembly is secured to the pilot mounting tube on the refractory frontplate with (4) 10-32 screws. A gasket is used between the pilot & pilot mounting flange for a gas-tight seal.

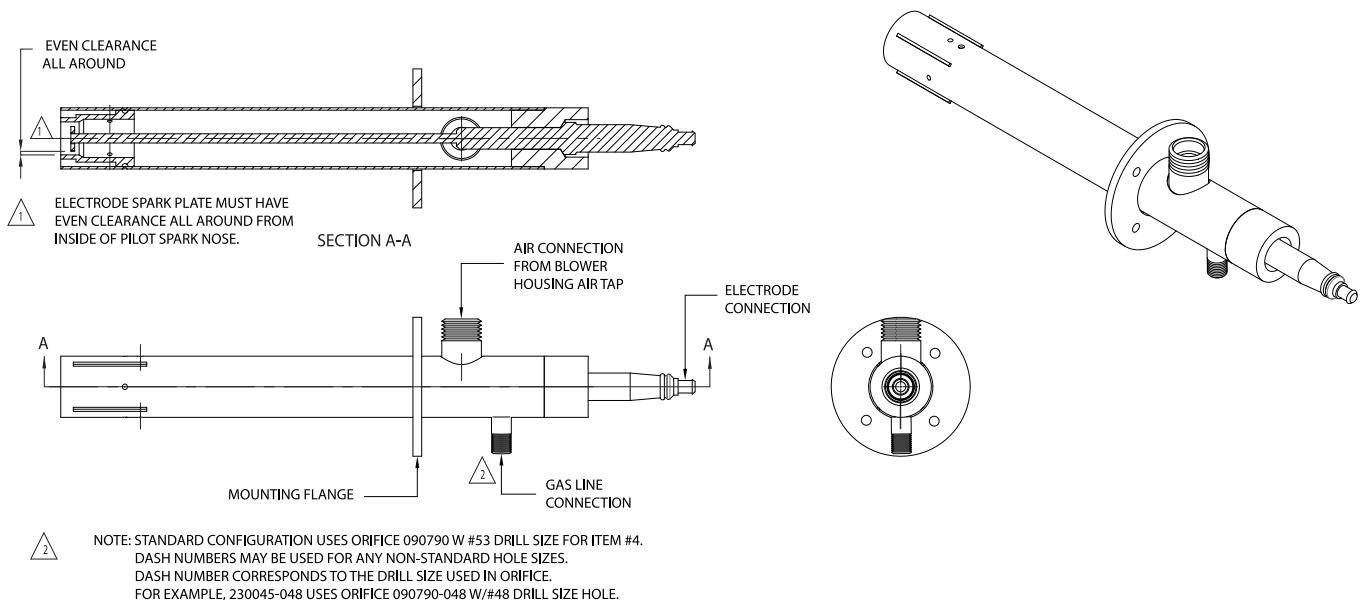
There are 2 tubing connections to the pilot. A larger 5/8" aluminum tube is used to supply combustion air from the blower housing to the pilot. A smaller 3/8" aluminum tube is used to supply gas to the pilot from the pilot train. A small orifice is provided just inside the gas connection to limit the gas flow into the pilot. Air and gas tubing should have as

few bends as possible with generous bend radii and the connection points should be tight and leak-free. Check for leaks at all tubing connection points during burner commissioning.

Pilot ignition is accomplished via a center electrode which travels through the center of the pilot to the end. The square electrode at the end must be kept centered in the pilot tube for proper operation. If the electrode shorts out against the inner wall at the end of the pilot tube, the pilot will not light. Ignition energy is supplied via a high tension lead coming from the ignition transformer.

Pilot gas pressure should be measured at the 1/8" port located on the downstream side of the last pilot solenoid valve.

**Figure H-1 Pilot Assembly**



## I. STARTUP AND OPERATING ADJUSTMENTS

1. Pre-start Check List
2. Gas Setup
3. Operating Control Adjustments
4. Limit Tests
5. Pilot Test
6. Burner Shutdown

This section covers the startup and operating adjustments of the Webster Models JBFX and HAFX burners.

### WARNING

**BURNER STARTUP, COMBUSTION ADJUSTMENTS AND LIMIT CONTROLS ADJUSTMENTS SHOULD ONLY BE PERFORMED BY EXPERIENCED SERVICE TECHNICIANS. ATTEMPTING TO PERFORM THESE FUNCTIONS WITHOUT THE PROPER TRAINING AND EXPERIENCE CAN RESULT IN EQUIPMENT DAMAGE, PERSONAL INJURY OR DEATH.**

Before proceeding with the startup and adjustment, be sure that the overall installation is complete. Review the boiler operating and installation manual, as well as all control manuals to verify that all equipment is ready for operation. These manuals must be read and understood prior to starting the equipment.

If you are not qualified to service this equipment, **DO NOT TAMPER WITH THE UNIT OR CONTROLS. CALL YOUR SERVICEMAN.**

At the conclusion of the startup, document valve and linkage positions, pressures and settings for future reference.

### READ AND SAVE THESE INSTRUCTIONS FOR FUTURE REFERENCE.

#### 1. Pre-Start Check List

Before starting the burner, a complete review of the installation, wiring and piping of the burner, boiler and all supporting equipment must be complete and all of these items must be ready for operation prior to starting. The following is a general review:

- \_\_\_\_\_ All wiring is connected. Test pulls on wire show them to be tight.
- \_\_\_\_\_ All fuel lines are connected and tight.
- \_\_\_\_\_ Pilot gas is connected.
- \_\_\_\_\_ Burner is mounted to vessel and floor, with all bolts secured.
- \_\_\_\_\_ The stack is connected and routed to the outside. Draft controls are installed and operational, if needed.

\_\_\_\_\_ Gas vent lines are connected and routed to the outside, if required per code.

\_\_\_\_\_ Do not start the unit unless all cleanout doors are in place and secured.

\_\_\_\_\_ The vessel is completely installed, filled with water and operating controls checked.

\_\_\_\_\_ Support equipment is in place and ready (feed pumps, draft controls, steam/hot water systems, boiler limits and controls and feedwater systems).

\_\_\_\_\_ A load must be available for the burner startup and adjustment process. The burner must be operated at high rates for extended periods of time and the load must be capable of using this energy.

\_\_\_\_\_ A combustion analyzer with O<sub>2</sub>, CO (for gas), and NOx must be available to tune combustion. All of these analyzers must be recently calibrated and able to provide accurate readings.

\_\_\_\_\_ Other test equipment, including manometers, gauges and volt meter shall be available.

\_\_\_\_\_ Manometer or gauge on the gas manifold.

\_\_\_\_\_ Manometer or gauge before and after gas pressure regulator.

\_\_\_\_\_ Draft gauge or manometer (at stack outlet).

\_\_\_\_\_ Draft gauge or manometer for furnace pressure.

#### 2. Gas Setup

- a. Place the burner switch in the "OFF" position.
- b. Place the "Auto-Manual" switch (if used) in the manual position, for modulation.
- c. Place the manual flame control potentiometer in the MIN (low fire) position on modulating units (if used).
- d. Close the downstream manual shutoff valve (closest to the burner head) on the gas train.
- e. Turn the electrical power on for the burner, boiler and related components.
- f. Verify that the gas metering valve is nearly closed, the vent valve (if equipped) is operating and the gas pilot valve is not open (the solenoid will hum and feel warm).
- g. Turn the burner switch on. This will start the blower motor and initiate the prepurge cycle.
- h. When the prepurge sequence is complete and the low fire start switch (if used) is made, the pilot valve will open and the pilot flame should be visible through the sight port.
- i. When the pilot flame is established, the flame safeguard will energize the main gas valve (indicated with the Fuel Valve Light). This operation of the main fuel valves must be visually checked by observing the valve stem operation.
- j. After the timer has completed the trial for main flame, the burner will go out on alarm (the closed manual gas valve prevented the burner from lighting). At this time, the gas valves must be visually checked to verify that they have closed. This test sequence proves the proper operation of the primary control.

k. Press the reset button and restart the burner. When the pilot has started, open the manual gas valve to allow the main flame to start.

l. If the burner is not operating as indicated, follow the troubleshooting guide steps to determine the problem and corrections required.

m. After a few seconds, the combustion analyzer should have an accurate reading of the  $O_2$  in the stack.  $O_2$  range should be between 7% - 9.5%. Rough settings for low and mid fire combustion settings are adequate at this time. Once the high fire is set, the other settings can be fine tuned.

n. Operate the burner until the boiler is warmed up, and near the operating pressure or temperature. Increase the firing rate using the manual potentiometer, or use parallel positioning control, while monitoring and adjusting the  $O_2$  level. Adjust the gas pressure regulator as needed to reach the high fire input.

o. Adjust the high fire input to match the maximum input listed on the rating label. At high fire, the gas butterfly valve should be at least 75 degrees open (more if available gas pressure is low), and the gas pressure regulator adjusted to obtain the rating. The input should be measured using the following equation:

#### Calculating Natural Gas Input

$$\text{HHV} \times [(\text{Patm} + \text{Pgas})/29.92] \times [520/(\text{Tgas} + 460)] \times [\text{measured ft}^3/\text{sec}] \times [3600 \text{ sec}/\text{hr}]$$

#### Where:

MBH = 1000's of BTU/M input

HHV = Higher heating value of gas, BTU/cubic feet

Patm = Atmospheric pressure in inches Hg

Pgas = Gas pressure before gas meter in inches Hg  
(inches HG = PSIG x 2.04)

Tgas = Gas temperature at the flow meter,  
in degrees F

Measured ft<sup>3</sup> = Volume of gas measured by meter

Sec = Time for measured ft<sup>3</sup> to flow through meter

**Note:** Some gas meters require a 7 inch wc correction to Pgas. Consult your meter calibration data.

**NOTE:** The listed manifold pressure is only an approximate value and can vary with operating conditions and normal tolerances. The fuel flow rate must be measured to obtain an accurate input value.

p. Adjust the air damper to obtain the correct  $O_2$  level.

q. Modulate the burner to low fire, adjusting the  $O_2$  level as the burner modulates.

r. Adjust the low fire input, using the air damper adjustments.

s. Readjust the midfire points for the correct  $O_2$  level.

t. Adjust the low gas pressure switch to be 10% below the lowest expected gas pressure.

- With a gauge or manometer at the same location as the low gas pressure switch, modulate the burner to determine the firing rate with the lowest gas pressure.

- At the lowest gas pressure, adjust the low gas pressure setting up until the switch breaks and causes the burner to shutdown.

- From the scale reading of the switch, adjust the setting to a pressure that is 10% lower than the shutdown pressure. For example, if the switch opened at 10 inches as indicated on the low gas pressure switch, the switch should be adjusted to a reading of 9 inches.

- Remove the gauge or manometer and plug the opening.

- Cycle the burner on and off to determine if the limit works properly.

- If the limit causes nuisance shutdowns because of small pressure drops during startup, reduce the pressure setting an additional 5%.

u. Adjust the high gas pressure switch to be 10% above the highest expected gas pressure.

- With a gauge or manometer at the same location as the high gas pressure switch, modulate the burner to determine the firing rate with the highest gas pressure.

- At the highest gas pressure, adjust the high gas pressure setting down until the switch opens and causes the burner to shutdown.

- From the scale reading of the switch, adjust the setting to a pressure that is 10% higher than the shutdown pressure. For example, if the switch opened at 10 inches as indicated on the high gas pressure switch, the switch should be adjusted to a reading of 11 inches.

- Remove the gauge or manometer and plug the opening.

- Cycle the burner on and off to determine if the limit works properly.

- If the limit causes nuisance shutdowns because of small pressure changes during startup, increase the pressure setting an additional 5%.

v. The burner should be operating at low fire to adjust the air proving switch. Turn the adjusting screw cw (in) until the burner trips out (shutdown caused by the air flow switch). Turn the adjustment screw ccw (out) 1 1/2 turns from the point of shutdown. Check the operation at higher rates.

### 3. Operating Control Adjustments

The operating controls must be adjusted to properly cycle the burner "ON and OFF" and provide modulation. The controls should not force the burner into rapid "ON-OFF" cycles, as this will cause premature failure of the motor and operating equipment. The operating control must be adjusted to provide the "ON" pressure or temperature desired. It must allow the burner to come on and start before the temperature or pressure drops into the modulating range.



The “OFF” pressure or temperature must be sufficiently above the “ON” point to allow a reasonable run time. The modulating control must be adjusted to start modulation at some reasonable point below the “ON” temperature or pressure and provide modulation to high fire at the lowest temperature or pressure.

#### 4. Limit Tests

Once the burner has been started and the operating pressures and temperatures have been set, the limit switches need to be adjusted so that they will trip if the pressure or temperature exceeds the operating value, but will not trip with normal variations. The switch should be checked for proper operation by allowing the temperature or pressure to vary below or above the recommended level to insure that they provide safe shutdown before the burner operation is affected. In high pressure or temperature switches where the temperature or pressure cannot be set high enough to trip the switch, the switch can be checked by lowering the set point to prove that the switch will provide a safe shutdown.

The limit switches would include the air proving switch on the burner. Limits for gas operation could include the high and low gas pressure switches. If in doubt about which limits are on a burner, refer to the wiring diagram that will show each item.

Limit switches need to be checked at regular intervals to ensure they are operating properly. See the maintenance section for details.

#### 5. Pilot Tests

Once the burner has been set for the firing rates intended for the burner, the pilot must be checked for proper operation and safety. The minimum pilot test is done to insure that a pilot which can be seen by the scanner will light the main flame.

- a. During a startup sequence, measure the time required to light the main flame after the fuel valves have been energized. This will be used to monitor the test with reduced pilot.
- b. Lock the flame safeguard into the pilot position (refer to the manual for the flame safeguard for this setting)
- c. Adjust the gas pressure regulator to the pilot for a minimum value while still holding the minimum signal strength for the scanner.
- d. Release the flame safeguard from the pilot position. Allow it to cycle through the main flame proving sequence.
- e. This reduced pilot must reliably light the main flame. Monitor the time from the main fuel valve opening and do not allow the burner to continue if the time is more than an additional two to three seconds from the initial time measured above.
- f. Run through two or three cycles.

g. If this is a combination fuel burner, repeat the test on the other fuel.

h. Failures due to reduced scanner signal are acceptable.

**WARNING**  
**THE MINIMUM PILOT TEST REQUIRES CLOSE SUPERVISION OF THE COMBUSTION PROCESS. FAILURE TO CLOSELY MONITOR THE MAIN FLAME TEST TIME COULD RESULT IN DAMAGE, INJURY OR DEATH.**

i. If the pilot does not light the main flame under these test conditions, check and adjust the pilot as shown in Sec. H.  
j. The infrared detector must be tested for hot refractory pickup. This test is performed to make sure that the scanner does not see hot refractory that could be mistaken for a flame.

k. After the burner has been operating for some time at high input levels and the refractory in the vessel is hot, the burner should be cycled off while monitoring the scanner signal.

l. The flame signal should drop off quickly as the flame goes out and should be well below the minimum level (indicating a flame) at the end of the post purge cycle.

m. The UV detector must be tested for spark pick-up. Turn the burner on, with the pilot shut off, during the ignition cycle the flame signal should be well below the minimum level (indicating a flame).

n. If the flame signal does not drop out as required, check the location of the pilot and scanner, as shown in section “H”. This may also indicate a faulty scanner or amplifier.

#### 6. Burner Shutdown

Normal operation of the burner will allow the operating controls to shut the burner down when the load demand is satisfied. If the burner needs to be shut down for any reason, the “ON-OFF” switch can be used to quickly turn the burner off. This will instantly cause the fuel valves to close and start a post purge cycle to remove any unburned fuel from the vessel.

In an emergency shutdown, all fuel and electrical power should be de-energized or turned off to secure the burner. This would include the main power disconnect and the manual gas shutoff valve at the drop down line.

It is recommended that the burner be manually driven to low fire before turning the burner off, as this reduces the dynamic and thermal stress. If the burner will remain off for some time, the manual fuel valves and power supply should be turned off.

**CAUTION**  
**ALWAYS KEEP THE FUEL SUPPLY VALVE SHUT OFF WHEN THE BURNER IS SHUT DOWN FOR AN EXTENDED PERIOD OF TIME.**

**CAUTION**  
**DO NOT START THE BURNER UNLESS ALL CLEANOUT DOORS ARE SECURED IN PLACE.**

## J. TROUBLESHOOTING

No.	System	Cause	Correction
1	No Ignition (lack of spark)	Electrode is grounded. Porcelain is cracked.	Replace
		Improperly positioned electrode	Recheck dimensions
		Loose ignition wire connection	Reconnect or tighten
		Defective ignition transformer	Check transformer, replace
2	No Ignition (spark, no flame)	Lack of fuel, no gas pressure, closed fuel valve	Check fuel supply and valves
		No voltage to pilot solenoid	Check electrical connections
		Defective pilot solenoid valve	Replace
		Improper raw gas tube position	Check location of raw gas tube
		Improperly positioned electrodes	Recheck dimensions
		Too much combustion air flow	Check air damper position
3	Pilot not detected (flame present)	Scanner tube not positioned correctly	Check location of scanner tube
		Scanner tube dirty or wet	Clean scanner tube / scanner
		Scanner or amplifier faulty	Replace
		Incorrect gas pressure to pilot	Readjust pressure
		Combustion air flow rate too high	Readjust damper
4	No main gas flame (pilot OK)	Weak scanner signal	Clean scanner lens and tube
		Damper or fuel control valve setting incorrect	Readjust
		Fuel valve(s) not opening	Check wiring to valves
5	Burner stays at low fire	Manual pot in low fire position (low fire hold)	Readjust to high fire position
		Manual-auto switch in wrong position	Change position of switch
		Modulating Control	Check wiring or replace
		Binding or valve	Readjust or replace
6	Burner shuts down during operation	Loose electrical connection	Check and tighten connections
		Loss of fuel supply	Replenish fuel supply
		Limit switch breaks (opens)	Readjust limit switch
7	Burner does not start	Main disconnect switch is open	Close switch
		Loose electrical connection	Check electrical connections
		Operating controls are tripped	Check and reset operating limits
		High or low fuel pressure	Check fuel supply - reset switches
8	High CO at low fire (firing gas)	Improper excess air level	Readjust excess air
		Input too low for burner components High stack draft (especially at low fire)	Check input, compare to rating label Stabilize draft
		Fluxuating gas pressure (regulator not holding pressure)	Check regulator pressure, sensing line and supply pressure: sized properly



No.	System	Cause	Correction
9	Gas combustion noise (rumbling)	Input too low for burner components	Check input, compare to rating label
		Improper excess air	Readjust excess air
		Fluxuating gas pressure (regulator not holding pressure)	Check regulator pressure and supply
		High stack draft (especially at low fire)	Stabilize draft
10	Fuel-Air-Ratios are not consistent	Fuel lines plugged	Check and clean lines, strainers & filters
		Fuel supply pressure changing	Check and/or replace pressure regulator
		Combustion air temperature changed	Retune burner
		Draft condition changed	Check draft and outlet damper
		Gas control valve - low fire stop not set (if used)	Adjust low-fire stop
11	Fuel-Air-Ratios have changed over time	Air damper seal worn	Replace air damper seals
		Fuel lines plugged	Check and clean lines, strainers & filters
		Fuel control valve worn	Replace fuel control valve
		Combustion air temperature changed	Retune burner
		Draft condition changed	Check draft and outlet damper
		Vessel plugged	Clean vessel
12	Cannot obtain capacity on gas	Wrong spring range in regulator	Install higher spring range
		Too many elbows before control valve	Rework piping to reduce elbows
		Gas line too small, high pressure drop	Use larger pipe size
		Supply pressure lower than stated	Increase supply pressure
		Supply pressure drops too low at high fire	Use larger gas line sizes/orifice in
			service regulator
		Regulator too small for flow and pressure	Change regulator
13	Cannot obtain NOx levels on gas	Insufficient excess air Excessive turndown	Add more excess air 3:1 max TD on MFB
14	Lazy/non-retaining flame	Too lean or too rich	Adjust O <sub>2</sub> level to recommended level

## K. GENERAL MAINTENANCE AND CARE

1. General
2. Physical Inspection
3. Fuel-Air-Ratio
4. Gas Fuel Systems
5. Combustion Air Fan

### 1. General

This burner has been designed to provide many years of trouble free operation. The reliability can be greatly improved with some simple inspection and maintenance programs.

One of the best tools for a good maintenance program is to keep a log on the key parameters of the burner and boiler. These would include operating temperatures, pressures, inspections and preventative maintenance activities. This document can be used to detect any changes in the operating characteristics of the burner, which can be used for preventative maintenance.

The maintenance schedule can be used to help generate this log. There are also many other good references that can be used to help develop your log. Adding check points for other equipment into a common log can help. It is common to integrate the boiler and burner log, so that all components are checked at the same time.

The frequency of inspection given in the following charts is only a guideline. Initial results should be used to adjust the time intervals to be more frequent when problems or potential problems are observed.

### 2. Physical Inspection

Listening and looking at the burner can detect many problems. For example, leakage can usually be seen early with a small buildup of oil. Valve and linkage problems can usually be detected early on by simply watching the movement and detecting rough uneven changes. The jackshaft, linkage and valve movement should occur smoothly with no rough jerks.

The flame condition can often be a good indicator of the firing head. If the flame does not look correct, there may be a problem with the hardware. The firing head is exposed to the high temperatures of combustion and can have reduced life due to the thermal stress. In particular, the diffuser, gas orifices, gas manifold, refractory and burner mounting plate should all be inspected.

### 3. Fuel-Air-Ratio Controls

The fuel-air-ratio controls must be maintained in good operating condition. Over time, these items will wear and may not operate smoothly. Corrective action must be taken. Check mechanical couplings between servo & valve for tightness. There should be no slip in them.

Some louver boxes also utilize linkage to operate all the blades in unison. Check these linkage points for wear and correct as required.

There are several different types of controls and the corrective action of each could be different. Refer to the control manufacturer's literature.

### 4. Gas Fuel System

The safety interlocks must be checked at regular intervals to ensure that they provide the proper safety. See the Inspection and Maintenance Schedule Chart (Figure 8) for frequencies.

The drip leg should be cleaned annually.

Monitoring the outlet gas pressure from the regulator will verify this control is working properly.

Other checks:

- a. The condensation traps must work properly and be installed to capture all of the condensation. If condensation passes through to the burner windbox, a condensate drain should be added to the bottom of the windbox.
- b. Valve movement must operate freely and smoothly.
- c. NOx emission levels.
- d. Other general items like the refractory.
- e. Stack temperature of boiler - high temperatures will increase NOx levels.
- f. Operation of safety equipment.
- g. Check safety limits, including pressure and temperature switches

### 7. Combustion Air Fan

If the fan and motor are ever removed, the following should be observed in re-assembly.

- a. There should be about 1/16" overlap of inlet cone and fan.
- b. Never re-use the fan to motor shaft set screws, always use new screws of the same type and style to maintain balance and fan retention.
- c. When tightening the fan hub set screws, rotate the fan to place the screws on the bottom. This way the screw is not lifting the fan.
- d. The motor shaft and fan hub must be clean and free of burrs.

As a minimum, the following replacement parts should be stocked to support uninterrupted burner operation.

- Pilot Electrode
- Blower Wheel
- Pilot Ignition Transformer
- Gas Pilot Solenoid Valve
- Flame Scanner

Items with greater life expectancy and/or greater dollar value, such as flame safety controls, main gas valves and blower motors should be obtained from your local Webster representative when a need arises.

**NOTE: Always give Webster Combustion Serial Number and/or UL Serial Number when ordering parts.**

An illustrated parts drawing is included within the Burner Instructions Manual to aid in parts identification. The noun name of the part needed should be established from the drawing, then the part number can be obtained from the burner material list contained in the Burner Instructions and Service Manual.

8 - Inspection and Maintenance Schedule									
Frequency						Component / Item	Recommended Action or Test	Performed By	
Daily	Weekly	Monthly	Seasonal	Annual	Annual As Required			Boiler Operator	Trained Burner Technician
X						Burner Flame	Visual inspection of burner flame.	X	
X						Air Damper	Visual inspection for smooth and free travel.	X	
X						Fuel Metering Valves	Visual inspection for smooth and free travel.	X	
X						Draft Controls (Stack)	Visual inspection for smooth and free travel.	X	
X						Gas Fuel Pressure	Record in log book, compare trends.	X	
X						Pilot	Visually inspect pilot flame, check and record flame signal strength if metered.		
	X					Flame SafeGuard - Pilot Test	Close manual fuel valve on pilot during cycle and check for safety shutdown, recording time.	X	
	X					Flame SafeGuard - Main Flame	Close manual fuel valve on pilot during cycle and check for safety shutdown, recording time.	X	
		X				Flame SafeGuard	Check flame safeguard components, including scanner.		X
				X		Flame SafeGuard	Replace flame safeguard components in accordance with manufacturers instructions.		X
				X	X	Pilot Turndown Test	Conduct pilot turndown test annually or after any component change.		X
				X	X	Hot Refractory Test	Conduct hot refractory hold in test. This test is required annually or after any component change.		X
		X				Interlock Controls	Check other interlocks that may be used on the burner for smooth operation and correct action.		X
			X			Firing Rate Control	Check firing rate control and verify settings.		X
			X			Combustion Tuning	Conduct a combustion test, verify setting and NOx emission levels.		X
		X				Pilot and Main Fuel Valves	Make visual and manual check for proper sequencing of valves.		X
				X		Pilot and Main Fuel Valves	Check all coils, diaphragms, interlock switch & other parts of all safety shutoff valves.		X
				X		Pilot and Main Fuel Valves	Perform leak tests on all safety shutdown control valves.		X
				X		Low Air Pressure Switch	Test low air pressure switch for proper operation and adjustment.		X
						Air Filter Switch	Test air filter switch for proper operation and adjustment.		X
	X	X				Air Filter	Inspect & clean air filter. May require greater frequency depending on operating environment	X	
				X		Mod Damper Switch	Check damper low fire proving switch per manufacturers instructions.		X
					X	Combustion Air Fan	Clean combustion air fan and housing.		X
X	X					Burner Components	Visually check the burner components for signs of cracks, deformation, slippage or other unusual indication		X
		X				Burner Mounting	Check burner mounting clamps and brackets for tightness.	X	
		X				Refractory and Seals	Check burner refractory for cracks or signs of leakage.	X	
				X		Metal Fiber Head	Visually inspect during periodic boiler maintenance		X

## L. CARE OF THE BURNER DURING EXTENDED SHUTDOWN

Heating equipment is often located in an environment conducive to corrosion and general deterioration if not properly protected and periodically checked, especially during an extended period of shut down. The following procedures should be followed if the burner is going to be placed out of service even for a short period of time.

1. Turn the main manual fuel valve OFF.

### CAUTION

Always keep the main fuel valve(s) **OFF** if the burner is shut down for an extended period of time.

2. Turn off the main electrical disconnect to the burner OFF. Follow tagout / lockout procedures.

3. Place a notification tag or label at the main manual fuel valve giving reason for shutdown. Follow tagout/ lockout procedures.

4. If the burner is in an area subject to sweating and condensation, cover the control cabinet and electrical devices with plastic and secure with twine or tape.

5. Should the burner be out of service for more than thirty (30) days, a complete operational safety check must be made at the time of restart. The restart must be treated as a new burner start-up (see burner start-up section in this manual).

## M. REPLACEMENT PARTS

## N. WARRANTY VALIDATION & FIELD START-UP REPORT

As a final step, forward the top copy of the Warranty Validation and Field Startup Report, Form 113, to:  
Webster Combustion Technology, LLC, 619 Industrial Road, Winfield, KS 67156.

WEBSTER Series JBFX and HDFX burners are listed by Underwriters Laboratories, Inc. (U.L.). Also by the State of Massachusetts Fire Marshall, City of New York Board of Standards and Appeals, State of Minnesota, and can be packaged to meet specific requirements of CSD-1, GE GAP, IRI, FM, NFPA, MIL or other special insurance or local code requirements.

## WARRANTY VALIDATION FIELD START-UP REPORT

CUSTOMER: \_\_\_\_\_ W.O. \_\_\_\_\_

BURNER MODEL: \_\_\_\_\_ BOILER MODEL: \_\_\_\_\_

CONTROL CIRCUIT COMPONENT OPERATIONAL TESTING (Check if Okay)

Primary LWCO \_\_\_\_\_ High Limit \_\_\_\_\_ Firing Rate Control \_\_\_\_\_  
 Secondary LWCO \_\_\_\_\_ Operational Control \_\_\_\_\_ Low Fire Start Switch \_\_\_\_\_  
 High Gas Press. Switch \_\_\_\_\_ High Fire Purge Switch \_\_\_\_\_  
 Low Gas Press. Switch \_\_\_\_\_ Air Flow Switch \_\_\_\_\_ Other \_\_\_\_\_

FIELD COMBUSTION SETTINGS				GAS FIRED		
				Low	Med.	High
Firing Rate						
CO <sub>2</sub>						
O <sub>2</sub>						
CO (ppm)						
NOx (ppm)						
Stack Temp. Net °F						
Room Temperature °F						
Overfire Draft " WC						
Breeching Draft " WC						
Water Temp. °F/Steam Press.						
Air Inlet Shutter (" Open)						
Flame Signal Pilot						
Flame Signal Main						
Combustion Efficiency						
Running Motor Amps & Volts	L1		L2		L3	

**Comments:**

Having read the Manufacturer's service manual as to the proper installation, start-up and service of the unit above, I verify that the burner has been put into operation as specified, and that the above information and checks are complete and correct.

START-UP BY \_\_\_\_\_ Date \_\_\_\_\_

Company \_\_\_\_\_ Phone No. \_\_\_\_\_

Address \_\_\_\_\_

**NOTE:** Warranty Validation - Field Start-up report must be completed, signed, dated and the top copy sent to Webster Combustion Technology, Winfield, KS 67156, to validate equipment warranty.

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## WARRANTY MATTERS AND EXCLUSION OF IMPLIED WARRANTIES

The following warranty applies: All Products manufactured by the Company are warranted to be free from defects in material and workmanship under normal use and service for a period of eighteen months from the date of shipment or twelve months from the date of start-up; whichever should occur first. Products which are purchased by the Company and resold without further processing by the Company are not covered by the Company's warranty. The Company shall pass to the Buyer whatever warranty the Company receives on such products. The Company will repair or replace, at its option, its products which prove to be defective within the warranty period, F.O.B. the factory. The Company's warranty shall be voided by any abuse, misuse, or neglect of the products by use not in accordance with the Company's published instructions. The remedies for any failure of the Company's product to meet warranty specified herein shall be those remedies herein and no others; these remedies being exclusive remedies as a condition of sale irrespective of the theory upon which any claim might be based, including negligence, breach of contract or strict liability.

IN ALL EVENTS, THE COMPANY WILL NOT BE LIABLE FOR AND WILL NOT REIMBURSE ANY LABOR, MATERIAL, OR OTHER REPAIR CHARGES INCURRED BY ANYONE OTHER THAN THE COMPANY ON ANY WARRANTY EQUIPMENT, UNLESS SUCH CHARGES HAVE BEEN SPECIFICALLY AUTHORIZED IN ADVANCE IN WRITING, BY THE COMPANY. THIS PARAGRAPH CONTAINS THE COMPANY'S SOLE WARRANTY. THE COMPANY MAKES NO IMPLIED WARRANTY, AND THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

## DAMAGE LIMITATION

Under no circumstances shall the Company be liable for any loss of profits, down time, or any incidental, consequential, special, punitive, exemplary, enhanced, or indirect damages of any kind with respect to its products or the transaction by which its products are sold.

IN NO EVENT SHALL THE COMPANY'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THE EQUIPMENT OR THE TRANSACTION BY WHICH THE EQUIPMENT IS SOLD, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, EXCEED THE TOTAL OF THE AMOUNTS PAID TO THE COMPANY WITH RESPECT TO SUCH EQUIPMENT.

## EXCUSE

In no event shall the Company be liable for any loss or damage resulting from any delay or failure in shipment or other failure, loss or damage that is the proximate result of any act of government authority, revolution, riot, civil disorder or disturbance, act of enemies, delay or default in transportation, inability to obtain materials or facilities from normal sources of fire, flood, act of God, or any cause not within the reasonable control of the Company, whether of the class of causes enumerated or otherwise. Without limiting the generality of the foregoing, the Company may, without causing a breach or incurring liability, allocate goods which are in short supply irrespective of the reasons therefore among customers in any manner which the Company in its sole discretion deems advisable. If an event occurs that is beyond the control of the Company's performance and causes its cost of production to increase because of the delay, the Company may pass such increase on to the Buyer.



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