



CBEX Elite

Packaged Boiler

1300-2200 HP

Installation, Operation, Maintenance



Manual Part No. 750-275

12/2009

 **WARNING**

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

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

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

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

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

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

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

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

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

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

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

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

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

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

CONTENTS

1 Introduction

- A. General 1-1
- B. The Boiler 1-2
- C. Construction 1-2
- D. Steam Controls (All Fuels) 1-2
- E. General 1-7
- F. Feedwater Piping 1-7
- F.. Major Components/Service Connections 1-8

2 Waterside Care and Requirements

- A. General 2-1
- B. Water Treatment 2-2
- C. Cleaning 2-2
- D. Boil-Out Of New Unit 2-3
- E. Washing Out 2-3
- F. Blowdown 2-4
- G. Periodic Inspection 2-6
- H. Preparation For Extended Lay-Up 2-6

3 Profire XL Burner

- A. General 3-1
- B. Description 3-1
- C. Operating Controls 3-1
- D. Combustion Air Handling System 3-2
- E. Firing Rate Controls 3-2
- F. Firing Head 3-2
- G. Gas System 3-2
- H. Installation 3-4
- I. Operation 3-7
- J. Adjustments 3-9
- K. Maintenance 3-11
- L. Extended Shutdown 3-11

4 Operational Controls

- A. General 4-1
- B. Modulating Pressure Control 4-3
- C. Operating Limit Pressure Control 4-3
- D. High Limit Pressure Control 4-3
- E. Low Water Cutoff Devices 4-5
- F. Combustion Air Proving Switch 4-5
- G. Atomizing Air Proving Switch 4-5
- H. Low-gas-pressure Switch 4-5
- I. High-gas-pressure Switch 4-5

5 Inspection and Maintenance

- A. General 5-1
- B. Fireside Cleaning 5-2
- C. Water Level Controls 5-2
- D. Water Gauge Glass 5-2
- E. Electrical Controls 5-4
- F. Gas Burner Maintenance 5-4
 - G. Safety Valves 5-8
 - H. Refractory 5-10
 - I. Front Smoke Box 5-10
 - J. Rear Access Plug 5-11
 - K. Lubrication 5-11
 - L. Combustion 5-11

CHAPTER 1

Introduction

A. General	1-1
B. The Boiler	1-2
C. Construction	1-2
D. Steam Controls (All Fuels)	1-2
E. General	1-7
F. Feedwater Piping	1-7
G. Major Components/Service Connections	1-8

A. GENERAL

The CBEX Elite is a two-pass wetback boiler designed for high pressure (200-250 psig) steam applications. Standard equipment includes a CB Profire XL burner, Hawk ICS Advanced boiler control system with parallel positioning, Level Master water level control system, and modulating feedwater valve with 3-valve bypass.

Note: For information regarding the boiler control system, see also the following manuals:

**750-229 Hawk ICS Advanced/Intermediate
750-217 Hawk ICS Parallel Positioning**

For ultra-low NOx applications, see also:

750-291 Profire NTXL Burner

The general information in this manual applies directly to Cleaver-Brooks Model CBEX Elite Boilers in sizes ranging from 1300 through 2200 boiler horsepower for the following fuels:

- Series 100 Light Oil (No. 2)
- Series 200 Light Oil (No. 2) Or Gas
- Series 700 Gas Only

When ordering spare or replacement parts for the CBEX Elite, always order genuine Cleaver-Brooks parts from your local Cleaver-Brooks authorized representative.

The boiler and related equipment installation are to be in compliance with the standards of the NFPA. Installation should also conform to state and local codes governing such equipment. Prior to installation, the proper authorities having jurisdiction are to be consulted, permits obtained, etc. All boilers in the above series comply, when equipped with optional equipment, to XL GAP, Factory Mutual (FM), or other insuring underwriters requirements.

Figure 1-1: CBEX Elite 1300-1500 HP

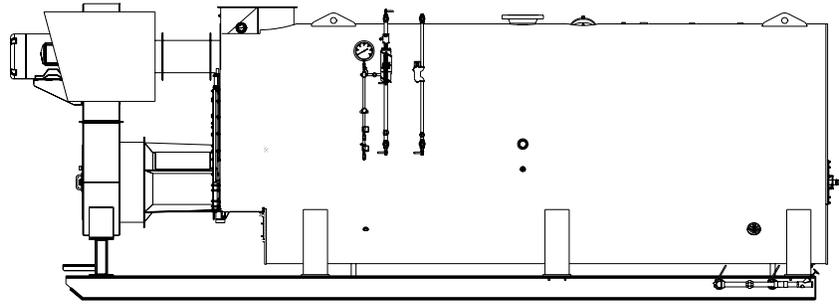
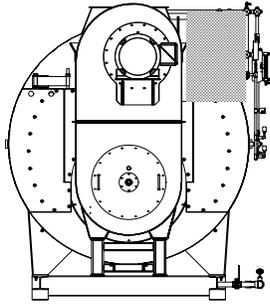
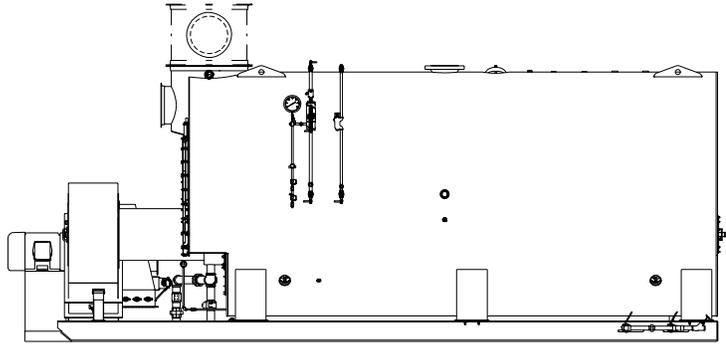
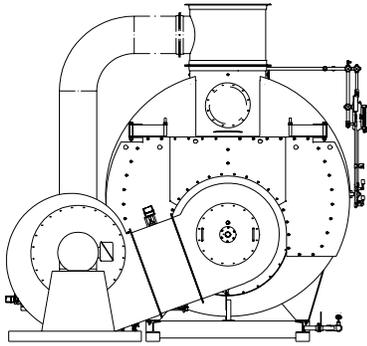


Figure 1-2: CBEX Elite 1600-2200 HP



B. THE BOILER

The Model CBEX Elite boiler is a packaged firetube boiler of welded steel construction and consists of a pressure vessel, burner, burner controls, burner accessories, refractory, and appropriate boiler trim.

The horsepower rating of the boiler is indicated by the numbers following the fuel series. Thus, CBEX 700-2200 indicates a gas-fired 2200 hp boiler.

The firetube construction provides some characteristics that differentiate it from other boiler types. Because of its vessel size, the firetube contains a large amount of water, allowing it to respond to load changes with minimum variation in steam pressure.

Firetube boilers are rated in boiler horsepower (BHP), which should not be confused with other horsepower measurements.

Steam boilers are designed for low pressure or high pressure applications. Low pressure boilers are limited to 15 psig design, and are typically used for heating applications. High pressure boilers are typically used for process loads and can have a design pressure of 150 psig and higher.

Steam boilers are defined according to design pressure and operating pressure. Design pressure is the maximum pressure used in the design of the boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the pressure vessel parts of the boiler. Typically, the safety valves are set at or below design pressure. Operating pressure is the pressure of the boiler at which it normally operates. The operating pressure usually is maintained at a suitable level below the setting of the pressure relieving valve(s) to prevent opening during normal operation.

Chapter 2 contains information on waterside care and feedwater requirements. The type of service that your boiler is required to provide has an important bearing on the amount of waterside care it will require.

CAUTION

Waterside care is of prime importance. For specific information or assistance with your water treatment requirements, contact your Cleaver-Brooks service and parts representative or your local water treatment professional. Failure to follow these instructions could result in equipment damage.

C. CONSTRUCTION

CBEX Elite boilers are designed for high pressure steam applications (200-250 psig) and are constructed in accordance with Section I, Power Boilers, of the ASME Code.

D. STEAM CONTROLS (ALL FUELS)

1. Operating Limit Pressure Control: Breaks a circuit to stop burner operation on a rise of boiler pressure at a selected setting. It is adjusted to stop or start the burner at a preselected pressure setting.
2. High Limit Pressure Control: Breaks a circuit to stop burner operation on a rise of pressure above a selected setting. It is adjusted to stop the burner at a preselected pressure above the operating limit control setting. The high limit pressure control is equipped with a manual reset.
3. Modulating Pressure Control: Senses changing boiler pressures and transmits the information to the modulating motor to change the burner firing rate when the manual-automatic switch is set on "automatic".
4. Low Water Cutoff and Feedwater Valve Control (CB Level Master): Float-operated control responds to the water level in the boiler. It performs two distinct functions:
 - Stops firing of the burner if water level drops below the safe operating point. Energizes the low-water light in the control panel; also causes low-water alarm bell (optional equipment) to ring. Code requirements of some models require a manual reset type of low water cutoff.
 - Modulates feedwater control valve to maintain water level in boiler.

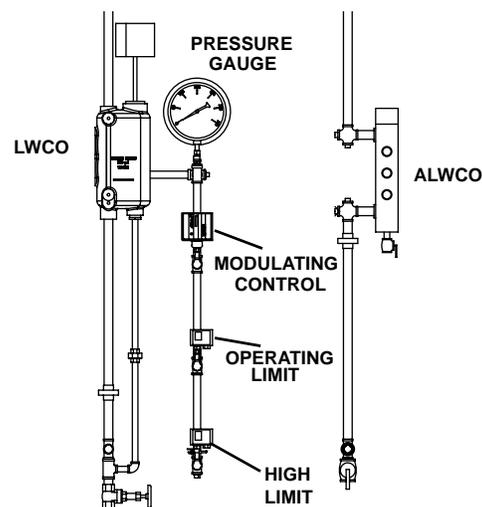
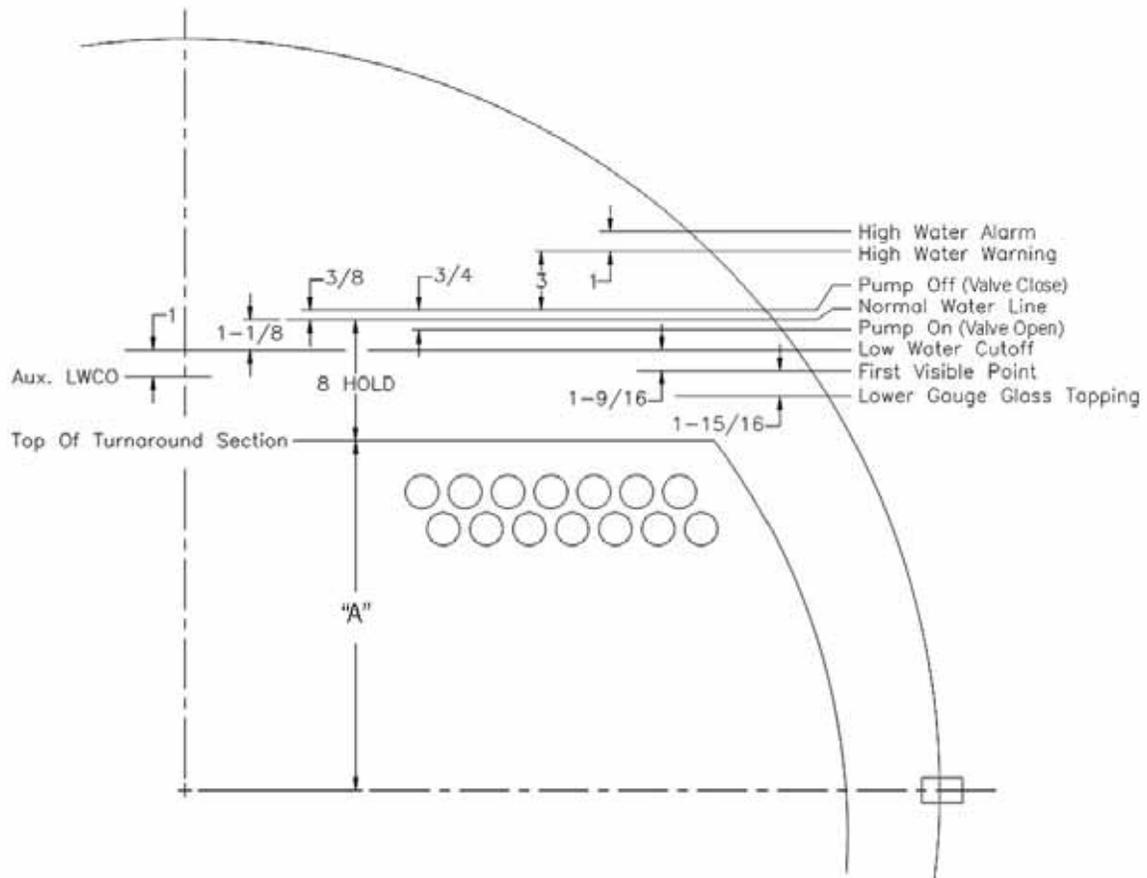


Figure 1-4: Water Column Assemblies & Pressure Controls (typical - configurations may vary)

Figure 1-5: Water Levels - CBEX Elite



Boiler size	Dim. A
1300-1500 HP	26-1/2"
1600-1800 HP	
2000-2200	35-1/2"

Note: For complete information on the CB Level Master water level control system (standard with the CBEX Elite) see also manual 750-281.

⚠ CAUTION

Determine that the main and auxiliary low water cutoffs and pump control are level after installation and throughout the equipment's operating life. Failure to follow these instructions could result in equipment damage.

5. Water Column Assembly: Houses the low-water cutoff and pump control and includes the gauge glass and gauge glass shutoff cocks.
6. Water Column Drain Valve: Provided so that the water column and its piping can be flushed regularly to assist

in maintaining cross-connecting piping and in keeping the float chamber clean and free of sediment.

7. Gauge Glass Drain Valve: Provided to flush the gauge glass.
8. Vent Valve: Allows the boiler to be vented during filling, and facilitates routine boiler inspection as required by ASME Code.
9. Auxiliary Low Water Cutoff: Breaks the circuit to stop burner operation in the event boiler water drops below the master low-water cutoff point. Manual reset type requires manual resetting in order to start the burner after a low-water condition.

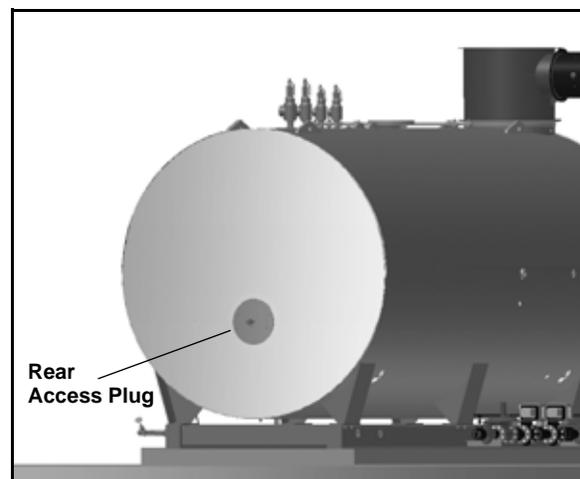
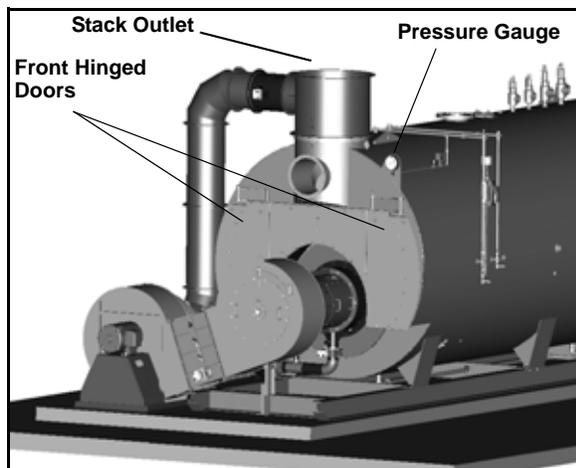
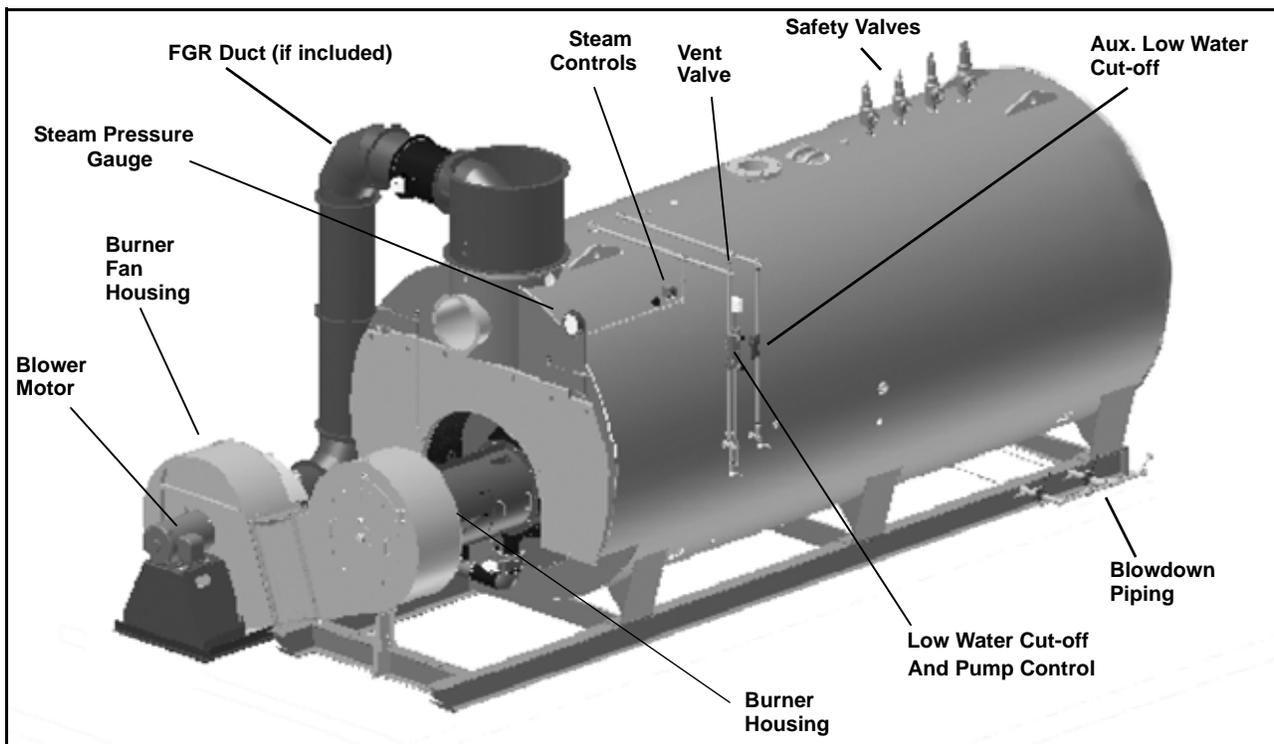


Figure 1-6: Principal components (2200 HP shown)

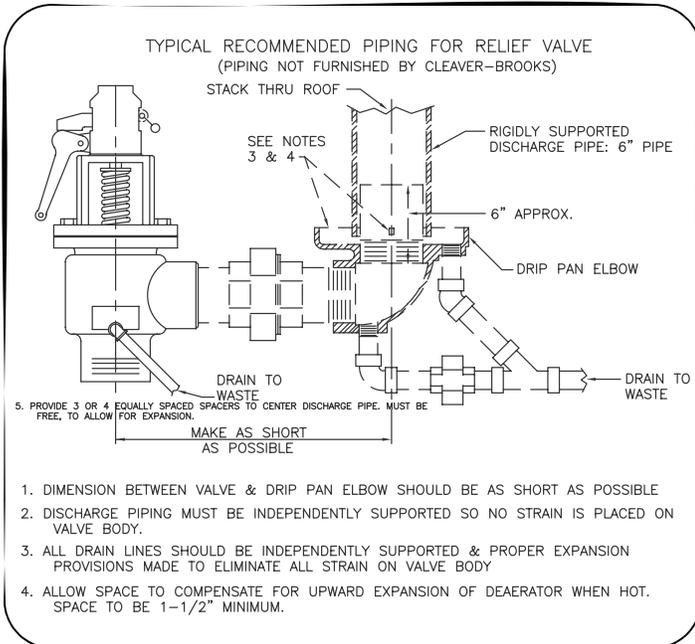


Figure 1-7: Recommended Installation - Safety Valve

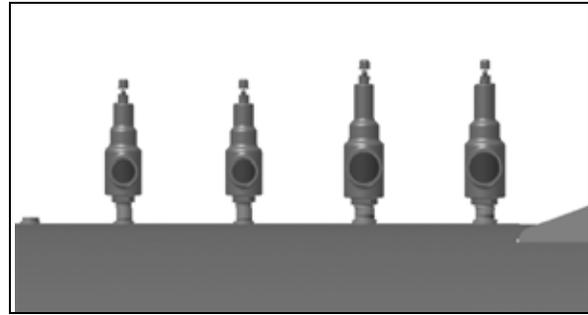


Figure 1-8: Safety Valves

WARNING

Only properly certified personnel such as the safety valve manufacturer's certified representative can adjust or repair the boiler safety valves. Failure to follow these instructions could result in serious personal injury or death.

10. Safety Valve(s): Prevent buildup over the design pressure of the pressure vessel. The size, rating and number of valves on a boiler is determined by the ASME Boiler Code. The safety valves and the discharge piping are to be installed to conform to the ASME code requirements. The installation of a valve is of primary importance to its service life. A valve must be mounted in a vertical position so that discharge piping and code-required drains can be properly piped to prevent buildup of back pressure and accumulation of foreign material around the valve seat area. Apply only a moderate amount of pipe compound to male threads and avoid overtightening, which can distort the seats. Use only flat-jawed wrenches on the flats provided. When installing a flange-connected valve, use a new gasket and draw the

mounting bolts down evenly. Do not install or remove side outlet valves by using a pipe or wrench in the outlet.

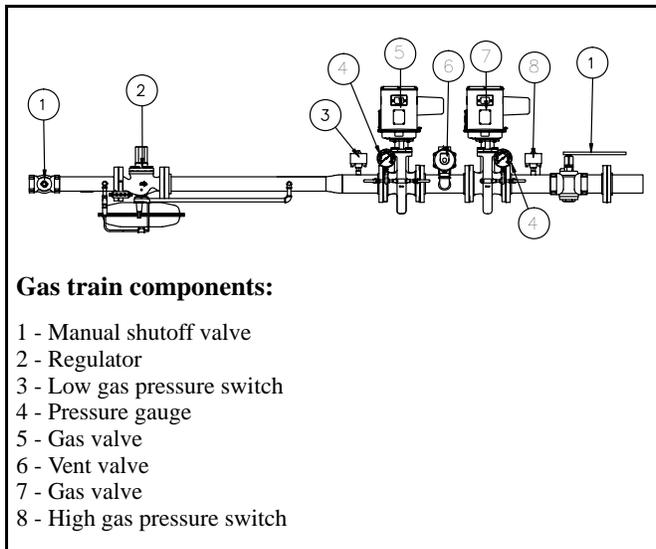
A drip pan elbow or a flexible connection between the valve and the escape pipe is recommended. The discharge piping must be properly arranged and supported so that its weight does not bear upon the valve.

Do not paint, oil, or otherwise cover any interior or working parts of the safety valve. A valve does not require any lubrication or protective coating to work properly.

E. GAS TRAIN

Standard gas train includes:

- Gas pressure regulator
- Primary motorized gas shutoff valve with proof of closure
- Second motorized safety shutoff valve
- Vent valve
- High and low gas pressure switches
- Leak test connections.



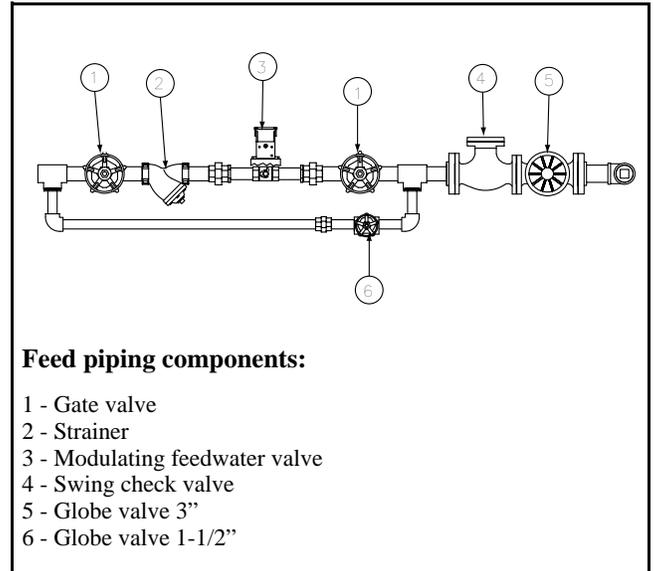
See **Chapter 3 - Profire XL Burner** for additional detail on the main gas train and pilot train.

Note: Gas train configuration may vary depending on installation.

F. FEEDWATER PIPING

Boiler feed piping includes:

- Modulating feedwater valve
- 3-valve bypass
- Strainer and check valve



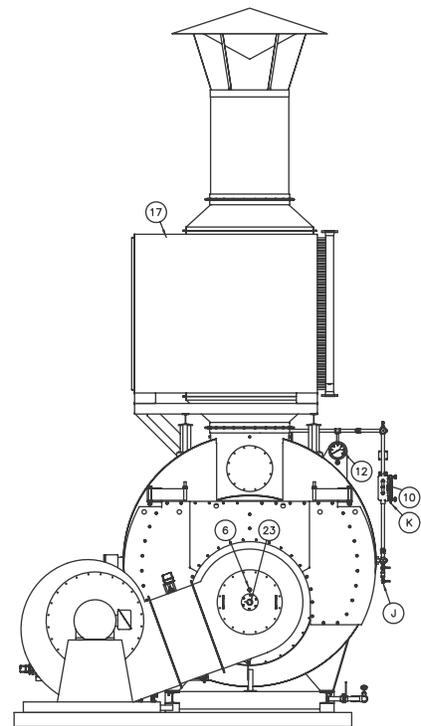
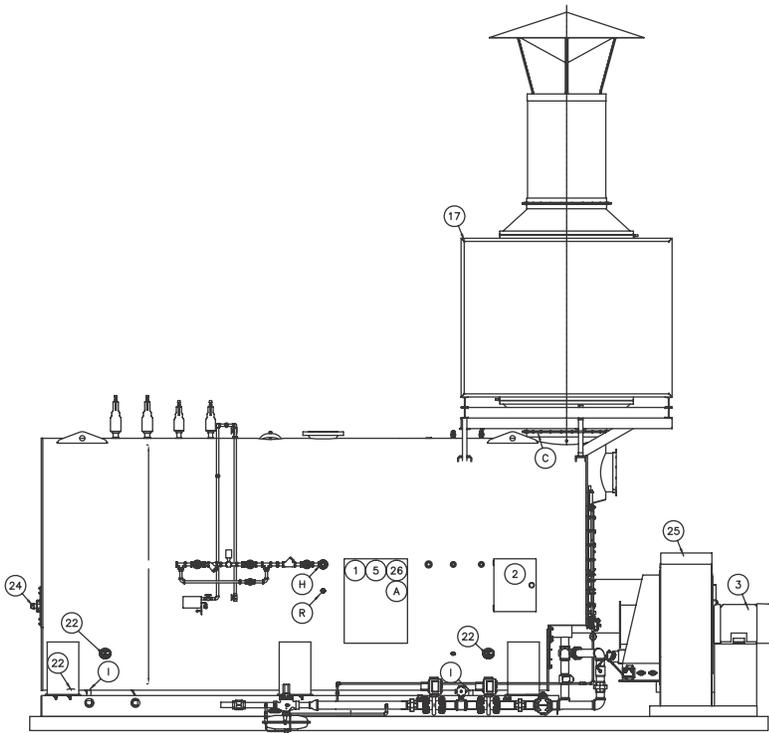
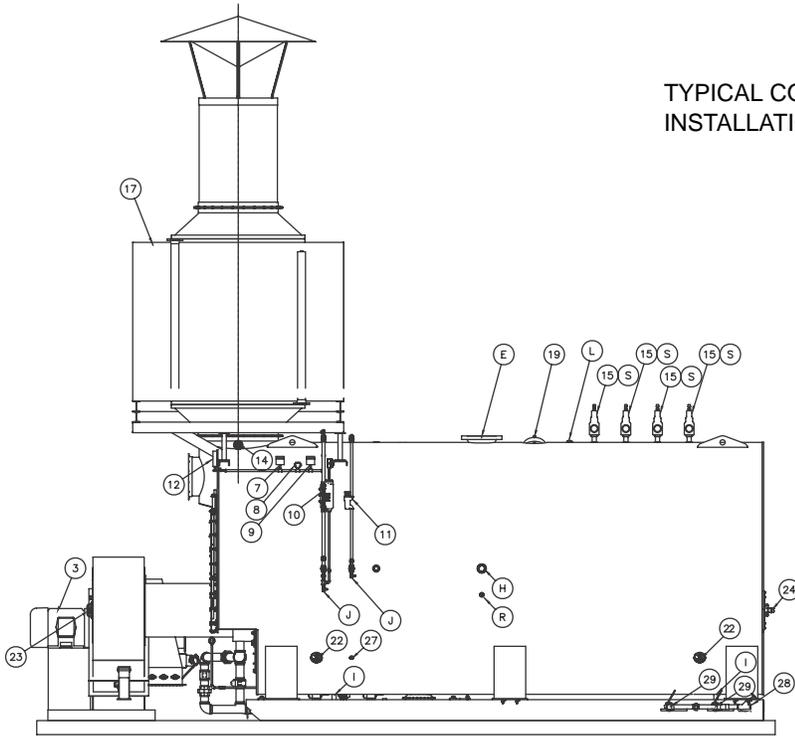
G. MAJOR COMPONENTS/SERVICE CONNECTIONS

(see illustration on next page)

ITEM	MAJOR COMPONENTS
1	CONTROL PANEL (NEMA 4X)
2	JUNCTION BOX
3	BLOWER MOTOR 100 HP
4	N/A
5	COMBUSTION SAFEGUARD CONTROL – CB120
6	FLAME SCANNER – ULTRAVIOLET
7	PRESSURE CONTROL – OPERATING LIMIT
8	PRESSURE CONTROL – HIGH LIMIT MANUAL RESET
9	PRESSURE CONTROL – MODULATING
10	MAIN WATER COLUMN LOW WATER CUTOFF WITH HIGH WATER ALARM – LEVEL MASTER
11	AUXILIARY LOW WATER CUTOFF – WARRICK #C-2 MANUAL RESET FUNCTION
12	STEAM GAUGE
13	N/A
14	STACK THERMOMETER
15	SAFETY VALVE – (4) SET AT 200# (SHIPPED LOOSE)
16	GAS TRAIN SEE DETAIL
17	ECONOMIZER
18	N/A
19	MANWAY 12 X 16
20	N/A
21	N/A
22	HANDHOLES(5) 4 X 6
23	FRONT SIGHT PORT
24	REAR SIGHT PORT
25	BURNER
26	ALARM WITH SILENCING FUNCTION
27	MINIMUM TEMPERATURE – LOW FIRE HOLD CONTROL
28	SLOW OPENING BLOWDOWN VALVE – EVERLASTING #4261-S 2.0" FLG
29	QUICK OPENING BLOWDOWN VALVE – EVERLASTING #4001-S 2.0" FLG

ITEM	SERVICE CONNECTIONS
A	ELECTRIC – MAIN POWER SUPPLY 460/3/60
B	N/A
C	EXHAUST VENT PIPE 44" OD
D	N/A
E	STEAM OUTLET – 8" 300# RF FLANGE
F	N/A
G	N/A
H	FEED WATER (2) 3.0 NPT
I	BLOWDOWN/DRAIN (2) 2.0 NPT
J	WATER COLUMN BLOWDOWN – 0.75 NPS
K	GAUGE GLASS BLOWDOWN – 0.25 NPS
L	SURFACE BLOWOFF – 1.0 NPS (WITH COLLECTOR PIPE)
M	N/A
N	GAS TRAIN – 3.0 NPS
O	MINIMUM GAS PRESSURE REQUIRED IS 15 PSI AT THE ENTRANCE TO THE MAIN GAS TRAIN
P	OIL INLET – N/A
Q	OIL RETURN – N/A
R	CHEMICAL FEED – 0.75 NPT
S	SAFETY VALVE – (4) 3.0" FPT OUTLET KUNKLE AKH
T	N/A

TYPICAL CONFIGURATION SHOWN -
INSTALLATIONS MAY VARY



Notes

CHAPTER 2

Waterside Care And Requirements

A. General	2-1
B. Water Treatment	2-2
C. Cleaning	2-2
D. Boil-Out Of New Unit	2-3
E. Washing Out	2-3
F. Blowdown	2-4
G. Periodic Inspection	2-6
H. Preparation For Extended Lay-Up	2-6

A. GENERAL

A complete discussion of water supply and treatment is beyond the scope of this manual. For specific information or assistance with your water treatment requirements, contact your Cleaver-Brooks service and parts representative.

Feedwater equipment should be ready for use upon installation of the boiler. Be sure that all valves, piping, boiler feed pumps, and receivers are installed in accordance with prevailing codes and practices.

The careful observance of water requirements is essential to boiler life and length of service. It is vital that care be taken in placing the pressure vessel into initial service. The waterside of new boilers and new or remodeled systems may contain oil, grease or other foreign matter. A method of boiling out the vessel to remove the accumulations is described later in this chapter.

Boilers, as a part of a hot water system, require proper water circulation. The system must be operated as intended by its designer in order to avoid thermal shock or severe, possibly damaging, stresses from occurring to the pressure vessel.

Feed Pump Operation

Before placing the feed pump into service, momentarily energize the pump motor to establish correct pump rotation. With the correct rotation established, close the boiler feed pump entrance switch. The pump should run continuously while the modulating feedwater valve maintains the proper boiler water level.

Feedwater pumps must have adequate capacity to maintain required water level under all operating conditions. Check the feedwater pumps periodically and maintain as necessary to prevent unexpected breakdowns.

Note: Prior to operating the pump, carefully check the alignment of the flexible coupling, if one is used. A properly aligned coupling will last a long time and provide trouble-free mechanical operation.

Note: If water column isolation valves are installed, the valves must be open and seated or locked in the open position. If the valves are installed, it is illegal to operate the boiler with closed or unsealed open valves.



The isolation valves in the water column piping must be locked open during operation. Failure to do so may result in a low water condition.

B. WATER TREATMENT

Properly treated boiler feed water, coupled with good engineering and operating practices, lead to maximum effectiveness and long trouble-free life of pressure vessels, at the lowest operating cost. Contact your local Cleaver-Brooks authorized representative for information on how to prevent the presence of unwanted solids and corrosive gases.

Objectives of water treatment in general are:

- (1) Prevent hard scale deposits or soft sludge deposits, which reduce heat transfer and can lead to overheated metal and costly downtime and repairs.
- (2) Eliminate corrosive gases in the supply or boiler water.
- (3) Prevent intercrystalline cracking or caustic embrittlement of boiler metal.
- (4) Prevent carryover and foaming.

Accomplishment of the above objectives generally requires proper feedwater treatment before and after introduction of the water into the boiler. The selection of pre-treatment processes depends upon the water source, its chemical characteristics, amount of makeup water needed, plant operating practices, etc. Treating methods include filtering, softening, de-mineralizing, deaerating, and preheating. After-treatment involves chemical treatment of the boiler water.

Because of the variables involved, no single water treatment compound can be considered a “cure-all” nor is it advisable to experiment with homemade treating methods. Sound recommendations and their employment should be augmented by a periodic analysis of the feedwater, boiler water, and condensate.

The internal or waterside surfaces of the pressure vessel should be inspected with enough frequency to determine the presence of any contamination, accumulations of foreign matter, or corrosion, and/or pitting. If any of the conditions are detected, contact your local Cleaver-Brooks authorized representative for advice on corrective action.

A properly sized water meter should be installed in the raw water make-up line in order to accurately determine the amount of raw water admitted to the boiler and to aid in maintaining proper waterside conditions.

C. CLEANING

1. STEAM PIPING

Steam and piping systems connected to the boiler may contain oil, grease, or foreign matter. The impurities must be removed in order to prevent damage to pressure vessel heating surfaces. On a steam system, the condensate should be wasted until tests show the elimination of undesirable impurities. During the period that condensate is wasted, attention must be given to the treatment of the raw water used as make-up so that an accumulation of unwanted materials or corrosion does not occur. For more information, contact your local Cleaver-Brooks authorized representative.

2. PRESSURE VESSEL

The waterside of the pressure vessel must be kept clean from grease, sludge, and foreign material. Such deposits, if present, will shorten the life of the pressure vessel, will interfere with efficient operation and functioning of control of safety devices, and quite possibly cause unnecessary and expensive re-work, repairs, and down-time.

The installation and operating conditions that the boiler will be subjected to should be considered and cleaning of the waterside of the pressure vessel should be provided during the course of initial start-up.

The pressure vessel and the steam and return lines represent, in effect, a closed system. Although the steam and return (condensate) lines may have been previously cleaned, it is possible that:

- (1) Cleaning has been inadequate.
- (2) Partial or total old system is involved.
- (3) Conditions may prevent adequate cleaning of piping.

The pressure vessel waterside should be inspected on a periodic basis. An inspection will reveal true internal conditions and serve as a check against conditions indicated by chemical analysis of the boiler water. Inspection should be made three months after initial starting and at regular 6-, 9-, or 12-month intervals thereafter. The frequency of further periodic inspections will depend upon the internal conditions found.

If any unwanted conditions are observed, contact your local Cleaver-Brooks authorized representative for recommendations.

Any sludge, mud or sediment found will need to be flushed out. If excessive mud or sludge is noticed during the blowdown the scheduling or frequency of blowdown may need to be revised. The need for periodic draining or washout will also be indicated.

Any oil or grease present on the heating surfaces should be removed promptly by a boil-out with an alkaline detergent solution.

Note: Temperature of initial fill of water for hydrostatic tests, boil-out, or for normal operation should be as stated in the ASME Boiler Code.

D. BOIL-OUT OF NEW UNIT

The internal surfaces of a newly installed boiler may have oil, grease or other protective coatings used in manufacturing. Such coatings must be removed because they lower the heat transfer rate and could cause over-heating of a tube. Before boiling out procedures may begin, the burner should be ready for firing. The operator must be familiar with the procedure outlined under burner operation.

**WARNING**

Use of a suitable face mask, goggles, rubber gloves, and protective garments is strongly recommended when handling or mixing caustic chemicals. Do not permit the dry material or the concentrated solution to come in contact with skin or clothing. Failure to follow these instructions could result in serious personal injury or death

Your local Cleaver-Brooks authorized representative will be able to recommend a cleaning or boil-out procedure. In the event such service is unavailable or is yet unscheduled, the following information may be of assistance.

There are several chemicals suitable for boil-out. One combination often used is soda ash (sodium carbonate) and caustic soda (sodium hydroxide) at the rate of 3 to 5 pounds each per 1,000 pounds of water, along with a small amount of laundry detergent added as a wetting agent.

The suggested general procedure for cleaning a boiler is as follows:

- (1) Have sufficient cleaning material on hand to complete the job.
- (2) When dissolving chemicals, the following procedure is suggested. Warm water should be put into a suitable container. Slowly introduce the dry chemical into the water, stirring it at all times until the chemical is completely dissolved. Add the chemical slowly and in small amounts to prevent excessive heat and turbulence.
- (3) An over-flow pipe should be attached to one of the top boiler openings and routed to a safe point of discharge. A relief or safety valve tapping is usually used.
- (4) Safety valves must be removed before adding the boil-out solution so that neither it nor the grease which it may carry will contaminate the valves. Use care in removing and reinstalling the valves.
- (5) All valves in the piping leading to or from the system must be closed to prevent the cleaning solution from getting into the system.
- (6) Fill the pressure vessel with clean water until the top of the tubes are covered. Add the cleaning solution and then fill to the top. The temperature of the water used in the initial fill should be at ambient temperature.
- (7) The boiler should then be fired intermittently at a low rate sufficient to hold solution just at the boiling point. Boil the water for at least five hours. Do not produce steam pressure.
- (8) Allow a small amount of fresh water to enter the boiler to create a slight overflow that will carry off surface impurities.
- (9) Continue the boil and overflow process until the water clears. Shut the burner down.

- (10) Let the boiler cool to 120°F or less.

**WARNING**

Be sure to drain the hot water to a safe point of discharge to avoid scalding. Failure to follow these instructions could result in serious personal injury or death

- (11) Remove handhole plates and wash the waterside surfaces thoroughly using a high pressure water stream.
- (12) Inspect the surfaces. If they are not clean, repeat the boil out.
- (13) After closing the handholes and reinstalling the safety or relief valves, fill the boiler and fire it until the water is heated to at least 180°F to drive off any dissolved gases, which might otherwise corrode the metal.

The above procedure may be omitted in the case of a unit previously used or known to be internally clean. However, consideration must be given to the possibility of contaminating materials entering the boiler from the system.

E. WASHING OUT

No later than three months after initially placing the boiler into operation and starting service, and thereafter as conditions warrant, the pressure vessel should be drained after being properly cooled to near ambient temperature. Handhole covers should be removed and waterside surfaces should be inspected for corrosion, pitting, or formation of deposits.

Flushing of Pressure Vessel Interior

Upon completion of the inspection, the pressure vessel interior should be flushed out, as required, with a high pressure hose. If deposits are not fully removed by flushing, a consultation may be required with your local Cleaver-Brooks authorized representative. In extreme cases, it may be necessary to resort to acid cleaning. Professional advice is recommended if acid cleaning is required.

The inspections will indicate the effectiveness of the feedwater treatment. The effectiveness of treatment, the water conditions, and the amount of fresh water make-up required are all factors to be considered in establishing frequency of future pressure vessel washouts. Contact your local Cleaver-brooks authorized representative for more information.

F. BLOWDOWN

Boiler water blowdown is the removal of some of the concentrated water from the pressure vessel and its replacement with feedwater so that the lowering of the concentration of solids in the boiler water occurs.

Solids are brought in by the feedwater even though the water is treated prior to use through external processes that are designed to remove unwanted substances which contribute to scale and deposit formations. However, none of the processes can remove all substances. Regardless of their high efficiency, some solids will be present in the boiler feedwater.

Solids become less soluble in the high temperature of the boiler water and tend to accumulate on heating surfaces. Therefore blowdown and internal chemical treatment are required to prevent the solids from forming harmful scale and sludge.

Scale has a low heat transfer value and acts as an insulation barrier. Scale retards heat transfer, which not only results in lower operating efficiency, and consequently higher fuel consumption, but more importantly, can cause overheating of boiler metal. Over heating of boiler metal can result in tube failures or other pressure vessel metal damage and lead to boiler down-time and costly repairs.

Scale is caused primarily by calcium and magnesium salts and silica. Any calcium and magnesium salts in the boiler water are generally precipitated by the use of sodium phosphate, along with organic materials, to maintain the precipitates or “sludge” in a fluid form. The solids such as sodium salts and suspended dirt do not readily form scale. But as the boiler water boils off as relatively pure steam, the remaining water is thickened with the solids. If the concentration is permitted to accumulate, foaming and priming will occur and the sludge can cause harmful deposits that bring about overheating of the metal.

The lowering or removal of the concentration requires the use of boiler water blowdown.

1. BOILER BLOWDOWN

There are two principal types of boiler blowdown: intermittent manual blowdown, and continuous blowdown.

Intermittent Manual Blowdown

Manual or sludge blowdown is necessary for the operation of the boiler regardless of whether or not continuous blowdown is employed.

The blowdown tappings are located at the bottom or lowest part of the boiler in order to lower the dissolved solids in the pressure vessel water, and to remove a portion of the sludge that accumulates in the lower part of the vessel.

Equipment generally consists of a quick opening valve(s) and a shut-off valve. All piping must be to a safe point of discharge. Piping must be properly supported and free to expand.

Continuous Blowdown

Continuous blowdown is used in conjunction with a surface blow-off tapping and is the continuous removal of concentrated water.

The surface blow-off opening, when furnished, is on the top center line of the pressure vessel. It is provided with an internal collecting pipe terminating slightly below the working water level for the purpose of skimming surface sediment, oil or other impurities from the surface of the pressure vessel water.

A controlled-orifice valve is used to allow a continual, yet controlled, flow of concentrated water.

Periodic adjustments are made to the valve setting to increase or decrease the amount of blowdown in accordance with the test analysis.

The flow control valve and piping are generally provided by others. All piping must be to a safe point of discharge.

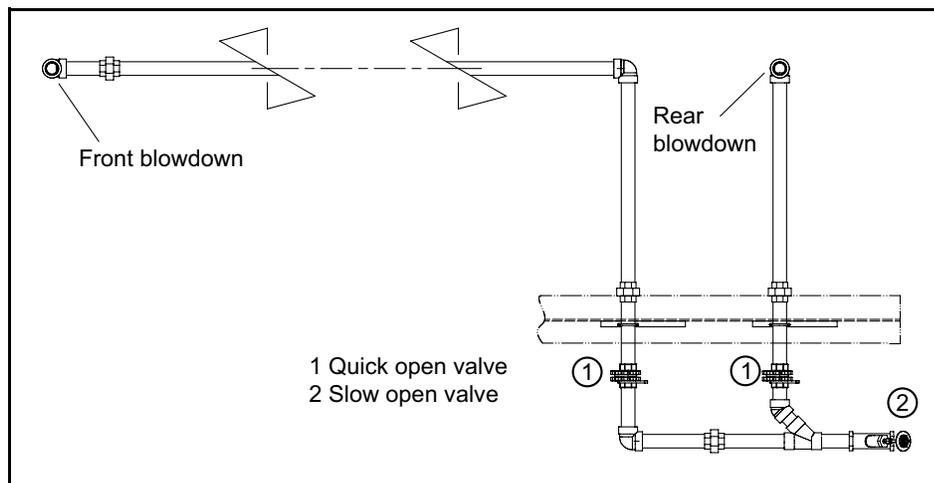


Figure 2-1: Top view of blowdown piping

Frequency of Manual Blowdown

When continuous blowdown is utilized, manual blowdown is primarily used to remove suspended solids or sludge. The continuous blowdown removes sediment and oil from the surface of the water along with a prescribed amount of dissolved solids.

When surface or continuous blowdown is not utilized, manual blowdown is used to control the dissolved or suspended solids in addition to the sludge.

In practice, the valve(s) of the bottom blowdown are opened periodically in accordance with an operating schedule and/or chemical control tests. From the standpoint of control, economy and results, frequent short blows are preferred to infrequent lengthy blows. The length and frequency of the blowdown is particularly important when the suspended solids content of the water is high. With the use of frequent short blows a more uniform concentration of the pressure vessel water is maintained.

In cases where the feedwater is exceptionally pure, or where there is a high percentage of return condensate, blowdown may be employed less frequently since less sludge accumulates in the pressure vessel. When dissolved and/or suspended solids approach or exceed predetermined limits, manual blowdown to lower the concentrations is required.

It is generally recommended that a steam boiler be blown down at least once in every eight-hour period, but frequency may vary depending upon water and operating conditions. The blowdown amounts and schedule should be recommended by your local Cleaver-Brooks authorized representative.

Manual Blowdown Procedure

Blowdown is most effective at a point in time when the generation of steam is at the lowest rate and feedwater input is also low, thus providing a minimum dilution of the boiler water with low concentration feedwater.

Be sure the blow-off piping and tank, if used, are in proper operating condition. Discharge vents should be clear of obstruction, and the waste should be piped to a point of safe discharge.

Most blow-off lines are provided with two valves, generally a quick opening valve nearest the boiler and a slow opening globe type valve downstream. Valves will vary depending upon pressure involved and make or manufacturer. If seatless valves are installed, follow the manufacturer's recommendations.

If a quick opening valve and globe type of slow opening valve are in combination, the former is normally opened first and

closed last with blow down accomplished with the globe or slow opening valve.

Larger vessels may have two bottom blowdown lines, each with a quick opening valve. Lines may be blown down simultaneously by opening both quick opening valves before opening the downstream valve.

When opening the second or downstream valve, crack it slightly to allow the lines to warm, then continue opening slowly.

CAUTION

Do not pump the lever action valve open and closed, as water hammer is apt to break the valve bodies or pipe fittings. Failure to follow these instructions could cause damage to the equipment.

The length of each blow should be determined by actual water analysis. Lowering the water in the gauge glass approximately 1/2" is often acceptable as a guide to adequate blow. However, lowering the water 1/2" should not be interpreted as a rule since water analysis procedures should prevail. If the glass cannot be viewed by the party operating the valve, another operator should watch the glass and direct the valve operator.

Close the downstream (slow opening) valve first and as fast as possible. Then close the valve(s) next to the boiler. Slightly crack the downstream valve and then close it tightly.

Under no circumstances should a blow-off valve be left open and the operator should never leave until the blowdown operation is completed and the valves are closed.

2. WATER COLUMN BLOWDOWN

It is recommended that the water column be blown down daily (or more often, depending on water quality). In addition, the water column must be blown down after a power outage.

The Level Master controller helps simplify this process by providing a reminder routine that will notify the operator at least once every 24 hours that the water column requires blowdown if a successful blowdown has not been performed during that period.

See the Level Master manual for complete step-by-step instructions.

G. PERIODIC INSPECTION

Insurance regulations or local laws will require a periodic inspection of the pressure vessel by an authorized inspector. Sufficient notice is generally given to permit removal of the boiler from service and preparation for inspection.



To avoid the hazard of electrical shock, we recommend the use of a low voltage flashlight during an internal inspection. Preferably, inspectors should work in pairs. Failure to follow these instructions could result in serious personal injury or death

When shutting down the boiler, the load should be reduced gradually and the pressure vessel cooled at a rate that avoids damaging temperature differential that can cause harmful stresses. Vessels should not normally be drained until all pressure is relieved - again to prevent uneven contraction and temperature differentials that can cause expanded tubes to leak. Draining the unit too quickly may cause the baking of deposits that may be present on the heating surfaces. Some heat, however, may be desirable to dry out the interior of the boiler.

If the internal inspection is being made at the request of an authorized inspector, it is well to ask the inspector observe the conditions prior to cleaning or flushing of waterside surfaces.

Be certain that a supply of manhole and handhole gaskets is available, along with any other gaskets or items needed to place the unit back into operation after inspection.

Have available information on the boiler design, dimensions, generating capacity, operating pressure or temperature, time in service, defects found previously, and any repairs or modifications. Also have available for reference records of previous inspections.

Be prepared to perform any testing required by the inspector including a hydrostatic test.

After proper cooling and draining of the vessel, flush out the waterside with a high pressure water hose. Remove any scale or deposits from the waterside surfaces and check for internal or external corrosion and leakage.

The fireside surface should also be thoroughly cleaned so that metal surfaces, welds, joints, tube ends, fittings and any previous repairs can be readily checked.

Be sure that steam valves, feedwater valves, blow-off valves, all fuel valves, and electrical switches are shut off prior to opening any handholes, manholes, doors, or access plugs. Adequately vent the pressure vessel prior to entry.

Clean out the low-water cutoff piping, the water level controls and cross-connecting pipes. Replace the water gauge

glass and clean out the water cocks. Also check and clean the drain and the blowdown valves and piping.

Check all water and steam piping and valves for leaks, wear, corrosion, and other damage. Replace or repair as required.

H. PREPARATION FOR EXTENDED LAY-UP

Many boilers used for heating or seasonal loads or for stand-by service may have extended periods of non-use. Special attention must be given to idle boilers so that neither waterside nor fireside surfaces are allowed to deteriorate from corrosion.

Too many conditions exist to lay down definite rules. There are two methods of storage: wet or dry. Your local Cleaver-Brooks authorized representative can recommend the better method depending upon circumstances in the particular installation.

Whichever method is used, common sense dictates a periodic recheck of fireside and waterside conditions during lay-up to allow variations from the above methods for special area or job-site conditions.

Swing open the boiler head at the stack end of the unit to prevent flow of warm, moist air through the boiler tubes.

Although pollution control regulations will continue to limit the permissible sulphur content of fuel oils, care must be taken to avoid corrosion problems that sulphur can cause, especially in a boiler that is seasonally shut town. Dormant periods, and even frequent shutdowns, expose the fireside surfaces to condensation below the dew point during cooling. Moisture and any sulphur residue can form an acid solution. Under certain conditions, and especially in areas with high humidity, the corrosive effect of the acid will be serious enough to eat through or severely damage boiler tubes or other metal heating surfaces during the time that a boiler is out of service.

The condition does not generally occur during normal firing operation, because the high temperature of operation vaporizes any condensation. However, proper boiler operation must be maintained to prevent the flue gases from falling below the dew point.

At the start of lay-up, thoroughly clean the fireside by removing any soot or other products of combustion from the tubes, tube sheets and other fireside surfaces. Brushing will generally suffice. Sweep away or vacuum any accumulation. The fireside surfaces may be flushed with water. However, all moisture must be eliminated after flushing and the surface dried by blowing air or applying some form of heat. It is good practice to protect the cleaned surfaces by coating them with an anti-corrosive material to prevent rust.

To prevent condensation from forming in the control cabinet, keep the control circuit energized. For extended lay-up periods, especially where high humidity or large swings in ambient temperature occur, the program relay should be removed and stored in a dry atmosphere.

Dry storage is generally employed when the boiler will be out of service for a significant period of time, or where freezing temperatures may exist. In the dry storage method the boiler must be thoroughly dried because any moisture would cause corrosion. Both fireside and waterside surfaces must be cleaned of all scale, deposits, soot, etc. Steps must be taken to eliminate moisture by placing moisture-absorbing materials such as quick lime (at 2 pounds for 3 cubic feet of volume) or silica gel (at 5 pounds for 30 cubic feet of volume) on trays inside the vessel. Fireside surfaces may be coated with an anti-corrosive material, or grease or tar paint. Refractories should be brushed clean and wash-coated. All openings to the pressure vessel, such as manhole and handholes, should be shut tightly. Feedwater and steam valves should be closed. Damper and vents should be closed to prevent air from reaching fireside surfaces. Periodic inspection should be made and absorption materials renewed.

Wet storage is generally used for a boiler held in stand-by condition or in cases where dry storage is not practical. The possibility of freezing temperatures must be considered. Care must again be taken to protect metal surfaces. Variables preclude definite recommendations. However, it is suggested that the pressure vessel be drained, thoroughly cleaned internally, and re-filled to overflowing with treated water. If deaerated water is not available, the unit should be fired to boil the water for a short period of time. Additional chemicals may be suggested by your local Cleaver-Brooks authorized representative to minimize corrosion. Internal water pressure should be maintained at greater than atmospheric pressure. Nitrogen is often used to pressurize the vessel. Fireside surfaces must be thoroughly cleaned and refractory should be wash-coated.

CHAPTER 3

Profire XL Burner

A. General.....	3-1
B. Description.....	3-1
C. Operating Controls	3-1
D. Combustion Air Handling System	3-2
E. Firing Rate Controls	3-2
F. Firing Head.....	3-2
G. Gas System.....	3-2
H. Installation.....	3-4
I. Operation.....	3-7
J. Adjustments.....	3-9
K. Maintenance.....	3-11
L. Extended Shutdown	3-11



A. GENERAL INFORMATION

CB Profire XL/Series burners are assembled and wired at the factory. They are wired in accordance with the National Electrical Code (NEC) and where applicable, the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes. Other regulatory agency control options are available.

CAUTION

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

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

B. DESCRIPTION

The CB Profire XL/Series gas burners are of the peripheral mix type. All burners feature ignition by spark-ignited gas pilot flame. With either fuel, the burner operates with full modulation. A switch permits changeover from automatic fully modulated firing to manually set firing at any desired rate between minimum and maximum. Additional safeguards assure that the burner always returns to minimum firing position for ignition. XL/Series burners are designed for automatic, unattended operation where code allows,

except for periodic inspection and maintenance. After selecting the proper overload settings for the starter, the rest of the control panel components require little attention except for occasional cleaning.

C. OPERATING CONTROLS

CBEX Elite boilers feature as standard the Cleaver-Brooks HAWK ICS, an exclusive boiler management and control system specifically designed to integrate the functions of a Programmable Logic Controller (PLC) and Burner Management Controller, as well as other boiler operating and ancillary controls. The PLC and associated devices comprise a modular design providing flexibility for expansion and easily serviceable components. The HAWK ICS system incorporates a user-friendly, graphical touch screen Human Machine Interface (HMI) that displays boiler parameters, fault annunciation and alarm history, as well as providing access to boiler configuration and control functions.

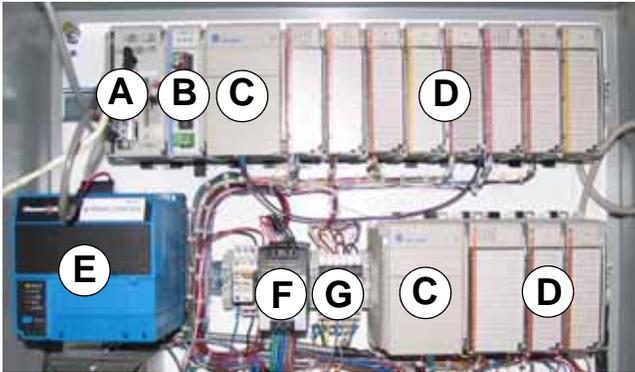
Figure 3-1: Hawk HMI



NOTE - For complete information on the CBEX Elite control system, see the following manuals:

- 750-229 Hawk ICS
- 750-217 Parallel Positioning

Figure 3-2: Control panel interior



- A - Programmable Logic Controller
- B - SM2 Modbus Module
- C - Power Supply
- D - Input and Output Modules
- E - Flame Safety Control
- F - Power Supply
- G - Panel Circuit Breakers

WARNING

Read all manuals provided with the boiler and controls before attempting to operate this equipment. Failure to do so may result in serious personal injury or death.

D. COMBUSTION AIR HANDLING SYSTEM

The combustion air handling system consists of two major components:

- 1. DAMPER ASSEMBLY.** A rotary damper regulates the combustion air volume and is positioned by an actuator. The damper is normally **ALMOST CLOSED** in the low-fire position and opens as the burner drives toward a high-fire position.
- 2. MOTOR DRIVEN IMPELLER.** The diameter of the impeller determines available air pressure and the width determines air capacity in cubic feet per minute. Alternate motor-impeller combinations are available for 50 Hz or 60 Hz power and for firing against either moderate or high furnace pressure. For higher altitudes and higher furnace pressures,

motor and impeller combinations and determined at the factory.

E. FIRING RATE CONTROLS

Regardless of the fuel used, burner input is fully modulated between low fire and high fire on boiler demand. Firing rate is controlled by a parallel positioning system utilizing electric actuators.

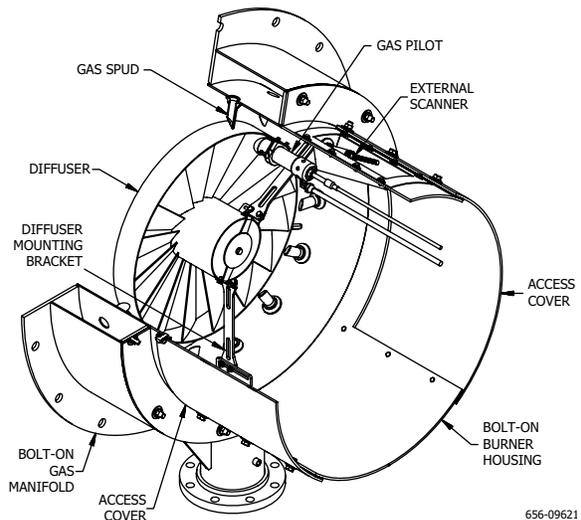
F. FIRING HEAD

Access to the firing head is provided by a hinged rear access door and removable side access covers on the burner housing.

G. GAS SYSTEM

Gas is introduced into the combustion zone from a circular manifold through multiple ports in the blast tube, and through a pre-mix zone. Firing rate is determined by the size and number of ports, by manifold pressure and by combustion zone pressure. The firing rate is regulated by a rotary, butterfly type throttling valve at the manifold inlet. Two safety shutoff motorized main gas valves are provided for installation in the gas train upstream of the butterfly valves. Safety shutoff gas valves are wired into the programming control to automatically open and close at the proper time in the operating sequence.

Figure 3-3: XL Burner Head



MAIN GAS TRAIN COMPONENTS

Depending upon the requirements of the regulating authority, the gas control system and gas train may consist of some, or all, of the following items. A typical gas train is shown in Figure 3-3.

GAS VOLUME VALVE. One or two butterfly type valves are positioned by actuators and control the rate of flow of gas.

MAIN GAS VALVES. Electrically operated safety shutoff valve(s) that open to admit gas to the burner. Standard burners include: Two motorized gas valve(s) w/closure interlock.

MAIN GAS REGULATOR Regulates gas train pressure to specified pressure re-quired at inlet to gas train. Input is set by main gas pressure regulator adjustment.

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

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

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

GAS PILOT VALVE(S). Solenoid valve(s) that open during the ignition period to admit fuel to the pilot. They close after main flame is established.

GAS PRESSURE REGULATOR. Reduces gas pressure to that required by the pilot.

GAS PILOT SHUT-OFF COCK. For manually closing the pilot gas supply.

OPERATION

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

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

Figure 3-2: Burner head, BF valve, and dry oven

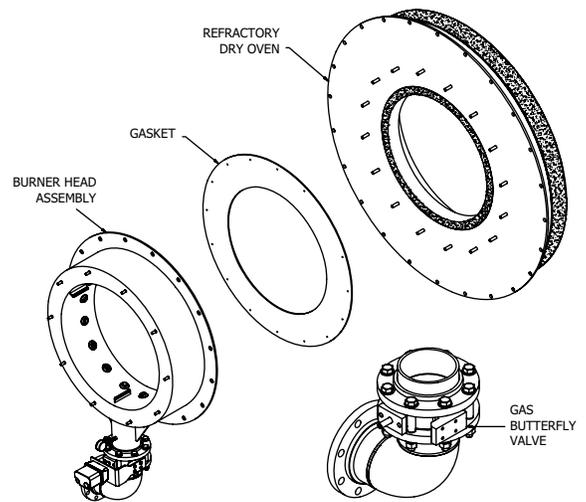
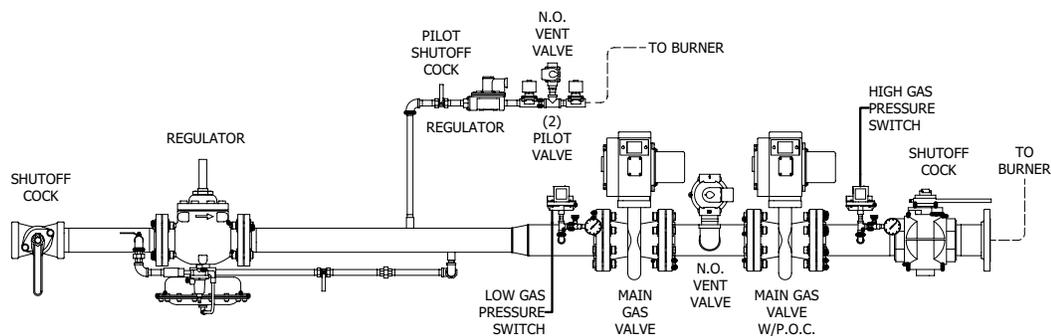


Figure 3-3: Gas Train



H. INSTALLATION

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

Locate the burner properly. The burner is designed for operation with the blast tube level. Do not tilt burner up or excessively downward. Securely support the burner pedestal on the floor or foundation. The face of the boiler and burner flange must be sealed with the gasket provided with the burner. Carefully place the gasket over the dry oven bolts before it is mounted onto the burner flange. The I.D. of the dry oven is slightly larger than the blast tube I.D. Make sure the dry oven and burner blast tube are concentric. Due to bolt hole tolerances, the dry oven may have to be shifted to accomplish this. After the dry oven nuts are properly tightened, the burner and dry oven assembly can then be mounted into the boiler.

PACKING PLASTIC REFRACTORY AROUND OVEN

The area between the outside circumference of the dry oven and existing refractory should be packed with Kaiser Refractory Mono T-9 Airset or equal within two hours after coating the dry oven with Trowleze. From inside the furnace, ram plastic refractory from the front to the rear parallel to outside surface of the dry oven. See Figure 3-4.

GAS PIPING Gas service and house piping must supply the quantity of gas demanded by the unit at the pressure required at the burner gas train inlet. All piping must be in strict accordance with applicable codes, ordinances and regulations of the supplying utility. In the absence of other codes, piping should be in accordance with the following standards: "National Fuel Gas Code" NFPA No. 54, ANSI No. Z 223.1. (for Canada: the Canadian Gas Association (CGA) B149 and Canadian Standards Association (CSA) B140 codes shall prevail) Unless specified otherwise, gas train components upstream of the butterfly valve are CB-mounted. These components should be mounted by the installer as close to the butterfly valve as practical. Normally, the control train is ordered to suit a particular code or insurance regulation - such as Underwriters Laboratories, Inc., CGA, or Factory Mutual.

Arrange gas piping at the burner so that the burner is accessible for servicing without disassembly. The gas pilot supply line must be connected upstream of the main gas regulator. If a reducing bushing is required between the house piping and the burner piping, it should be close to the burner shut-off valve. The gas piping must be internally clean and

free of foreign material. Before using in service, a leak test must be performed.

INSTALLATION CHECKLIST

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

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

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

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

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

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

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

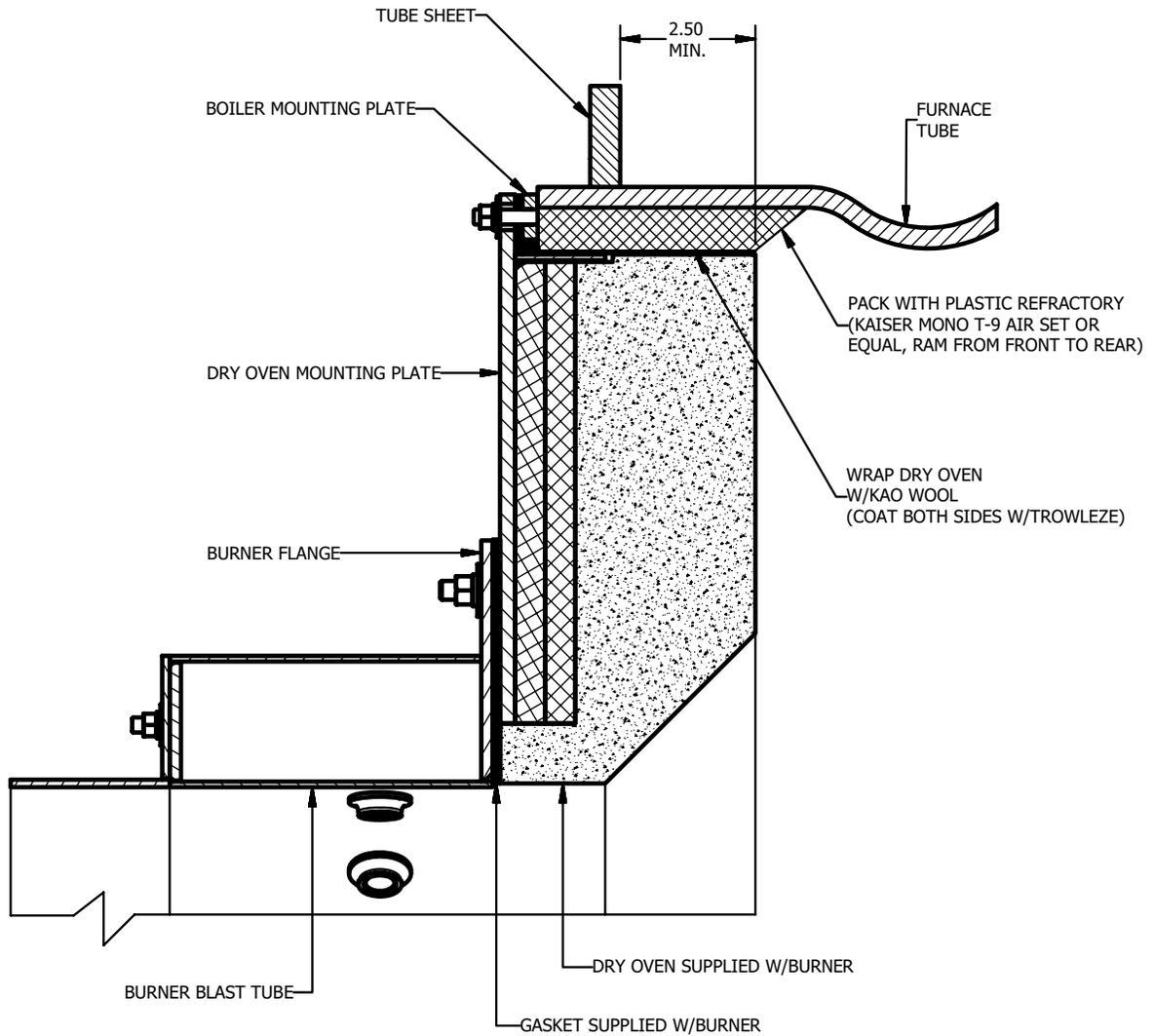
CAUTION

THE BURNER REFRACTORY CONE IS AIR-CURED ONLY. HEAT-CURING MUST BE INITIATED AT INITIAL START-UP. RUN THE BURNER AT LOW FIRE FOR A PERIOD OF 6 TO 8 HOURS BEFORE STARTING TO GRADUALLY INCREASE THE FIRING RATE. FAILURE TO DO SO WILL RESULT IN DAMAGE AND CRACKS IN THE REFRACTORY.

CAUTION

BEFORE OPENING THE GAS SHUT-OFF VALVES, READ THE REGULATOR INSTRUCTIONS CAREFULLY. OPEN SHUT-OFF VALVE SLOWLY TO ALLOW INLET PRESSURE TO BUILD UP SLOWLY IN THE REGULATOR UNTIL IT IS FULLY PRESSURIZED. OPENING THE SHUT-OFF VALVE TOO QUICKLY WILL DAMAGE THE REGULATOR. DO NOT EXCEED THE REGULATOR PRESSURE RATINGS.

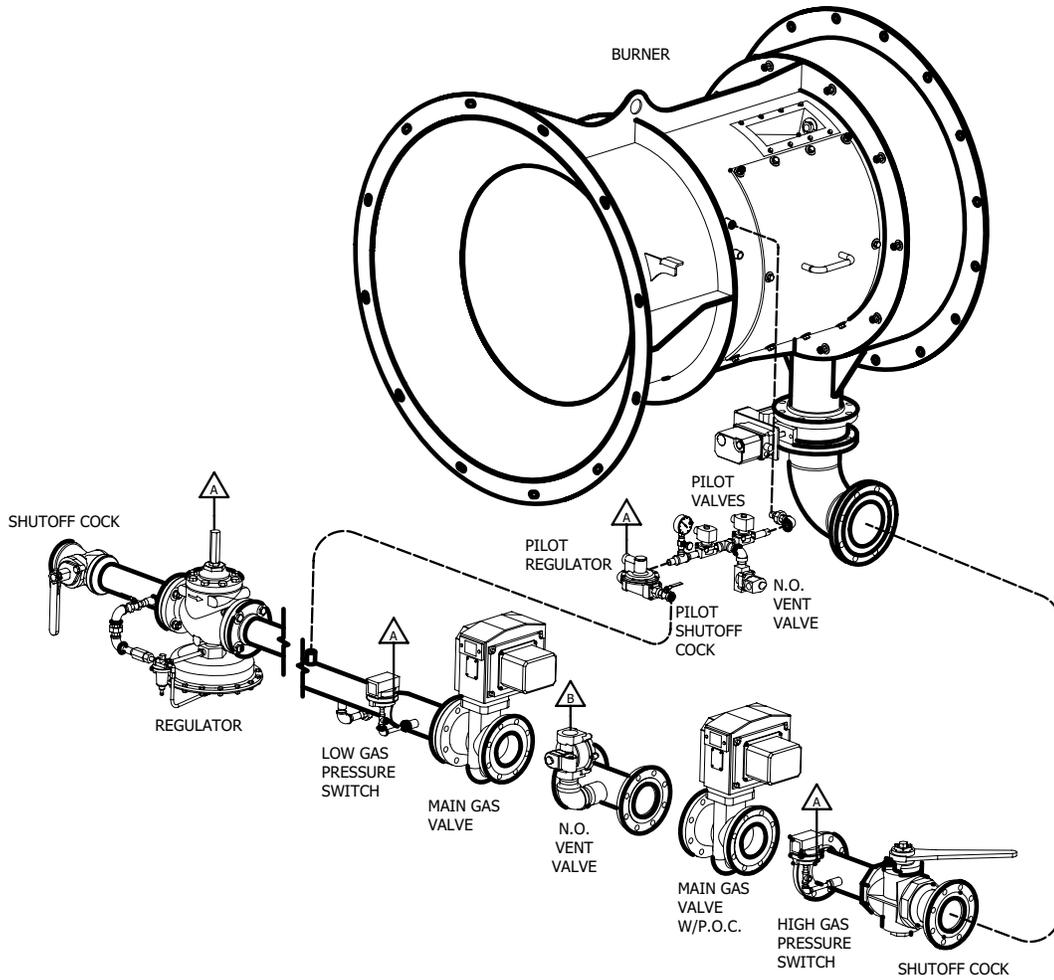
Figure 3-4: Dry oven/refractory installation



NOTES

- 1 - LAY THE DRY OVEN ON THE FLOOR WITH THE MOUNTING STUDS FACED UP. CAREFULLY PRESS THE BURNER SUPPLIED GASKET OVER THE THREADED STUDS.
- 2 - LIFT THE DRY OVEN ONTO THE BURNER FLANGE AND GENTLY TIGHTEN THE BOLTS.
- 3 - MAKE SURE THE DRY OVEN IS CENTERED ON THE BURNER FLANGE SO THAT THE SPACE IS EQUAL ALL AROUND THE BURNER'S BLAST TUBE.
- 4 - ENSURE THAT NONE OF THE GASKET IS PROTRUDING INTO THE BURNER BLAST TUBE AIR STREAM. FULLY TIGHTEN THE DRY OVEN MOUNTING NUTS.
- 5 - WRAP THE DRY OVEN WITH TROWLEZE COATED KAO-WOOL, THEN LIFT THE BURNER/DRY OVEN ASSEMBLY ONTO THE BOILER MOUNTING PLATE STUDS AND SECURE IN PLACE.
- 6 - FINISH REFRACTORY WORK INSIDE FURNACE.

Figure 3-5: Pilot train, main gas train, and burner housing



- A** 1 - FULL SIZE (1/4" OR LARGER) PIPE TO BE RUN FROM THE VENT OPENING TO OUTSIDE OF BUILDING.
- 2 - NO TRAPS ALLOWED IN VENT LINE.
- 3 - VENT LINE SHALL TERMINATE AWAY FROM ALL DOORS AND WINDOWS.
- 4 - PROVISIONS SHALL BE MADE TO PREVENT FOREIGN OBJECTS FROM ENTERING VENT PIPING.

- B** 1 - NORMALL OPEN VENT VALVE LINE SHALL BE HALF OF THE MAIN GAS TRAIN PIPING SIZE (3/4" MIN.)

I. OPERATION

PREPARATIONS FOR STARTING

When the installation is complete and all electrical, fuel, water and vent stack connections are made, make certain said connections are tight. The operator should become familiar with the burner, boiler controls and components. Adjustment procedures should be reviewed prior to firing. The wiring diagram should also be studied along with the burner programmer operating sequence. Read and understand starting instructions before attempting to operate the burner. Before attempting to start the burner, the following checks must be made:

1. **BOILER** Check the boiler water level. Be sure all boiler valves are installed correctly and positioned properly. Set the high limit control slightly above the desired temperature or pressure. Set modulating controls at the desired temperature or pressure.
2. **BURNER** Check the electrical power supply to the burner in accordance with the nameplate voltage on all motors and the control circuit. Check the direction or rotation of the motors. Open the housing to check the electrode setting. Check the gas pilot pressure at the pilot gas regulator. Normal setting is 18" to 20" W.C. Press the flame safety manual reset button to be sure safety switch contacts are closed. Check control actuators for proper movement of the air damper and fuel metering components.
3. **FIRING PREPARATIONS FOR GAS BURNERS.** A representative of the gas utility should turn on the gas. Determine by a test gauge upstream of the burner regulator that sufficient pressure exists at the entrance to the gas train. The gas pressure regulator must be adjusted to the pressure required and the pressure setting recorded. On combination fuel models, set the selector switch to gas. On initial start-up, it is recommended that the main gas shutoff cock remain closed until the programmer has cycled through pre-purge and pilot sequences to determine that the main gas valve opens. Turn the burner switch "OFF" and let programmer finish its cycle. Check to see that gas valve closes tightly. Set the high and low gas pressure switches. Check for leaks and determine there is adequate gas pressure available at the burner for operating at full capacity. Check with the local utility if necessary. Check gas pressure at the pilot and the main burner. Close the manual gas valve.

ELECTRICAL INTERFERENCE TEST ("SPARK PICK UP")

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

Close the pilot and the main line manual gas valves. Start the burner and at time of pilot trial with just the electrical ignition system energized, the flame relay should not pull in (i.e. energize). Upon completion of successful test, proceed with start-up procedures.

GAS PILOT FLAME ADJUSTMENT

The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 18" to 20" WC when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame. Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal. The flame safeguard amplifier has a meter jack for this purpose. At initial start-up and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout.

START-UP SEQUENCE

The programming control sequences the operation of all controls and components through the starting, ignition, firing, and shutdown cycle. The burner and control system are in starting condition when:

- The operating and high limit control (temperature or pressure) are below their cutoff setting;
- All power supply switches are closed;
- Power is present at the control panel. Refer to the controls manuals and burner wiring diagrams for detailed information.

The table on the following page describes the steps in the burner sequence, from pre-ignition to shutdown.

Note — For complete descriptions of startup, operating, and combustion setup procedures see the following CB manuals:

750-229 Hawk ICS

750-217 Parallel Positioning

Users should read all manuals provided with the boiler and control system before attempting a startup.

LEAK TEST

1. Begin starting sequence with burner switch off and with all manual valves closed. Switch main power on.
2. When firing on gas, open the main manual gas valve.
3. When firing on gas, manually reset the high and low gas pressure switches.
4. Place the gas / oil selector switch in position for desired fuel. With all limit and operating controls calling for heat, the burner will follow the Flame Safeguard Sequence below.
5. When the burner motor starts, open the gas cock.
6. If firing on gas, when the main fuel lamp lights indicating pilot flame proven open the the manual leak test valve.

BURNER SEQUENCE

Time in Seconds	Description of Burner Operation
0	Provided the fuel valve is proven closed the burner motor and flame safeguard timer will start.
7	Air flow must be proven before ignition, or the flame safeguard will lock out. If the interlock circuit opens during a firing period, the burner will shut off and the flame safeguard will lock out.
60	Firing on gas and providing the air flow and low-fire have been proven, the pilot ignition transformer and ignition lamp are energized and the gas pilot valve opens to ignite the pilot.
70	When on gas, the main valve opens to ignite the burner at low fire.
80	The pilot ignition transformer is de-energized, and the main safety shut-off pilot valve closes; scanner proves main flame only. If the low/auto switch is in the auto position, the following will occur: On gas, the butterfly valve and the burner air louvre moves to "low-fire" position.
100	"Normal run" position. Burner continues until one of the SHUTDOWN conditions below is met.
<p>AUTOMATIC SHUTDOWN: Limit or operating controls open.</p> <ol style="list-style-type: none"> 1. Fuel valves close. Main fuel lamp goes off. 15 second flame safeguard timer starts. 2. When timer expires, burner motor stops. Burner is ready for start-up on the next call for heat. 	
<p>SAFETY SHUTDOWN:</p> <ol style="list-style-type: none"> 1. If at any time during the operating cycle a flame failure occurs, the burner shuts down as in Automatic Shutdown, with an additional post-purge, and the flame failure lamp is energized. <ul style="list-style-type: none"> • <i>The lockout switch on the flame safeguard control must be manually reset before the burner will fire again.</i> 2. If a low water condition occurs, the burner shuts down as in Automatic Shutdown. 3. If a high or low gas pressure condition occurs while firing on gas, the burner shuts down as in Automatic Shutdown. <ul style="list-style-type: none"> • <i>Condition must be corrected and the respective gas pressure switch manually reset before the burner will fire again on gas.</i> 	
<p>MANUAL SHUTDOWN:</p> <ol style="list-style-type: none"> 1. To shut burner down manually, turn gas/oil selector switch to OFF. Burner shuts down as in Automatic Shutdown above. 2. When burner motor stops, close all manual valves. 	

START-UP AND OPERATING

Close the main and pilot gas cocks. Make sure the “ON-OFF” switch is in the “OFF” position and the fuel selector switch on “GAS”. Actuate the manual reset button of the flame safeguard control to close the safety switch contacts.

Set the “MANUAL-AUTO” switch in the “MANUAL” position.

Open the gas pilot cock. Set the “ON-OFF” switch to “ON”. The burner will start and pre-purge. After pre-purge, the ignition transformer and the gas pilot solenoid are energized. Before proceeding, conduct electrical interference and pilot turndown tests if not previously done.

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

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

Do not repeat unsuccessful light off attempts without rechecking burner and pilot adjustment. Vent fuel vapors from the combustion chamber after each unsuccessful light off attempt. Set the gas low fire rate by adjusting butterfly valve and air linkage. When low fire is adjusted, shut down burner. Restart several times to be sure the low fire setting is suitable. Readjust if necessary. Never start the burner with fuel vapor in the furnace. In case of emergency, open main power switches and close all fuel valves. After combustion adjustments are satisfactorily set, allow the heating vessel to slowly reach normal operating pressure or temperature.

Modulate the boiler to the high fire position. Check high fire at this point using combustion instruments.

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

High fire combustion analysis typically is 9 to 10.5 percent CO₂. When conditions covered above are assured, refer to NORMAL OPERATION below.

NORMAL OPERATION

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

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

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

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

Refer to adjustment procedures and maintenance instructions in this manual, and to manuals for the control system.

SHUTDOWN

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

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

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

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

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



**AN ULTRAVIOLET FLAME SENSOR
ELECTRICAL SPARK INTERFERENCE
TEST MUST BE PERFORMED AFTER FINAL
ADJUSTMENT.**

J. ADJUSTMENTS

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

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

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

COMBUSTION ADJUSTMENT ON GAS AND OIL

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

The proper settings of air-fuel ratios must be determined by flue gas analysis. Combustion gas analysis indicates the air to fuel ratio and the degree of complete combustion. Instruments are available to measure carbon dioxide (CO₂), oxygen (O₂), and carbon monoxide (CO).

STACK TEMPERATURE Net stack temperature is obtained by subtracting the ambient temperature from the flue gas temperature. A high net stack temperature indicates wasted heat. Stack temperature should be as low as possible without causing flue gas condensation. Stack heat loss can be reduced by decreasing either the temperature or the volume of the flue gas, or both. Flue gas temperature is reduced by improving heat transfer or by reducing excess combustion air. A certain amount of excess air is necessary to complete combustion. More efficient burners require minimum excess air.

SMOKE MEASUREMENT Smoke measurements can be made using a variety of different methods. The standards will vary somewhat according to the equipment used, and instructions accompanying the instrument should be followed. Smoky combustion can result from: Improper air delivery, insufficient draft, improper fuel viscosity, improper fuel-air ratio, excessive air leaks in the combustion chamber, or improper fuel oil temperature.

GAS ADJUSTMENTS Low fire combustion analysis typically is 7 to 9 percent CO₂ and less than .04 percent CO (400 ppm). High fire reading typically is 9 to 10.5 percent CO₂ and less than .04 percent CO. Typically these burners are capable of operating at CO levels less than 50 ppm.

FUEL OIL ADJUSTMENTS Adjust for a "clean fire". Typically for No. 2 oil, CO₂ is 8 to 11 percent at low fire and 10 to 13 percent at high fire, with a maximum of #1 spot (ATSM D2156 Shell-Bacharach scale).

GAS SYSTEM

GAS PRESSURE Gas must be supplied at a pressure high enough to overcome the pressure loss in the burner gas train and furnace pressure while running at full input. Refer to name-plate inside control panel for gas pressure requirements at train inlet and manifold. The pressures listed are based on

nominal 1000 Btu/cu ft natural gas at elevations up to 2000 feet above sea level.

GAS FLOW The volume of gas is measured in cubic feet as determined by a meter reading. The gas flow rate required depends on the heating value (Btu/cu ft). The supplying utility can provide this information as well as pressure correction factors. To determine the required number of cubic feet per hour of gas, divide burner input (Btu/hr) by the heating value (Btu/cu ft).

Note: When checking the input rate, make sure no other equipment is operating on the same meter.

GAS PILOT FLAME ADJUSTMENT The gas pilot flame is regulated by adjusting the pressure setting of the pilot regulator. Normal setting is 18" to 20" W.C. when the pilot is burning. The flame must be sufficient to be proven by the flame detector and ignite the main flame. Although it is possible to visibly adjust the size of the pilot flame, obtain a proper DC volt or microamp reading of the flame signal. The flame safeguard amplifier has a meter jack for this purpose. At initial start-up and during planned maintenance, test the pilot flame signal, pilot turndown, and safety switch lockout.

MAIN GAS PRESSURE REGULATOR The gas pressure required at the burner manifold is the pressure that is required to fire the burner at its rated capacity. The gas pressure regulator must be adjusted to achieve this pressure to assure full input. Refer to manufacturer's literature for regulator adjustment.



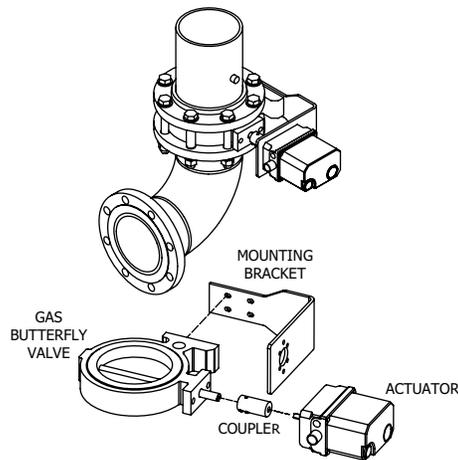
AN ULTRA-VIOLET FLAME SENSOR ELECTRICAL SPARK INTERFERENCE TEST MUST BE PERFORMED AFTER FINAL ADJUSTMENT.

LOW GAS PRESSURE SWITCH Turn adjusting screw until indicator moves to a pressure setting slightly below the operating gas pressure. The control will break a circuit if pressure is below this set point. The control should be finally adjusted to prevent operation with low gas pressure, but not at a pressure so close to normal operating pressure that unnecessary shutdowns occur. The switch must be manually reset after tripping. To reset, allow gas pressure to rise and press the manual reset button.

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

reset after tripping. To reset, allow gas pressure to drop and press the manual reset button.

Figure 3-6: Gas BF valve & actuator



NOTES:
 1 - CAUTION.....GAS BUTTERFLY VALVE BLADE DOES NOT ROTATE 360°.
 2 - POSITION OF BLADE MAY BE DETERMINED BY A MARKING ON BLADE SHAFT.
 3 - ENSURE COUPLER SET SCREWS ARE TIGHT AT ALL TIMES.

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GAS COMBUSTION ADJUSTMENT After operating for a sufficient period of time to assure a warm boiler, make adjustments for most efficient combustion. The butterfly gas valve directly controls the rate of flow. The low fire light-off setting should be regarded as preliminary until proper gas pressure for high fire operation is established. Determine the actual gas flow from a meter reading at high fire. With the butterfly valve open and with regulated gas pressure set, the actual flow rate should be quite close to the required input. If corrections are necessary, increase or decrease the gas pressure by adjusting the gas pressure regulator, following manufacturer's directions for regulator adjustment. When proper gas flow is obtained, take a flue gas analysis reading.

With the high fire air-fuel ratio established, the gas pressure regulator needs no further adjusting. Recheck low fire and adjust if necessary. Proper setting of the air/fuel ratios at all rates must be determined by combustion analysis.

GAS VALVES ADJUSTMENT The secondary valve feeds gas to the inner spuds. A slot in the valve stem in relationship to the shut/open scale on the valve indicates the blade position. Both low and high-fire positions are approximate. The primary valve which feeds the outer spuds should be adjusted as normal.

ACTUATORS

Refer to the Hawk ICS Parallel Positioning manual 750-217.

FIRING RATE CONTROLS

Refer to the Hawk ICS manual 750-229 and the Hawk ICS Parallel Positioning manual 750-217.

Normally, the air control damper will be almost closed in low fire position. For best pilot operation, the damper should be set as low as possible. Excessive opening in low fire can cause pilot ignition problems. Air to the pilot is supplied under pressure to compensate for variations in furnace pressure, but the damper must be in low fire position for reliable ignition.

K. MAINTENANCE

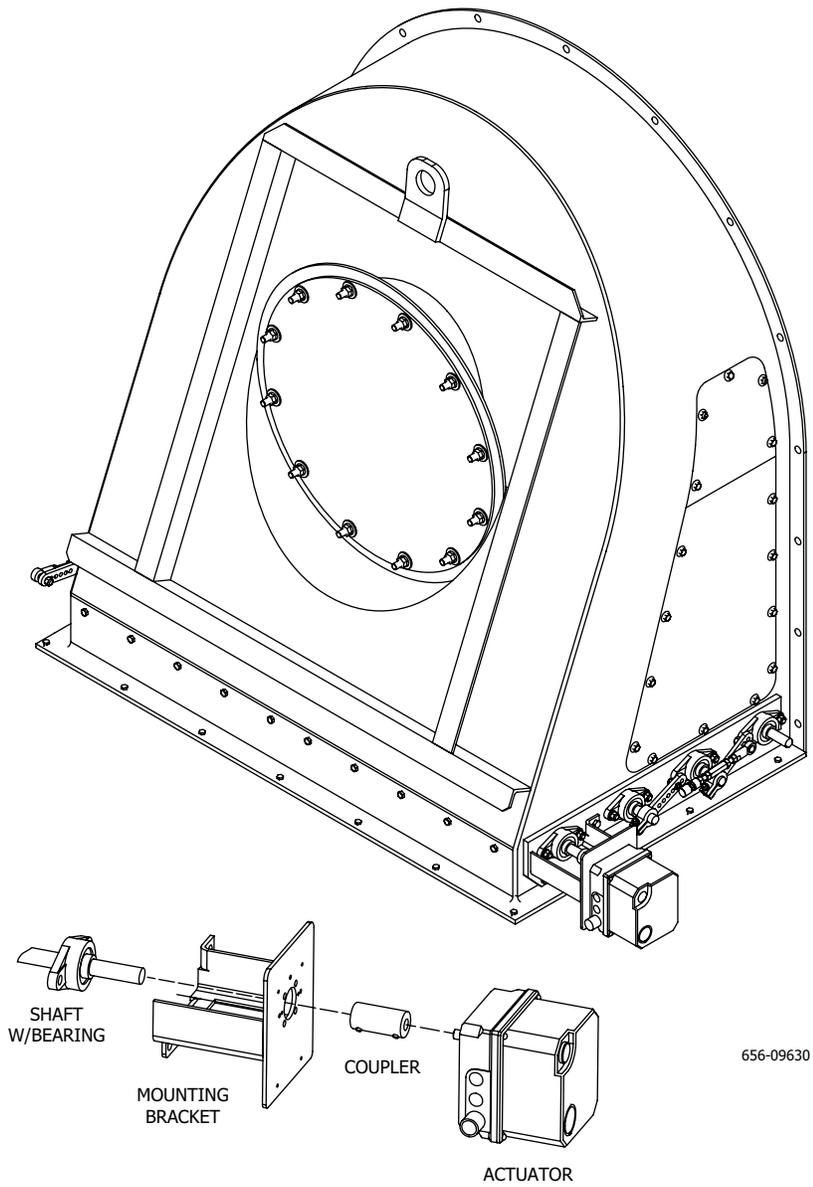
See **Chapter 5 - Inspection and Maintenance** for burner maintenance procedures.

L. EXTENDED SHUTDOWN

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

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

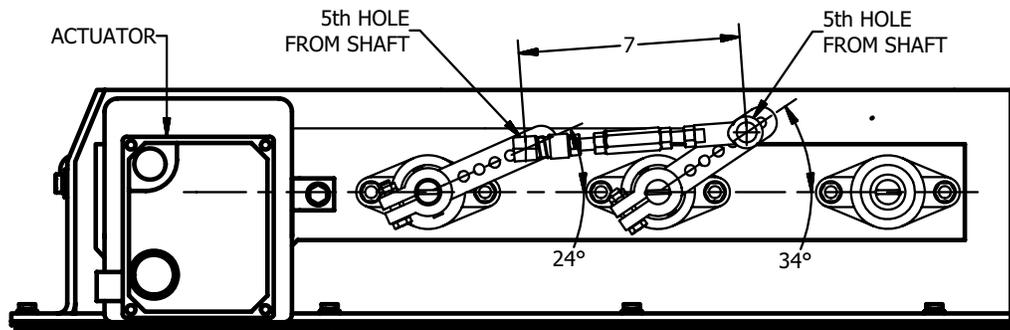
See also **PREPARATION FOR EXTENDED LAY-UP** in Chapter 2.



- NOTES
- 1 - POSITION OF DAMPER BLADES MAY BE DETERMINED BY MARKINGS ON BLADE SHAFT'S.
 - 2 - ENSURE COUPLER SET SCREWS ARE TIGHT AT ALL TIMES.

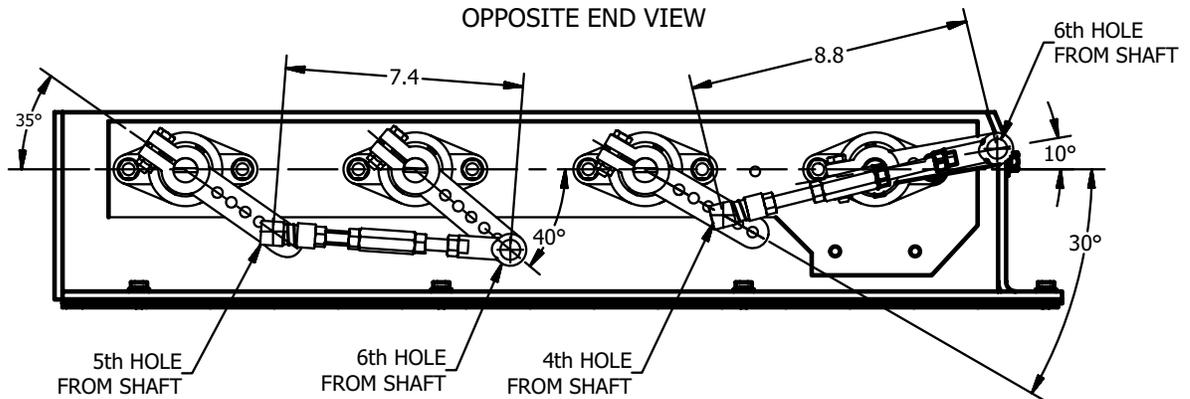
Figure 3-7: Combustion Air Damper

Figure 3-8: Air damper linkage



ACTUATOR END VIEW

AIR DAMPER BLADE LINKAGES



OPPOSITE END VIEW

NOTES

1 - ENSURE ALL LINKAGE HARDWARE IS SECURELY FASTENED.

656-09628

CHAPTER 4

Operational Controls

A. GENERAL	4-1
B. MODULATING PRESSURE CONTROL	4-3
C. OPERATING LIMIT PRESSURE CONTROL	4-3
D. HIGH LIMIT PRESSURE CONTROL	4-3
E. LOW WATER CUTOFF DEVICES	4-5
F. COMBUSTION AIR PROVING SWITCH	4-5
G. ATOMIZING AIR PROVING SWITCH	4-5
H. LOW-GAS-PRESSURE SWITCH	4-5
I. HIGH-GAS-PRESSURE SWITCH	4-5

A. GENERAL

Each Cleaver-Brooks boiler is tested for correct operation before shipment from the factory. However, variable conditions such as burning characteristics of the fuel and operating load conditions may require further adjustment after installation to assure maximum operating efficiency and economy.

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

Prior to placing the boiler into service, a complete inspection should be made of all controls, connecting piping, wiring, and all fastenings such as nuts, bolts and setscrews to be sure that no damage has occurred, or that adjustments have not changed during shipment and installation.

Note: Adjustments to the boiler operating controls should be made by an authorized Cleaver-Brooks Service Technician.

The standard boiler operating control package consists of three separate controls, the High Limit Control, Operating Limit Control and the Modulating control.

The High Limit Control senses the hot water temperature or steam pressure. It is used as a safety limit to turn the burner

off in the event the operating limit control fails. The high limit control should be set sufficiently above the operating limit control to avoid nuisance shutdowns.

The Operating Limit Control senses temperature or pressure and automatically turns the burner on to initiate the start up sequence when required and turns the burner off to initiate the shutdown sequence when the demand is satisfied. The control must be set to initiate startup only at the low fire position.

The Modulating Control senses changes in the hot water temperature or steam pressure and signals the modulating motor to control the flow of fuel and air to the burner. With either steam or hot water boilers, the modulating control must be set to ensure the burner is at its minimum low fire position before the operating limit control either starts or stops the burner.

When adjusting or setting controls, first be sure all control devices are securely mounted and level. With the temperature sensing control, make sure the sensing bulb is properly bottomed in its well and is secured against movement. Be sure the connecting tubing is not kinked.

The dial settings are generally accurate; although it is not unusual to have a slight variation between a scale setting and an actual pressure gauge or thermometer reading. Always adjust the control setting to agree with the pressure gauge or thermometer readings. Accurate instrument readings are

required. When necessary use auxiliary test equipment to set controls.

Burner controls correctly set to match load demands will provide operational advantages and achieve the following desirable objectives:

- The burner will be operating in low fire position prior to shut down.
- The burner will operate at low fire for a brief period on each start during normal operation.
- Eliminates frequent burner on-off cycling.

Separate and independent controls affect modulated firing and burner on-off cycling. Page 4-4 shows a typical setting relationship of the operating limit control, modulating control and the high limit control.

The burner will be “on” whenever the pressure or temperature is less than point **B** and “off” whenever pressure or temperature is greater than point **A**. The distance between points **A** and **B** represents the “on-off” differential of the operating limit control.

In normal operation, the burner will shut down whenever the pressure or temperature rises above setting **A**. At that point the switch in the operating limit control will open. As the pressure or temperature drops back to **B**, the operating limit control closes and the burner will restart. The modulating control will signal the modulating motor to be in a low fire position. If the load demands exceed the low fire input potential, the modulating control will increase the firing rate proportionately as pressure or temperature falls toward point **D**. The modulating motor will stop at any intermediate point between **C** and **D** whenever the fuel input balances the load requirement.

As the load requirement changes, the firing rate will change accordingly. Thus it is referred to as **modulated firing**.

Point **D** represents the maximum firing rate of the burner, or highfire. In the event pressure or temperature drops while the burner is firing at highfire, it indicates that the load exceeds the capacity of the boiler.

The firing graph shows that point **B** and point **C** do not coincide. Extreme load conditions could require the points be closely matched.

When set as shown, with a time lag between **B** and **C**, the burner will be in a low fire position upon a restart and will fire at that rate for a short period of time before falling pressure or temperature requires an increase in the firing rate.

Note: On-Off cycling in excess of 8 cycles per hour will shorten the life of the

combustion air motor and cause excessive wear on switch gear and pilot electrodes.

If points **B** and **C** overlap when restart occurs, the burner would drive to a higher firing position immediately after the main flame was proven.

Note: It is not recommended that the boiler controls be set so as to overlap the modulating control range and operating control range.

When firing a cold boiler, it is recommended that the burner be kept at low fire, under manual flame control, until normal operating pressure or temperature is reached. If the burner is not under manual control on a cold start, it will immediately move toward high fire as soon as the program control releases the circuit that holds the burner in low fire. The modulating control will be calling for high fire and the burner will move to that position as rapidly as the damper motor can complete its travel.

Note: Rapid heat input can subject the pressure vessel metal and refractory to undesirable conditions.

Do not operate the boiler in excess of 90% of the safety valve relief setting. The closer the operating pressure is to the safety valve relief pressure, the greater the possibility of valve leakage. Continued leakage, however slight, will cause erosion and necessitate early safety valve replacement. The control settings on a hot water boiler must be within the temperature limits of the boiler.

Ideally, the boiler operating controls should be set under actual load conditions. Especially under new construction conditions, the boiler is initially started and set to operate under less than full load requirements. As soon as possible thereafter, the controls should be reset to provide maximum utilization of the modulating firing system. To accomplish maximum utilization, and assuming that air/fuel combustion ratios have been set, make the required adjustments to the controls to bring the boiler pressure or temperature up to meet the load requirements.

To properly set the modulating control, carefully adjust it under load conditions, until the load is maintained with the burner firing at a steady rate. The firing rate at that point may be full high fire or slightly less, depending upon the relationship of the boiler size to the load.

When the modulating control is set and the burner is in full high fire, the scale setting of the modulating pressure control on a steam boiler will indicate the low point of the modulating range. The scale setting of the modulating temperature control on a hot water boiler will have a reading that indicates the midpoint of the modulating range.

The operating limit control should now be adjusted and the differential established. In an installation that does not require a very close control of steam pressure or water temperature the adjustable differential should be set as wide as conditions permit, since a wide setting will provide less frequent burner cycling.

The high limit control provides a safety factor to shut the burner off in the event the operating limit control should fail. The setting of the control should be sufficiently above the operating limit control to avoid nuisance shutdowns. The setting, however, must be within the limits of the safety valve settings and should not exceed 90% of the valve setting. The control requires manual resetting after it shuts off the burner.

In the setting of the controls, consideration must be given to the time required for a burner restart. Each start, requires a prepurge period, plus the fixed time required for proving the pilot and main flame. In addition, approximately one-half minute is required for the damper motor to travel from low to high fire. The time lag may allow pressure or temperature to drop below desirable limits.

B. MODULATING PRESSURE CONTROL

Turn the adjusting screw until the indicator is opposite the low point of the desired modulating range. Modulated firing will range between the low point and a higher point equal to the modulating range of the particular control. In 0-15 psi controls the range is 1/2 lb; in 5-150 psi controls the range is 5 lbs; in 10-300 psi controls the range is 12 lbs.

CAUTION

To prevent burner shutdown at other than low-fire setting, adjust the modulating pressure control to modulate to low fire BEFORE the operating limit pressure control shuts off the burner. Failure to follow these instructions could result in damage to the equipment

C. OPERATING LIMIT PRESSURE CONTROL

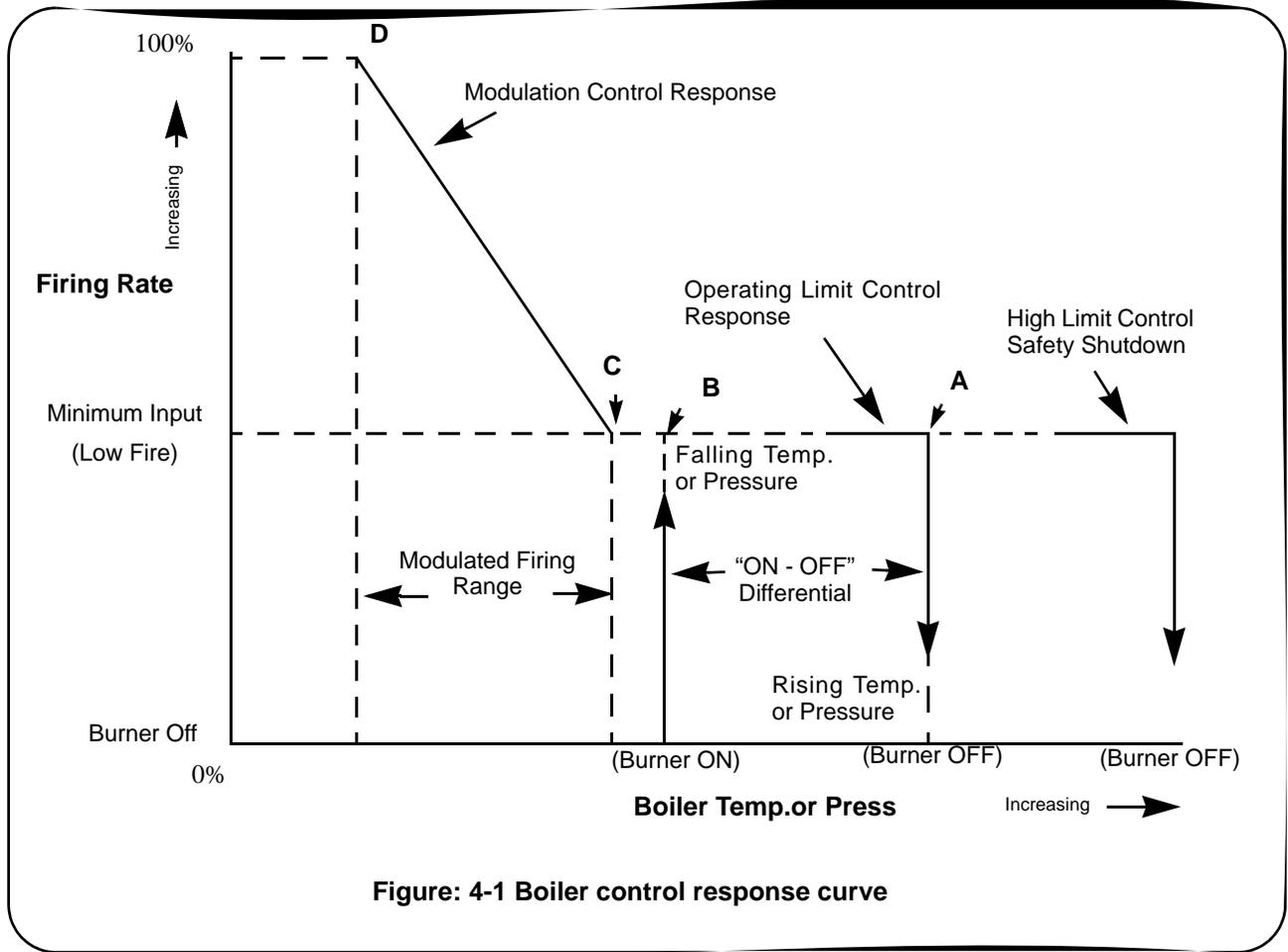
Set the “cut-out” (burner-off) pressure on the main scale using the large adjusting screw. Set the differential on the short scale by turning the small adjusting screw until the indicator points to the desired difference between cut-out and cut-in pressures. The “cut-in” (burner-on) pressure is the cut-out pressure MINUS the differential. The cut-out pressure should not exceed 90% of the safety valve setting.

D. HIGH LIMIT PRESSURE CONTROL

Set “cut-out” (burner off) pressure on the main scale using the adjusting screw. The control will break a circuit when pressure reaches this point. The setting should be sufficiently above the operating limit pressure control to avoid shutdowns, and preferably not exceed 90% of safety valve setting. The control requires manual resetting after tripping on a pressure increase. To reset, allow pressure to return to normal and then press the reset button.

CAUTION

To prevent burner shutdown at other than low-fire setting adjust modulating control to modulate to low fire BEFORE the operating limit control shuts off the burner. Failure to follow these instructions could result in damage to the equipment.



E. LOW WATER CUTOFF DEVICES

No adjustment is required since LWCO controls are preset at the factory. However, if the water level is not maintained as necessary, inspect the devices immediately and replace as required.

F. COMBUSTION AIR PROVING SWITCH

Air pressure against the diaphragm actuates the switch which, when made, completes a circuit to prove the presence of combustion air. Since the pressure of the combustion air is at its minimum value when the damper is full closed, the switch should be adjusted under that situation. It should be set slightly below the minimum pressure, but not too close to that point to cause nuisance shutdowns.

The run/test switch on the program relay should be set to TEST. Turn the burner switch on. The blower will start (provided that all limit circuits are completed) and the programmer will remain in the low-fire (damper closed) portion of the prepurge.

Note: On an oil fired boiler, the atomizing air proving switch (AAPS) must also be closed.

Note: On a combination fuel burner, the fuel selector switch could be set to GAS to eliminate the atomizing air proving switch from the circuitry.

Slowly turn down the air switch adjusting screw until it breaks the circuit. Here the programmer will lock out and must be manually reset before it can be restarted. Add a half turn or so to the adjusting screw to remake its circuit.

Recycle the program relay to be sure that normal operation is obtained. Return the test switch to the RUN position.

G. ATOMIZING AIR PROVING SWITCH

The air pressure against the diaphragm actuates the switch which, when closed, completes a circuit to prove the presence of atomizing air. Since the pressure of the atomizing air is at its minimum value when there is no fuel present at the nozzle, adjustment of the switch should be done while the unit is running but not firing. The control should be set slightly below the minimum pressure, but not too close to that point to cause nuisance shutdowns.

The control adjustment may be made during the prepurge period of operation by stopping the programmer during the

prepurge period through the use of the TEST switch. Refer to the control instruction bulletin for details.

The adjustment screw of the atomizing air proving switch can then be adjusted until it breaks the circuit. Here, the programmer will lock out and must be manually reset before it can be restarted. Turn the adjusting screw up a half turn or so to remake the circuit.

Since the adjustment of the air switch may be made either during the damper closed or damper open position of prepurge, it is also possible to make the adjustment with the relay stopped in the damper open position in a similar manner to the adjustment of the combustion air proving switch.

After making the adjustment, recycle the control to be sure that normal operation is obtained. The TEST switch must be set to RUN position.

H. LOW GAS PRESSURE SWITCH

Adjust the scale setting to slightly below the normal burning pressure. The control circuit will be broken when pressure falls below this point. Since gas line distribution pressure may decrease under some conditions, shutdowns may result if the setting is too close to normal. However, regulations require that the setting may not be less than 50% of the rated pressure downstream of the regulator.

Manual reset is necessary after a shutdown due to low gas pressure. Press the reset lever after pressure is restored.

I. HIGH GAS PRESSURE SWITCH

Adjust the scale setting to slightly above the normal burning pressure. The control circuit will be broken when pressure exceeds the normal operating pressure. Unnecessary shutdowns may result if the setting is too close to normal; however, regulations require that the setting may not be greater than 150% of rated pressure.

Manual reset is necessary after a shutdown due to high gas pressure. Press the reset lever after pressure falls.

CHAPTER 5

INSPECTION AND MAINTENANCE

A. General	5-1	J. Rear Access Plug	5-11
B. Fireside Cleaning	5-2	K. Lubrication	5-11
C. Water Level Controls	5-2	L. Combustion	5-11
D. Water Gauge Glass	5-2		
E. Electrical Controls	5-4		
F. Gas Burner Maintenance	5-4		
G. Safety Valves	5-8		
H. Refractory	5-10		
I. Front Smoke Box	5-10		

A. General

A well-planned maintenance program will help avoid unnecessary down-time or costly repairs, promote safety, and aid boiler inspectors. An inspection schedule with a listing of procedures should be established. It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly, and yearly maintenance activities provides a valuable guide and aids in obtaining economical and lengthy service from Cleaver-Brooks equipment. A boiler inspection schedule is shown in Figure 5-3. It is important to realize that the frequency of inspection will depend on variable conditions: such as load, fuel, system requirements, boiler environment (indoor/outdoor) etc.

Good housekeeping helps maintain a professional appearing boiler room. Only trained and authorized personnel should be permitted to operate, adjust, or repair the boiler and its related equipment. The boiler room should be kept free of all material and equipment not necessary to the operation of the boiler or heating system.

Even though the boiler has electrical and mechanical devices that make it automatic or semi-automatic in operation, the devices require systematic and periodic maintenance. Any automatic feature does not relieve the operator from responsibility, but rather frees the operator from certain repetitive chores providing time to devote to upkeep and maintenance.

Alertness in recognizing an unusual noise, improper gauge reading, leaks, etc., can make the operator aware of a developing malfunction and permit prompt corrective action that may prevent extensive repairs or unexpected downtime. Any leaks - fuel, water, steam, exhaust gas - should be repaired promptly and under conditions that observe

necessary safety precautions. Preventive maintenance measures, such as regularly checking the tightness of connections, locknuts, setscrews, packing glands, etc., should be included in regular maintenance activities.

Periodic Inspection

Insurance regulations and local laws require periodic inspection of the pressure vessel by an authorized inspector.

Inspections are usually, though not necessarily, scheduled for periods of normal boiler down time, such as an off season. This major inspection can often be used to accomplish maintenance, replacement or repairs that cannot easily be done at other times. Inspection also serves as a good basis for establishing a schedule for annual, monthly, or other periodic maintenance programs.

While the inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, it provides the operator an excellent opportunity for detailed inspection and check of all components of the boiler including piping, valves, pumps, gaskets, refractory, etc. Comprehensive cleaning, spot painting or repainting, and the replacement of expendable items should be planned for and taken care of during this time. Any major repairs or replacements that may be required should also, if possible, be coordinated with the period of boilers shutdown.

Replacement spare parts, if not on hand, should be ordered sufficiently prior to shutdown.

Note: To ensure proper operation, only Cleaver-Brooks genuine parts should be used. Contact your local Cleaver-Brooks representative for parts information and ordering.

Cleaver-Brooks boilers are designed, engineered, and built to provide long life and excellent service. Good operating practices and conscientious maintenance and care will assure efficiency and economy from their operation, and will contribute to many years of performance.

A total protection plan includes a planned maintenance program that covers many of the items included in this chapter.

For information regarding a total protection plan, contact your local Cleaver-Brooks authorized representative.

B. Fireside Cleaning

Soot and non-combustibles are effective insulators, and, if allowed to accumulate, will reduce heat transfer to the water and increase fuel consumption. Soot and other deposits can be very moisture-absorbent, and may attract moisture to form corrosive acids that will deteriorate fireside metal.

Clean-out should be performed at regular and frequent intervals, depending upon load, type, and quality of fuel, internal boiler temperature, and combustion efficiency. A stack temperature thermometer can be used as a guide to clean-out intervals since an accumulation of soot deposits will raise the flue gas temperature.

Tube cleaning is accomplished by opening the front doors. All loose soot and accumulations should be removed. Any soot, or other deposits, should be removed from the furnace and tube sheets.

The flue gas outlet and stack should be inspected annually and cleaned as necessary. Commercial firms are available to perform the work. The stack should be inspected for damage and repaired as required.

The fireside should be thoroughly cleaned prior to any extended lay-up of the boiler. Depending upon circumstances, a protective coating may be required. For more on boiler lay-up, see section H in Chapter 2.

C. Water Level Controls

The need to periodically check water level controls and the waterside of the pressure vessel cannot be overemphasized. Most instances of major boiler damage are a result of operating with low water or of using untreated (or incorrectly treated) water.

Always be sure of the boiler water level. On steam boilers, the water column should be blown down daily or more often depending on water quality. Check samples of boiler water and condensate in accordance with procedures recommended by your local Cleaver-Brooks authorized representative.

Since water levels for low-water cutoff devices are generally set at the factory, no attempt should be made to adjust these controls to alter the point of low-water cutoff or point of valve

open or close. If a low-water device should become erratic in operation, or if its setting changes from previously established levels, contact your local Cleaver-Brooks authorized representative.

For complete information on the water level control system, see the CB Level Master manual.

Periodically remove the pipe plugs from the tees or crosses and make certain the cross-connecting piping is clean and free of obstructions. Controls must be mounted in a plumb position for proper performance. Determine that piping is vertically aligned after shipment and installation and throughout life of equipment.

A blowdown of the water controls on a steam boiler should be performed daily or more often depending on water quality.

D. Water Gauge Glass

A broken or discolored glass should be replaced at once. Periodic replacement should be a part of the maintenance program. Always use new gaskets when replacing a glass. Use a proper size rubber packing. Do not use loose packing, which could be forced below the glass and possibly plug the valve opening.

Close the valves when replacing the glass. Slip a packing nut, a packing washer, and packing ring onto each end of the glass.

Insert one end of the glass into the upper gauge valve body far enough to allow the lower end to be dropped into the lower body. Slide the packing nuts onto each valve and tighten.

It is recommended that the boiler is off and cool when the glass is replaced. However if the glass is replaced while the boiler is in service, open the blowdown and slowly bring the glass to operating temperature by opening the gauge valves slightly. After glass is warmed up, close the blowdown valve and open the gauge valves completely.

WARNING

Do not attempt to change the gauge glass while the boiler is in service. Failure to follow these instructions could result in serious personal injury or death.

Check try-cocks and gauge cocks for freedom of operation and clean as required. It is imperative that the gauge cocks are mounted in exact alignment. If they are not, the glass will be strained and may fail prematurely.

CAUTION

Inspection and maintenance should be performed only by trained personnel who are familiar with this equipment. Failure to fol-

Recommended Boiler Inspection Schedule

DAILY	WEEKLY	MONTHLY	SEMI ANNUALLY	ANNUALY
<ul style="list-style-type: none"> •Check water level •Check combustion visually •Blow down boiler •Blow down water column •Record feedwater pressure/temperature •Record flue gas temperature •Record oil pressure and temperature •Record gas pressure •Record atomizing air pressure •Record boiler water supply and return temperatures •Record makeup water usage •Record steam pressure •Note unusual conditions, noises, etc. •Treat water according to the established program 	<ul style="list-style-type: none"> •Check for tight closing of fuel valve •Check indicating lights and alarms •Check operating and limit controls •Check safety and interlock controls •Check for leaks, noise, vibration, unusual conditions, etc. 	<ul style="list-style-type: none"> •Inspect burner •Inspect for flue gas leak •Inspect for hot spots •Check for tight closing of fuel valve •Check indicating lights and alarms •Check operating and limit controls •Check safety and interlock controls •Check for leaks, noise, vibration, unusual conditions, etc. •Analyze Combustion 	<ul style="list-style-type: none"> •Clean low water cutoff •Clean oil pump strainer, filter •Clean air cleaner and air/oil separator •Clean air pump coupling alignment •Inspect refractory •Remove and clean oil preheater 	<ul style="list-style-type: none"> •Clean fireside surfaces •Clean breeching •Inspect waterside surfaces •Check operation of safety valves

low these instructions could result in equipment damage

E. Electrical Controls

The operating controls should be inspected monthly. Examine tightness of electrical connections and keep the controls clean. Remove any dust that accumulates in the interior of the control using a low pressure air. Take care not to damage any components.

The piping leading to the pressure control actuators should be cleaned, if necessary. Covers should be left on controls at all times.

Dust and dirt can cause excessive wear and overheating of motor starter and relay contacts. Use a burnishing tool or a hard surface paper to clean and polish contacts. Starter contacts are plated with silver and are not harmed by discoloration and slight pitting. Replacement of the contacts is necessary only if the silver has worn thin.

 CAUTION

Do not use files or abrasive materials such as sandpaper on the contact points. Failure to follow these instructions could result in equipment damage.

Thermal relay units (overloads) must be given time to cool before the relay can be reset. If the overloads trip out repeatedly when the motor current is normal, replace them with new overloads. If the condition continues after replacement, it will be necessary to determine the cause of excessive current draw at the overloads.

Power supply to the boiler must be protected with dual element fuses (fusetrans) or circuit breakers. Similar fuses should be used in branch circuits. Standard one-shot fuses are not recommended.

Checking Pilot Flame Failure

Close the gas pilot shutoff cock. Also shut off the main fuel supply. Turn the burner switch “on.”

The pilot ignition circuit will be energized at the end of the pre-purge period. There should be an ignition spark, but no flame. Since there is no flame to be detected, the program relay will signal the condition. The ignition circuit will deenergize and the control will lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop.

Turn the burner switch off. Reset the safety switch. Reopen the gas pilot shutoff cock and re-establish main fuel supply.

Checking Failure to Light Main Flame

Leave the gas pilot shutoff cock open. Shut off the main burner fuel supply. Turn the burner switch on. The pilot will light upon completion of the pre-purge period. The main fuel valve(s) will be energized, but there should be no main flame.

The fuel valve(s) deenergize within 4 seconds after the main burner ignition trial ends. The control will lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop.

Turn the burner switch off. Reset the safety switch. Re-establish main fuel supply.

Checking Loss of Flame

With the burner in normal operation, shut off the main burner fuel supply to extinguish main flame.

The fuel valve(s) will be deenergized and the relay will signal the condition within 4 seconds. The control will then lock out on a safety shutdown. The flame failure light (and optional alarm) will be activated. The blower motor will run through the post-purge and stop.

Turn the burner switch off. Reset the safety switch. Re-establish main fuel supply.

F. Gas Burner Maintenance



ANY COVER PLATES, ENCLOSURES, OR GUARDS ANCHORED TO THE BURNER, OR ANY BURNER RELATED EQUIPMENT, MUST REMAIN IN POSITION AT ALL TIMES. ONLY DURING MAINTENANCE AND SERVICE SHUTDOWN CAN THESE COVER PLATES, ENCLOSURES, OR GUARDS BE REMOVED. THEY MUST BE REPLACED, AND SECURELY ANCHORED BEFORE TESTING, ADJUSTING, OR RUNNING THE BURNER OR BURNER RELATED EQUIPMENT.



IT IS IMPORTANT THAT YOU PROVIDE SUPPORT FOR THE HOUSING WHEN IN THE OPEN POSITION TO PREVENT DAMAGE TO THE HINGES AND SUBSEQUENT COMPONENTS.

GENERAL

A maintenance program avoids unnecessary down time, costly repairs, and promotes safety. It is recommended that a record be maintained of daily, weekly, monthly, and yearly maintenance activities. Electrical and mechanical devices require systematic and periodic inspection and maintenance. Any “automatic” features do not relieve the operator from responsibility, but rather free him from certain repetitive chores, providing time for upkeep and maintenance. Unusual noise, improper gauge reading, leak, sign of overheating, etc., can indicate a developing malfunction, requiring corrective action.

CONTROL SYSTEM

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

PROGRAMMING CONTROL

This control requires no adjustment, nor should any attempt be made to alter contact settings or timing logic. The manufacturer’s bulletin contains troubleshooting information. The flame detector lens should be cleaned as often as conditions demand. A periodic safety check procedure should be established to test the complete safeguard system. Tests should verify safety shutdown with a safety lock out upon failure to ignite the pilot or the main flame, and upon loss of flame. Each of these conditions

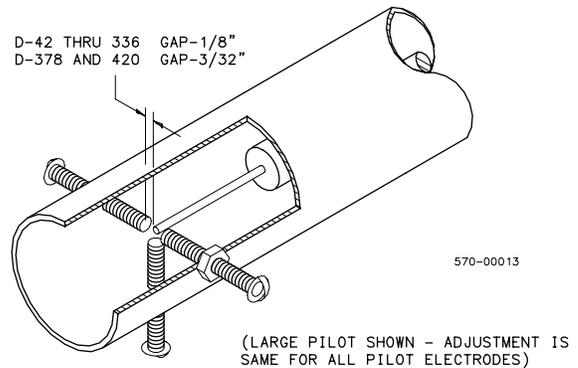
should be checked on a scheduled basis. The safety check procedures are contained in the manufacturer's bulletin.

FIRING HEAD INSPECTION

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

PILOT AND IGNITION ELECTRODE

The ignition transformer requires little attention other than making sure the ignition wire is firmly attached to the transformer and the electrode. Be sure the wire insulation is in good condition and not grounded. Failure to keep the ignition electrode clean and properly set can cause faulty operation. The pilot assembly is supported by a socket in the diffuser and gas inlet tube. No adjustment is required except proper positioning of the electrode wire.



FLAME SCANNER

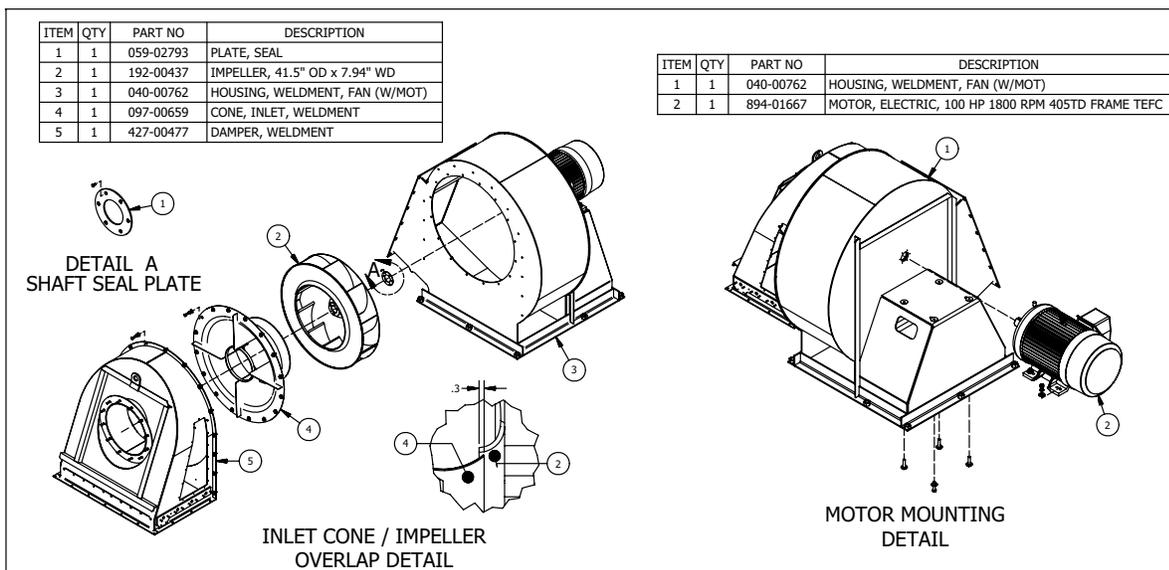
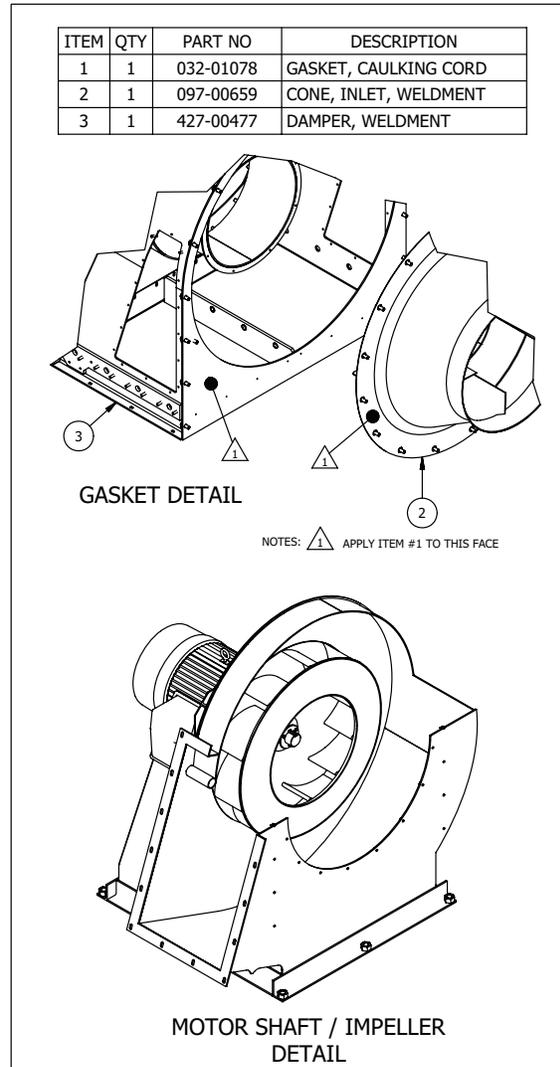
The scanner must be clean. Even a small amount of contamination will reduce the flame signal. Wipe the scanner lens with a clean soft cloth.

FAN REMOVAL

To access the fan wheel, first remove the air inlet housing. Support the weight of the air inlet housing using the lifting eye attached to the housing. If moving the air inlet housing far away from the fan housing, or if the conduit attached to the air damper actuator is too short, detaching the actuator first may be required. Remove all all of the bolts holding the air inlet housing to the fan housing. Remove air inlet cone by removing all perimeter bolts and pull away from the fan housing.

TO REMOVE WHEEL: The Chicago blower wheel has a taper lock hub that attaches to the shaft. To remove the wheel, remove the 3 bolts on the front of the hub. Insert two of the bolts in the threaded holes on the front of the taper lock hub. (refer to the Chicago Blower maintenance bulletin for details).

MOTOR SHAFT SEAL: A brass motor shaft seal plate is screwed to the fan housing to help block air from escaping through the motor shaft hole. No lubrication at this plate is required. This plate should be inspected periodically for abnormal wear.



RECOMMENDED BURNER MAINTENANCE SCHEDULE		
ITEM	SERVICE BY	REMARKS
DAILY		
Gauges, monitors, and indicators	Operator	Make visual inspection and record readings in log.
Instrument and equipment settings	Operator	Make visual check against recommended specifications.
Low water, fuel cutoff, and alarms	Operator	Refer to instructions
WEEKLY		
Firing rate control	Operator	Verify factory settings.
Igniter	Operator	Make visual inspection. Check flame signal strength.
Pilot and main fuel valves	Operator	Open limit switch. Make audible and visual check. Check valve position indicators and fuel meters.
Flame failure controls	Operator	Close manual fuel supply (1) pilot and (2) main fuel supply. Check safety shutdown timing. Record in log.
Flame signal strength controls	Operator	Read and log the flame signal for both pilot and main flame. Notify service if readings are very high, very low, or fluctuating.
Linkages	Operator	Check all damper linkages for tightness. Tighten if required.
MONTHLY		
Low fan pressure interlock	Operator	Manually adjust until switch opens.
High and low gas pressure interlocks	Operator	Refer to instructions. Manually adjust until switch opens.
Scanner and diffuser	Operator	Inspect and clean any soot buildup.
Pilot assembly	Operator	Check for loosening of components, erosion, or carbon buildup.
ANNUALLY		
Strainer (oil units)	Operator	Replace or clean the oil strainer element.
Impeller	Operator	Inspect and clean.
Combustion test	Service Technician	Perform a complete combustion test. Adjust burner if necessary. Read and log data.
Pilot turndown test	Service Technician	Required after any adjustment to flame, scanner, or pilot.
Operating controls	Service Technician	Refer to instructions.

DIFFUSER

The diffuser is factory set and does not require attention under normal operating conditions. If fouled with carbon, the diffuser should be removed for cleaning. First remove the electrode and scanner leads, the gas pilot assembly, air and oil tubes and the nozzle support assembly, before you attempt to remove the diffuser. Mark the diffuser relative position to the blast tube, with a scribed or pencil line where the three mounting screws are located, to insure that the diffuser is placed back in the same position. Remove the three screws holding the diffuser to the blast tube and slowly pull the diffuser along the blast tube towards the firing head. Keep the diffuser as parallel as possible. If it should become stuck or tight, do not apply any tool which would distort the shape or blade configuration. A small wooden block tapped gently against the diffuser's outer edge will help expedite its removal. Clean all carbon from the diffuser vanes and reinstall in reverse order of disassembly a disassembly aligning the diffuser with the scribed marks. Do not attempt to drive the diffuser back along the blast tube with anything other than a small block of wood tapped against the diffuser's outer edge. When reinstalling, be sure the diffuser is centered.

Note: It is essential that the cam spring, cam follower bearing wheel and cam follower arm at the pivot point be greased sparingly every month to ensure smooth operation of the cam assembly. Regular automotive bearing grease should be used.

FIRING RATE CONTROLS

Check all actuator couplings for tightness. Check all damper rods and linkages. Make sure all connections are tight. Adjust if necessary. Perform a combustion test as per Section 4 - Adjustments, and readjust burner if necessary.

BURNER MOUNTING INSPECTION

The seal between the burner flange and furnace front plate must not permit combustion gases to escape. Periodic inspection is important. If leakage occurs, refer to

GAS SYSTEM

MOTORIZED MAIN GAS VALVES: Should the valve fail to operate, check for voltage at the valve. Make certain that the main shutoff cock is closed prior to testing. The actuator is not field repairable nor should it be disassembled. Replace the actuator if the valve fails to operate. After replacement, cycle the valve with the fuel shutoff to determine that it opens and closes. If the valve has a visual indicator, observe its position for correct operation.

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

correct procedure in coil replacement. Should it become necessary to replace the complete valve, be sure that the flow is in the direction of the arrow on the body. Test for gas leaks and check valve action several times to ensure proper operation before attempting to relight burner.

CAUTION

ALL POWER MUST BE DISCONNECTED BEFORE SERVICING THE VALVES.

ELECTRICAL SYSTEM

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

ELECTRIC MOTORS

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

EXTENDED SHUTDOWN

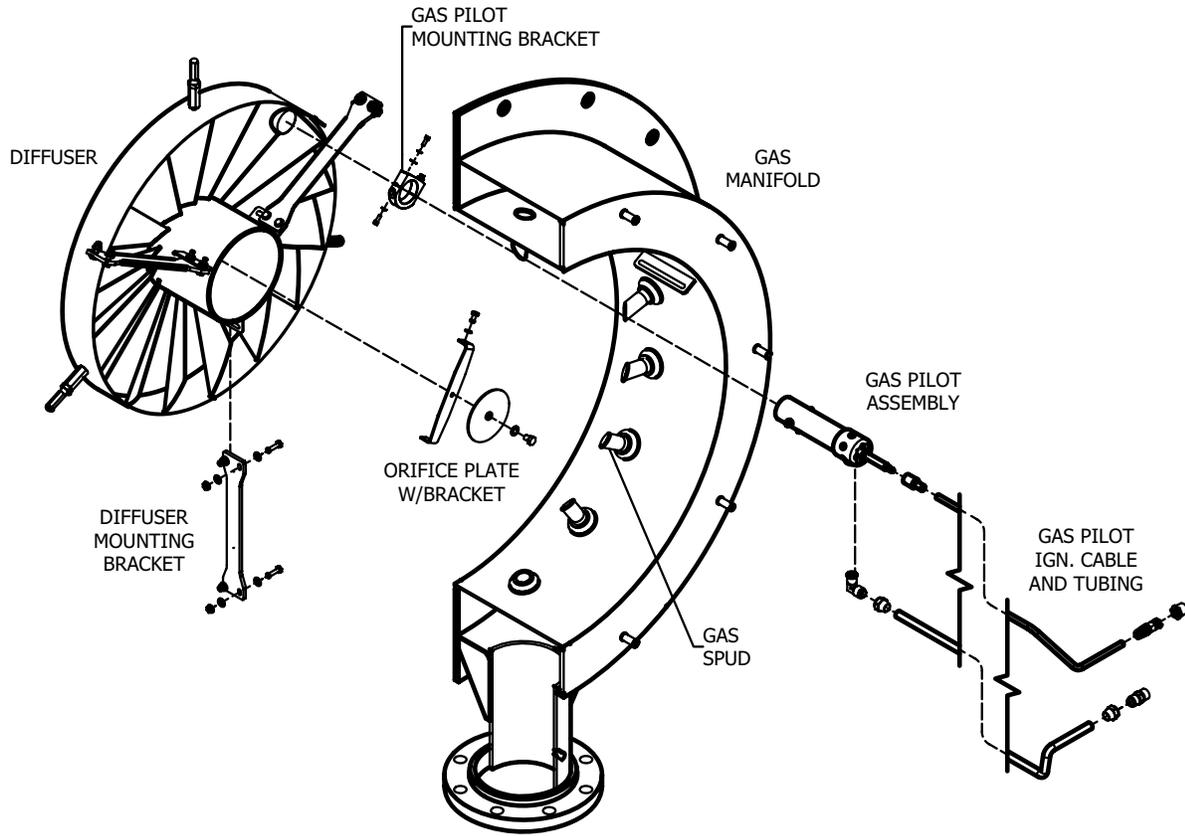
When shutting down the burner for an extended period of time, the operator should use the following general guidelines to protect the burner from its surrounding elements. This will add to the operating life of the burner.

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

G. Safety Valves

The safety valve is a very important safety device and deserves attention accordingly.

Follow the recommendations of your boiler inspector regarding valve inspection and testing. The frequency of testing, either by the use of the lifting lever or by raising the steam pressure, should be based on the recommendation of your boiler inspector and/or the valve manufacturer, and in accordance with sections VI or VII of the ASME Boiler and Pressure Vessel Code.



GAS-ONLY DRAWER ASSEMBLY

Avoid excessive operation of the safety valve; even one opening can provide a means of leakage. Safety valves should be operated only often enough to assure that they are in good working order. When a pop test is required, raise the operating pressure to the set pressure of the safety valve, allowing it to open and reseat as it would in normal service.

Do not hand operate the valve with less than 75% of the stamped set pressure exerted on the underside of the disc. When hand operating, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

Frequent usage of the safety valve will cause the seat and disc to become wire drawn or steam cut. This will cause the valve to leak and necessitate down time of the boiler for valve repair or replacement. Repair of a valve must be done only by the manufacturer or his authorized representative.

Avoid having the operating pressure too near the safety valve set pressure. A 10% differential is recommended. An even greater differential is desirable and will assure better seat tightness and valve longevity.

H. Refractory

The boiler is shipped with completely installed refractory. The refractory consists of the dry oven, the rear access plug, blanket insulation, wetpack and sealing rope. Normal maintenance requires little time and expense, and prolongs the operating life of the refractory.

Preventive maintenance through periodic inspection will keep the operator informed of the condition of the refractory, and will guard against unexpected and unwanted downtime and major repairs.

I. Front Smoke Box

1. Opening Doors

Before opening the door, tighten the nut on the davit arm to create slight tension. This will prevent sagging and facilitate opening of the door. After opening either door, check the gaskets and seating surfaces. Replace the door gaskets if they are hard or brittle. Clean the sealing surfaces of the door and tube sheet. If the blanket insulation is torn away the insulation will require replacing.

2. Insulating the Smoke Box

When replacing the insulation in the front smoke box area, be sure to clean the installation area. Be sure all firetubes are clean and free of old insulation material. If necessary replace the retainer pins. Cut the blanket insulation 1-1/2" to 2" back

from the door mounting flange. The space is required for the doors to close and compress into the inner lining of insulation without causing distortion to the blanket insulation. Use spray adhesive to hold the insulation in place prior to placing the wire mesh over the blanket insulation. Install the retainers and bend the pins parallel to the blanket insulation and retainers. WetPack insulation should be used on the base of the smoke box and around the furnace area.

Preparing to Close Doors

The doors are insulated with 2" blanket insulation and held in place with wire mesh, retainer pins and clips.

Before closing the doors check all the mounting studs by running a mounting nut down the threads to check for burs or flat spots. Checking the mounting studs before trying to close the door will greatly facilitate the closing process. If a flat spot or bur is found, remove the nut and chase the thread with the appropriate sized Thread die.

Note: When closing the doors, inspect the threads on all studs and where necessary use the correct sized die to clean the threads. Damaged stud threads can strip the brass nuts.

Use spray adhesive to secure the 1/2" rope (872-622) to the sealing area of the doors.

Cut 2" blanket insulation to fit in the door baffle seal area. Use a spray adhesive to hold the baffle seal in place.

3. Closing and Sealing Doors

Swing the door to the closed position, adjusting the davit bolt to align the door. Be sure the gasket is positioned correctly prior to tightening the door. Tighten the bolts uniformly, starting at the top center and alternating between the top and bottom bolts until both are tight. Do not over-tighten. Tighten alternate bolts until all are secure and the door is gas tight.

After closing the door, loosen the nut on the davit arm stud to release tension on the davit arm. Failure to do so may result in damage to the boiler due to thermal stresses during boiler operation.

After the boiler is back in operation, re-tighten the door bolts to compensate for compression of the gasket or movement of the door.

J. Rear Access Plug

The 22" rear access plug houses the rear sight port and is removable for rear fireside access.

Resealing the rear access plug requires cleaning the seal area. After cleaning, spray adhesive into the sealing area and insert the 2" rope gasket.

K. Lubrication

Electric Motors

Manufacturers of electric motors vary in their specifications for lubrication and care of motor bearings; their specific recommendations should be followed.

Ball bearing equipped motors are pre-lubricated. The length of time a bearing can run without having grease added will depend upon many factors, including the rating of the motor, type of motor enclosure, duty, atmospheric conditions, humidity, and ambient temperatures.

Complete renewal of grease, when necessary, can be accomplished by forcing out the old grease with new grease. Thoroughly wipe those portions of the housing around the filler and drain plugs (above and below bearings). Remove the drain plug (bottom) and free the drain hole of any hardened grease which may have accumulated. With the motor not running, add new grease through the filler hole until clear grease starts to come out of the drain hole. Before replacing the drain plug, run the motor for 10 to 20 minutes to expel any excess grease. The filler and drain plugs should be thoroughly cleaned before they are replaced.

The lubricant used should be clean and equal to one of the good commercial grades of grease locally available.

NOTE: Siemens motors used in Cleaver-Brooks applications require an **aluminum complex high temperature** grease; this may **not** be mixed with any other type grease.

Control Linkage

Apply a non-gumming, dripless, high temperature lubricant, such as graphite or a silicone derivative to all pivot points and moving parts. Work lubricant in well and wipe excess. Repeat application at required intervals to maintain freedom of motion of parts.

Solenoid and Motorized Valves

Solenoid valves and motorized valves require no lubrication.

L. Combustion

The frequency of burner adjustments depends upon several factors, including; type of burner, type of fuel, load conditions, ambient temperature, climatic variables, and general maintenance practices.

The air-fuel ratio should be checked monthly in order to alert the operator to losses in efficiency, which do not produce visible flame change. Any time maintenance is performed on the burner linkage, the air-fuel ratio should be checked. Readjustment of the burner may be required due to variations in fuel composition.

A combustion analyzer should be used to adjust air-fuel ratio for maximum operating efficiency.

If your burner requires adjustments, contact your local Cleaver-Brooks authorized representative for assistance.



e-mail: info@cleaverbrooks.com
Web Address: <http://www.cleaverbrooks.com>