Model CFH

ClearFire

Gas High-Efficiency Steam Boiler
10-60 HP

Operation, Service, and Parts Manual

750-295
7/09

c UL us LISTED

⚠WARNING

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

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

— WHAT TO DO IF YOU SMELL GAS

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

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

⚠WARNING

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

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

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

Notice

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

⚠WARNING

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

⚠WARNING

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

⚠WARNING

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

⚠WARNING

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

Notice

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

⚠WARNING

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

⚠WARNING

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

Notes

CLEAVER-BROOKS

Model CFH

ClearFire *Packaged Boiler*

Gas High Efficiency Boiler
Operation, Service, and Parts Manual

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

Manual Part No. 750-295
7/09

Printed in U.S.A.

⚠ WARNING

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

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

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

TO: Owners, Operators and/or Maintenance Personnel

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

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

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

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

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

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

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

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

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

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

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

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Chapter 1
Introduction

Figure 1-1 Model CFH Boiler

Figure 1-2 AluFer Tube Cross Section

1.1-MODEL CFH FEATURES AND BENEFITS

Compact Firetube Design

The Model CFH boiler is a compact horizontally fired firetube boiler (Figure 1-1). The extended heating surface tubes provide for very high levels of performance in a compact space. The Model CFH boiler is designed to fire natural gas or LP gas.

High Efficiency

With the extended heating surface provided by the patented AluFer tube design (Figure 1-2) the Model CFH has a nominal fuel to steam efficiency of 85%.

Advanced Construction

Constructed to ASME standards and utilizing AluFer Tube technology in a single-pass design, the Model CFH Boiler will provide many years of trouble free service. Single-pass design provides excellent thermal shock protection.

Ease of Maintenance

The enclosure is readily removable for access to all key burner components. A hinged door on the control panel provides access to all controls.

Quality Construction

ASME construction ensures high quality design, safety, and reliability.

ISO 9001 certified manufacturing process ensures adherence to the highest manufacturing standards.

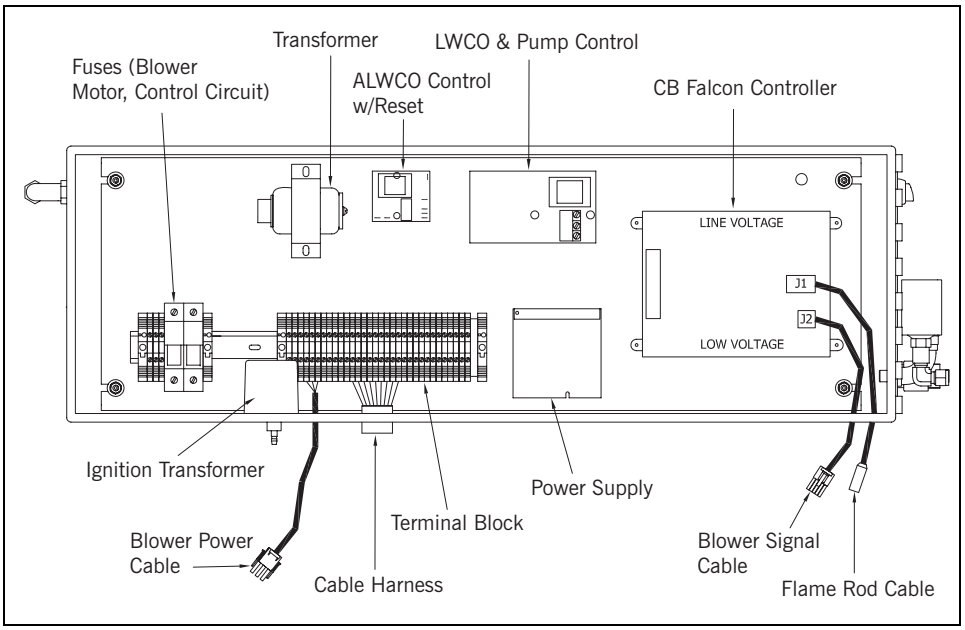


Figure 1-3 Model CFH Electrical Panel Interior

Full Modulation

The burner and combustion fan modulate to provide only the amount of heat required, providing quiet and efficient operation under all conditions.

Premix Technology

The Model CFH Boiler utilizes "Premix" technology to mix both fuel and combustion air prior to entering the firing chamber. This technology provides clean, efficient combustion with very low emission levels.

1.2-THE MODEL CFH BOILER

Firetube boilers are rated in boiler horsepower (BHP), which should not be confused with other horsepower measurements (1 BHP = 33,475 BTU/hr.).

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 75 to 150 psig.

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. In order to prevent the safety valve from opening too frequently during normal operation, the operating pressure should not exceed 90% of the safety valve setting.

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

As with any firetube boiler, waterside care and maintenance are of critical importance to the Model CFH. Constant attention to water requirements will pay dividends in the form of longer life, less down-time, and prevention of costly repairs.

Care taken in placing the pressure vessel into initial service is vital, as the waterside of new boilers and new or remodeled systems may contain oil, grease or other foreign matter.

The flue side of the Model CFH boiler is virtually maintenance free. Periodic inspection of furnace and Alufer tubes is recommended during required service and inspection intervals. See Chapter 5, Maintenance, for details.

⚠ 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. Failure to follow these instructions could result in equipment damage.

1.3-THE BURNER

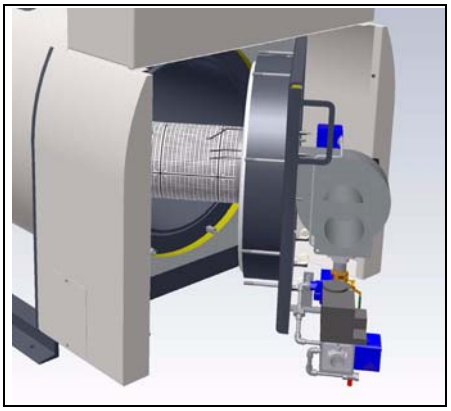


Figure 1-4 Model CFH Burner

- Incorporating "premix" technology, the burner utilizes a mixing venturi, dual safety shutoff-single body pressure regulating gas valve, variable speed blower, and Fecralloy metal fiber burner canister (see Figure 1-5).
- Full modulation is provided using the integral variable speed combustion air fan (up to 5:1 turndown).
- Solid body radiation of the burner flame provides clean, efficient combustion and low emissions.
- At maximum firing rate, the sound level of the burner is less than 70 dBA, measured in front of the boiler at a distance of 3 feet. At reduced firing rates, sound levels are even lower.
- Provision is made for optional direct venting.
- Combustion Air Proving Switch standard.
- Air filter for combustion air intake standard.

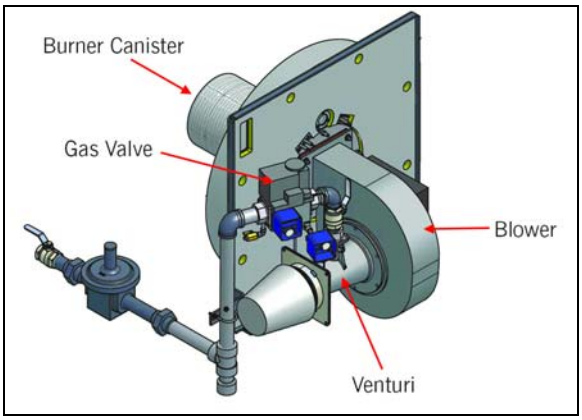


Figure 1-5 Burner Components

1.4-BURNER GAS TRAIN

The gas train assembly (Figure 1-6) is provided in accordance with UL/cUL certification and ASME CSD-1. The gas train assembly is factory assembled and wired, consisting of the following components:

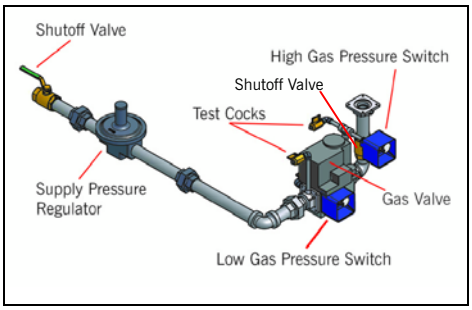


Figure 1-6 Gas Train

- Single body, dual safety shutoff gas valve with integral trim regulator
- Low Gas Pressure Switch
- High Gas Pressure Switch
- (2) Manual Shutoff Valves
- Leak Test Cocks
- Supply pressure regulator (1 psig max)

1.5-CONTROLS

The CB Falcon steam boiler control is an integrated burner management and modulation control with a touch-screen display/ operator interface.

The controller is capable of the following functions:

- Burner sequencing with safe start check, pre-purge, direct spark ignition, and post purge.
- Electronic ignition.
- Flame Supervision.
- Safety shutdown with time-stamped display of lockout condition.
- Variable speed control of the combustion fan.
- Supervision of low and high gas pressure, air proving, stack back pressure, high limit, and low water.
- First-out annunciator.
- Real-time data trending.
- (3) pump/auxiliary relay outputs.
- Modbus communication capability.
- Outdoor temperature reset.
- Remote firing rate or setpoint control
- Setback/time-of-day setpoint

Figure 1-7 CB Falcon touchscreen display

Figure 1-8 CB Falcon controller

1.6-COMPONENT/CONNECTION LOCATIONS

Figure 1-9 shows the Model CFH component orientation.

Figure 1-10 shows a detail of the low water and limit controls.

Refer to Chapter 3 for recommended vent sizes and lengths for the specific boiler installation.

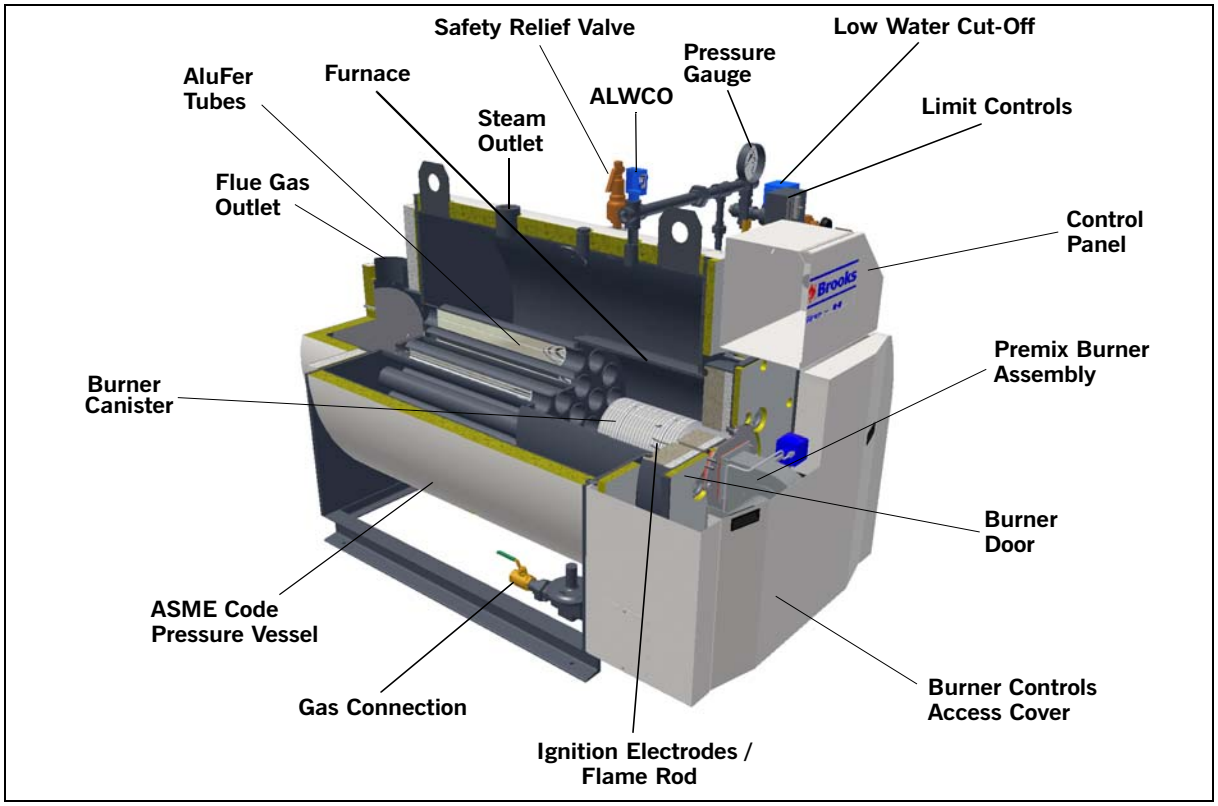


Figure 1-9 Model CFH Steam Boiler

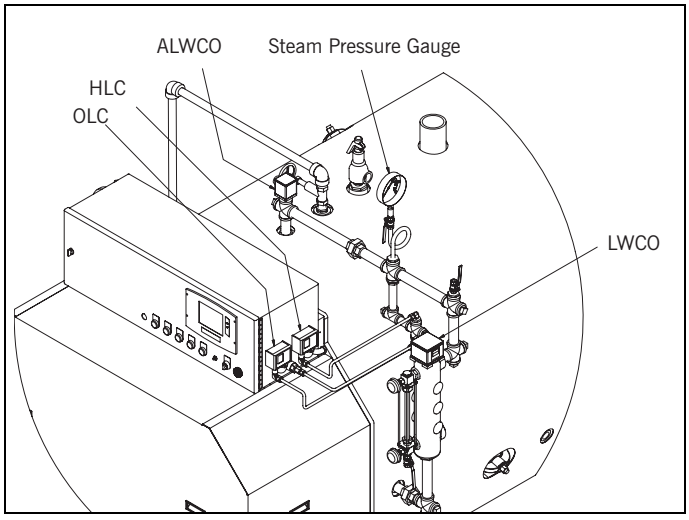


Figure 1-10 CFH Low Water and Limit Controls

1.7-OPTIONAL EQUIPMENT

Certain options are available for the Model CFH Boiler; normally these will have been specified at the time of order entry. In addition, some options may have been provided (by others) that are not part of Cleaver-Brooks scope of supply. In either case, the Cleaver-Brooks authorized representative should be consulted regarding specific project requirements.

Model CFH optional features (steam boilers)

- Boiler Staus Lights & Alarm horn
- High Gas Pressure Regulator (>1 psig supply; shipped loose)
- Gas pressure relief valve (>1 psig supply; shipped loose)
- Min. Temp./Hot standby
- Sealed combustion/direct vent kit - shipped loose
- Chemical Feed System
- Surface Blow-off
- Integral feedwater system (includes tank, pump, and control) - shipped separately
- Feedwater Valve (on/off)
- Blowdown valves
- Modulating Feedwater Valve & Level Control
- High Water Alarm
- Time clock for setback control - shipped loose
- Stack temp. limit control
- Reusable air filter
- Stack thermometer
- Economizer package (150# steam only)

Chapter 2
Installation

⚠ Warning

Provisions for combustion and ventilation air must be in accordance with UL 795, Commercial-Industrial Gas Heating Equipment, cUL, or applicable provisions of the local building codes. Failure to follow this warning could result in personal injury or death

⚠ Warning

If an external electrical source is utilized, the boiler, when installed, must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the National Electrical Code and/or UL 795, Commercial-Industrial Gas Heating Equipment.

⚠ Caution

The boiler must be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service. Failure to follow this warning could result in equipment failure.

Figure 2-1 Lifting boiler

2.1-Lifting and moving the boiler

The Model CFH boiler is equipped with two lifting lugs extending from the front and rear tube sheets. These lugs should be used to lift the boiler.

⚠ Caution

In order to avoid damage to the unit, lifting or moving the boiler should only be done by experienced personnel suitably equipped for moving heavy equipment.

Note: The boiler should not be lifted by the base, or moved by pushing, prying, or pulling on any part of the casing.

The boiler must be installed on a non-combustible floor. If the floor is not level, piers or a raised pad slightly larger in length and width than the boiler base dimensions will make boiler installation and leveling easier.

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections must be arranged so as to avoid interfering with removal of the casing panels or with the burner door.

2.2-Water Treatment

Properly treated boiler water will result in maximum effectiveness and long trouble-free life of the pressure vessel. Contact your local Cleaver-Brooks representative or water management consultant for complete information on how to prevent damage resulting from inadequate water treatment. See **Table 2-1** below for water quality guidelines.

⚠ Important

The use of soft water is highly recommended. Failure to observe this recommendation can lead to dangerous operating conditions, and may result in damage to the boiler. If necessary, your Cleaver-Brooks representative can provide additional information regarding your water softening needs.

The objectives of water treatment in general are to:

1. Prevent hard scale and soft sludge deposits that inhibit heat transfer and that could lead to overheated metal and costly downtime and repairs.
2. Eliminate corrosive gases in the supply or boiler water.

To accomplish these objectives, the boiler requires proper water treatment before and after introduction of water into the unit. The selection of pretreatment processes depends upon the water source, its chemical characteristics, the amount of makeup water needed, system operation practices, etc.

Because of the variables involved, no single boiler compound can be considered a cure-all; nor is it advisable to experiment with homemade treating methods. A sound treatment program should include a periodic analysis of the water in the system.

> **⚠ Warning** *Inadequate or improper water treatment will shorten the life of the boiler, and could result in a hazardous condition.*

The internal or waterside surfaces of the pressure vessel should be inspected at regular intervals for evidence of corrosion, pitting, contamination, or accumulations of foreign matter. If any of these conditions are detected, contact your local Cleaver-Brooks authorized representative for advice on corrective action. It is recommended that a properly sized water meter be installed in the raw water makeup line to accurately determine the amount of raw water admitted to the boiler.

Surface blow-off is available for steam boilers. This option allows removal of surface water impurities through a blowdown line located at the normal operating water level of the boiler. If allowed to accumulate, surface impurities may impede steam release and could cause foaming, leading to priming and carryover in the steam lines.

An optional chemical feed system can be used to introduce controlled amounts of feedwater treatment chemicals into the boiler.

Refer to ***Table 2-1 Water Quality Guidelines***.

Notice

Corrosion and sludge deposits in old systems must be removed prior to installation of a new boiler.

Table 2-1 Water Quality Guidelines

QUANTITY	LIMITS
Oxygen	<0.005 ppm
Hardness	<5.0 ppm
Suspended Matter	<15 ppm
pH	8.5 - 10.5
Silica	<150 ppm
Total Alkalinity	<700 ppm
Dissolved Solids	<7000 µmho/cm

2.3-Boiler Room

The boiler room must comply with all building codes and regulations. An adequate supply of combustion air and sufficient ventilation are required for safe operation. If the optional direct vent combustion air kit is not used, ventilation must be provided to meet applicable regulations for air supply.

⚠ Warning

The boiler must not be installed on combustible flooring.

Clean combustion air is required for optimum efficiency and boiler operation (minimum combustion air 10 cfm per boiler horsepower). Dust and airborne contaminants will adversely effect burner performance.

If conditions dictate, a serviceable filter must be placed at the burner inlet to eliminate airborne contamination to the burner.

If a direct vent air intake is used, the intake and flue venting should be terminated so as to prevent rain, snow, dust, or debris from entering the intake piping.

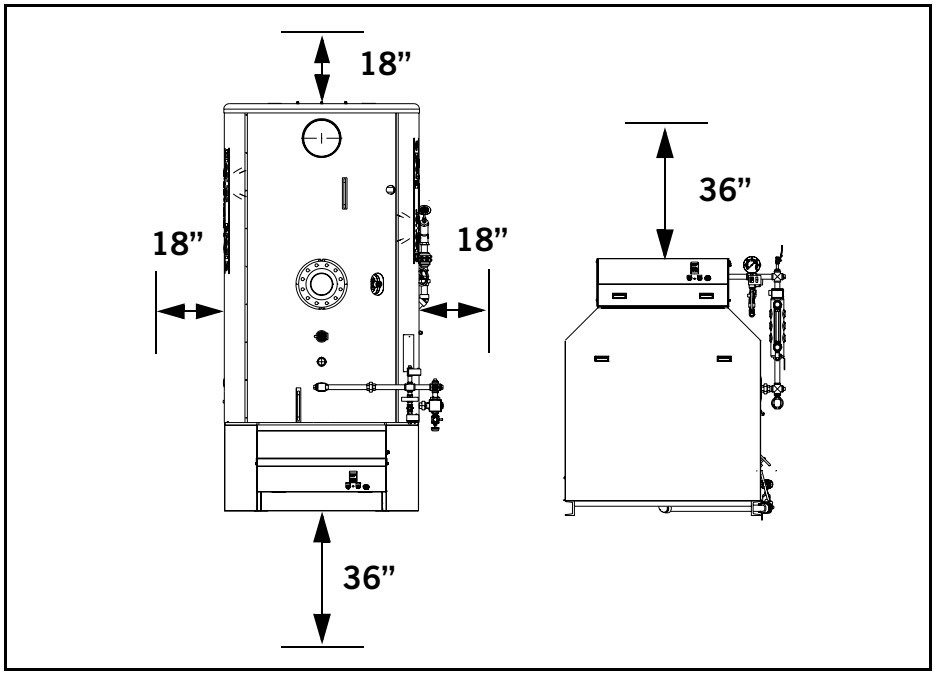


Figure 2-2 Clearances

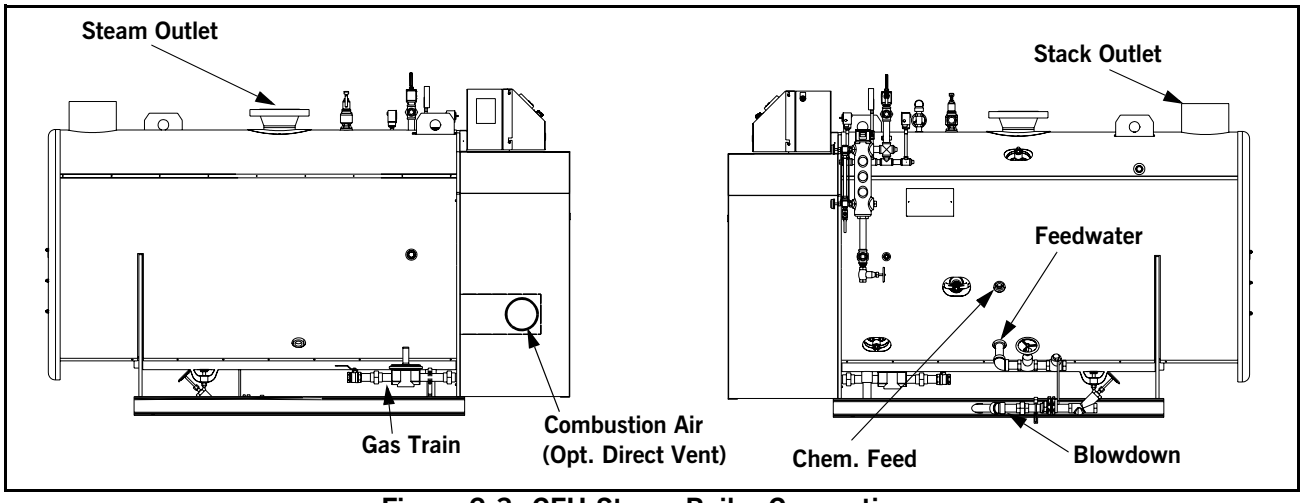


Figure 2-3 CFH Steam Boiler Connections

2.4-Flue Gas Connection

The flue gases from the ClearFire boiler are removed via a gas-tight, temperature and corrosion resistant flue gas pipeline. Only flue gas systems approved and tested by the relevant region or province are to be connected to the ClearFire boiler. Refer to flue piping manufacturer for proper installation and sealing instructions.

See Chapter 3 in this manual for more information.

2.5-Gas Connections

Gas Shut Off Valve and Gas Filter

A manually operated shut-off valve and pressure regulator are provided as standard on the CFH boiler (**Figure 2-4**). In some cases, local regulations may require the installation of an approved gas filter between the gas shut-off valve and the boiler. Please ask the local gas supply company whether any such regulations apply.

The boiler should be installed so that the gas ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service.

If building supply gas pressure is greater than 1 psig (27.8" WC), an upstream regulator with overpressure protection and proper gas venting will be required and must be piped to a safe point of discharge. A dedicated gas pressure regulator is required for each boiler to ensure consistent gas pressure at the boiler.

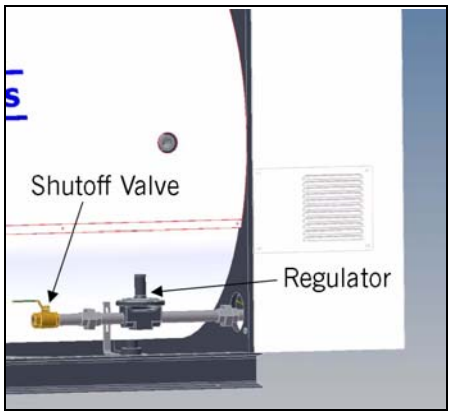


Figure 2-4 ClearFire Gas Piping Shut-off Valve and Regulator

Drip legs are required on any vertical piping at the gas supply to each boiler so that any dirt, weld slag, or debris can deposit in the drip leg rather than into the boiler gas train. The bottom of the drip leg should be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

⚠ Warning

A sediment trap must be provided upstream of the gas controls.

All gas piping and components to the boiler gas train connection must comply with NFPA 54, local codes, and utility requirements as a minimum. Only gas approved fittings, valves, or pipe should be used. Standard industry practice for gas piping is normally Schedule 40 black iron pipe and fittings.

Before starting the unit(s) all piping must be cleaned of all debris to prevent its' entrance into the boiler gas train. Piping should be tested as noted in NFPA 54 and the boiler must be isolated during any tests.

After initial startup, the inlet screen to the gas valve should be checked and cleaned for any debris buildup.

Gas Supply Pipe Sizing - For proper operation of a single unit or a multiple unit installation, we recommend that the gas pipe sizing be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted to confirm that sufficient volume and normal pressure are provided to the building at the discharge side of the gas meter or supply pipe.

For installations of new boilers into an existing building, gas pressure should be measured with a manometer to ensure sufficient pressure is available. A survey of all connected gas-using devices should be made. If appliances other than the boiler or boilers are connected to the gas supply line, then a determination must be made of how much flow volume (cubic feet per hour) will be demanded at one time and the pressure drop requirement when all appliances are firing.

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, gas piping **Table 2-2** through **Table 2-6** should be used. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a 40 HP unit with 1,613,253 btu/hr input divided by a gas calorific value of 1060 will result in a flow of 1,522 cubic feet per hour. The single boiler is approximately 20 feet from the gas supply header source. And with a measured gas supply pressure of 10" w.c. we find from **Table 2-2** that a supply pipe size of 2" should be used as a minimum.

Table 2-2 ***Gas line capacity - Schedule 40 metallic pipe***

Pipe Size							
Nominal	**1"**	**1-1/4"**	**1-1/2"**	**2"**	**2-1/2"**	**3"**	**4"**
Actual I.D.	**1.049**	**1.380"**	**1.610"**	**2.067"**	**2.469"**	**3.068"**	**4.026"**
Length in feet	****Maximum Capacity in Cubic Feet of Gas per Hour**						
10	514	1,060	1,580	3,050	4,860	8,580	17,500
20	363	726	1,090	2,090	3,340	5,900	12,000
30	284	583	873	1,680	2,680	4,740	9,660
40	243	499	747	1,440	2,290	4,050	8,290
50	215	442	662	1,280	2,030	3,590	7,330
60	195	400	600	1,160	1,840	3,260	6,640
70	179	368	552	1,060	1,690	3,000	6,110
80	167	343	514	989	1,580	2,790	5,680
90	157	322	482	928	1,480	2,610	5,330
100	148	304	455	877	1,400	2,470	5,040
125	131	269	403	777	1,240	2,190	4,460
150	119	244	366	704	1,120	1,980	4,050
175	109	209	336	648	1,030	1,820	3,720
200	102	185	313	602	960	1,700	3,460
****Fuel: Natural Gas**							
****Inlet Pressure: Less than 2.0 psi**							
****Pressure Drop: 0.30" w.c.**							
****Specific Gravity: 0.60**							

Table 2-3 ***Gas line capacity - Schedule 40 metallic pipe***

Pipe Size							
Nominal	**1"**	**1-1/4"**	**1-1/2"**	**2"**	**2-1/2"**	**3"**	**4"**
Actual I.D.	**1.049"**	**1.380"**	**1.610"**	**2.067"**	**2.469"**	**3.068"**	**4.026"**
Length in feet	****Maximum Capacity in Cubic Feet of Gas per Hour**						
10	678	1,390	2,090	4,020	6,400	11,300	23,100
20	466	957	1,430	2,760	4,400	7,780	15,900
30	374	768	1,150	2,220	3,530	6,250	12,700
40	320	657	985	1,900	3,020	5,350	10,900
50	284	583	873	1,680	2,680	4,740	9,600
60	257	528	791	1,520	2,430	4,290	8,760
70	237	486	728	1,400	2,230	3,950	8,050
80	220	452	677	1,300	2,080	3,670	7,490
90	207	424	635	1,220	1,950	3,450	7,030
100	195	400	600	1,160	1,840	3,260	6,640
125	173	355	532	1,020	1,630	2,890	5,890
150	157	322	482	928	1,480	2,610	5,330
175	144	296	443	854	1,360	2,410	4,910
200	134	275	412	794	1,270	2,240	4,560
****Fuel: Natural Gas**							
****Inlet Pressure: Less than 2.0 psi**							
****Pressure Drop: 0.50" w.c.**							
****Specific Gravity: 0.60**							

Table 2-4 ***Gas line capacity - Schedule 40 metallic pipe***

Pipe Size									
Nominal	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**	**2-1/2"**	**3"**	**4"**
Actual I.D.	**0.622**	**0.824**	**1.049"**	**1.380"**	**1.610"**	**2.067"**	**2.469"**	**3.068"**	**4.026"**
Length in feet	****Maximum Capacity in Cubic Feet of Gas per Hour**								
10	1,510	3,040	5,560	11,400	17,100	32,900	52,500	92,800	189,000
20	1,070	2,150	3,930	8,070	12,100	23,300	57,100	65,600	134,000
30	869	1,760	3,210	6,590	9,880	19,000	30,300	53,600	109,000
40	753	1,520	2,780	5,710	8,550	16,500	26,300	46,400	94,700
50	673	1,360	2,490	5,110	7,650	14,700	23,500	41,500	84,700
60	615	1,240	2,270	4,660	6,980	13,500	21,400	37,900	77,300
70	569	1,150	2,100	4,320	6,470	12,500	19,900	35,100	71,600
80	532	1,080	1,970	4,040	6,050	11,700	18,600	32,800	67,000
90	502	1,010	1,850	3,810	5,700	11,000	17,500	30,900	63,100
100	462	954	1,710	3,510	5,260	10,100	16,100	28,500	58,200
125	414	836	1,530	3,140	4,700	9,060	14,400	25,500	52,100
150	372	751	1,370	2,820	4,220	8,130	13,000	22,900	46,700
175	344	695	1,270	2,601	3,910	7,530	12,000	21,200	43,300
200	318	642	1,170	2,410	3,610	6,960	11,100	19,600	40,000
500	192	401	717	1,470	2,210	4,250	6,770	12,000	24,400
1000	132	275	493	1,010	1,520	2,920	4,650	8,220	16,800
1500	106	221	396	812	1,220	2,340	3,740	6,600	13,500

****Fuel: Natural Gas**

****Inlet Pressure: 2.0 psi**

****Pressure Drop: 1.0 psi**

****Specific Gravity: 0.60**

Table 2-5 ***Gas line capacity - Schedule 40 metallic pipe***

Pipe Size									
Nominal	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**	**2-1/2"**	**3"**	**4"**
Actual I.D.	**0.622**	**0.824**	**1.049"**	**1.380"**	**1.610"**	**2.067"**	**2.469"**	**3.068"**	**4.026"**
Length in feet	****Maximum Capacity in Cubic Feet of Gas per Hour**								
10	2,350	4,920	9,270	19,000	28,500	54,900	87,500	155,000	316,000
20	1,620	3,380	6,370	13,100	19,600	37,700	60,100	106,000	217,000
30	1,300	2,720	5,110	10,500	15,700	30,300	48,300	85,400	174,000
40	1,110	2,320	4,380	8,990	13,500	25,900	41,300	75,100	149,000
50	985	2,060	3,880	7,970	11,900	23,000	36,600	64,800	132,000
60	892	1,870	3,520	7,220	10,300	20,300	33,200	58,700	120,000
70	821	1,720	3,230	6,640	9,950	19,200	30,500	54,000	110,000
80	764	1,600	3,010	6,180	9,260	17,800	28,400	50,200	102,000
90	717	1,500	2,820	5,800	8,680	16,700	26,700	47,100	96,100
100	677	1,420	2,670	5,470	8,200	15,800	25,200	44,500	90,300
125	600	1,250	2,360	4,850	7,270	14,000	22,300	39,500	80,500
150	544	1,140	2,140	4,400	6,590	12,700	20,200	35,700	72,900
175	500	1,050	1,970	4,040	6,060	11,700	18,600	32,900	67,100
200	465	973	1,830	3,760	5,640	10,900	17,300	30,600	62,400
500	283	593	1,120	2,290	3,430	6,610	10,300	18,600	38,000
1000	195	407	897	1,380	2,360	4,550	7,240	12,000	26,100
1500	156	327	616	1,270	1,900	3,650	5,820	10,300	21,000

****Fuel: Natural Gas**

****Inlet Pressure: 3.0 psi**

****Pressure Drop: 2.0 psi**

****Specific Gravity: 0.60**

Table 2-6 ***Gas line capacity - Schedule 40 metallic pipe***

Pipe Size									
Nominal	**1/2"**	**3/4"**	**1"**	**1-1/4"**	**1-1/2"**	**2"**	**2-1/2"**	**3"**	**4"**
Actual I.D.	**0.622**	**0.824**	**1.049"**	**1.380"**	**1.610"**	**2.067"**	**2.469"**	**3.068"**	**4.026"**
Length in feet	****Maximum Capacity in Cubic Feet of Gas per Hour**								
10	3,190	6,430	11,800	24,200	36,200	69,700	111,000	196,000	401,000
20	2,250	4,550	8,320	17,100	25,600	49,300	78,600	139,000	283,000
30	1,840	3,720	6,790	14,000	20,900	40,300	64,200	113,000	231,000
40	1,590	3,220	5,880	12,100	18,100	34,900	55,600	98,200	200,000
50	1,430	2,880	5,260	10,800	16,200	31,200	49,700	87,900	179,000
60	1,300	2,630	4,800	9,860	14,800	28,500	45,400	80,200	164,000
70	1,200	2,430	4,450	9,130	13,700	26,400	42,000	74,300	151,000
80	1,150	2,330	4,260	8,540	12,800	24,700	39,300	69,500	142,000
90	1,060	2,150	3,920	8,050	12,100	23,200	37,000	65,500	134,000
100	979	1,980	3,620	7,430	11,100	21,400	34,200	60,400	123,000
125	876	1,770	3,240	6,640	9,950	19,200	30,600	54,000	110,000
150	786	1,590	2,910	5,960	8,940	17,200	27,400	48,500	98,900
175	728	1,470	2,690	5,520	8,270	15,900	25,400	44,900	91,600
200	673	1,360	2,490	5,100	7,650	14,700	23,500	41,500	84,700
500	384	802	1,510	3,100	4,650	8,950	14,300	25,200	51,500
1000	264	551	1,040	2,130	3,200	6,150	9,810	17,300	35,400
1500	212	443	834	1,710	2,570	4,940	7,880	13,900	28,400

****Fuel: Natural Gas**

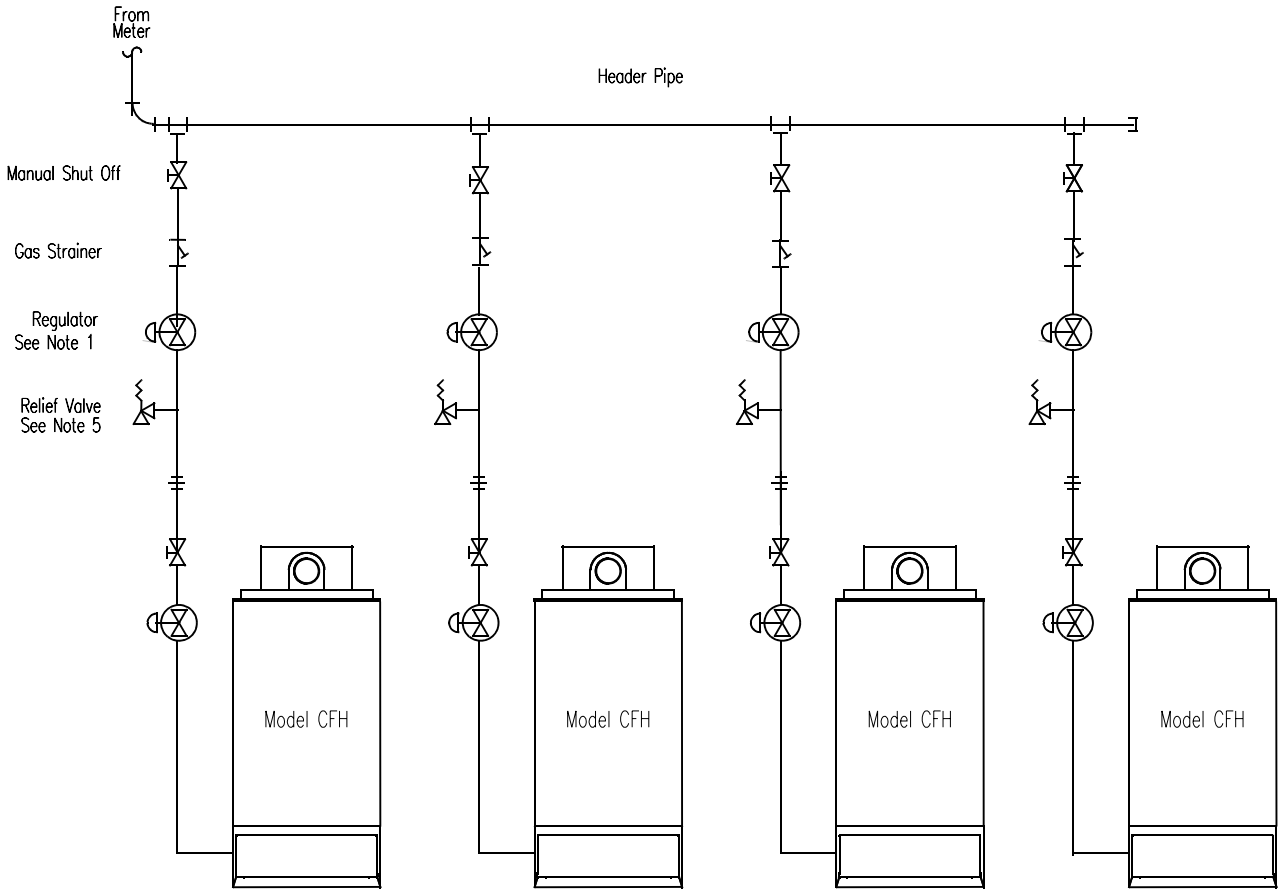
****Inlet Pressure: 5.0 psi**

****Pressure Drop: 3.5 psi**

****Specific Gravity: 0.60**

Gas Header - For multiple unit installations, a single common gas header is recommended with individual takeoffs for each boiler (See **Figure 2-5**). Boiler gas manifold piping should be sized based on volume requirements and lengths between each boiler and the fuel main header. **Table 2-7** through **Table 2-14** indicate the proper sizing for multiple units of equal size, placed on the factory standard center with the indicated take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, find length of run from the source and determine what size header will be needed for the flow of all units firing. Pipe sizes are based on **Table 2-2** with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to Tables 2-2 to 2-6 for pipe sizing.

Figure 2-5 Typical gas header piping



NOTES:
1. Upstream regulator required if supply pressure >1 psig.
2. Refer to local fuel gas codes when applicable.
3. Header to be sized for room capacity.
4. Provision required for measuring gas supply pressure at boiler.
5. Relief valve required if gas supply pressure >1 psig.

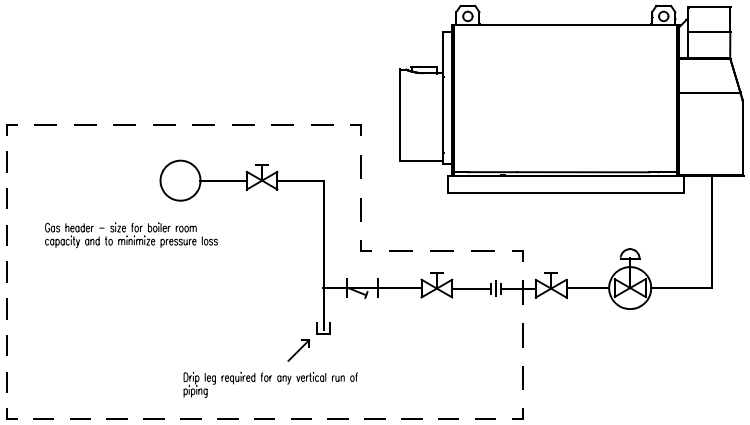


Figure 2-6 Example gas piping <1 psig supply

Pipe sizing for multiple unit manifolds

Table 2-7. CFH 10 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	1-1/4"	1-1/4"	1-1/4"	1-1/4"
Header Pipe Size	1-1/4"	1-1/4"	2"	2"

Table 2-8. CFH 15 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	1-1/4"	1-1/4"	1-1/4"	1-1/4"
Header Pipe Size	1-1/4"	2"	2"	2-1/2"

Table 2-9. CFH 20 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Header Pipe Size	1-1/2"	2"	2-1/2"	2-1/2"

Table 2-10. CFH 25 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Header Pipe Size	1-1/2"	2"	2-1/2"	3"

Table 2-11. CFH 30 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2"	2-1/2"	3"	3"

Table 2-12. CFH 40 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2"	2-1/2"	3"	4"

Table 2-13. CFH 50 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2"	3"	3"	4"

Table 2-14. CFH 60 HP Boilers

# of Units	1	2	3	4
Pipe Size To Boiler	2-1/2"	2-1/2"	2-1/2"	2-1/2"
Header Pipe Size	2-1/2"	3"	4"	4"

2.6-Boiler Water-Side Connections

Notice

Before filling boiler, check that all waterside openings/fittings are plugged and all inspection covers are secured.

A pressure relief valve (Safety Valve), provided with the boiler, must be installed in the mounting provided. Use pipe sealing compound and a flat sided wrench when securing the Safety relief valve. Do not use a pipe wrench and do not over tighten the relief valve. The safety 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.

Connection to the main steam header is made at the nozzle projecting upward from the boiler shell. ASME code requires a suitable stop valve to be installed between the boiler and main steam header if multiple boilers are tied to the header. This valve should be located as close as possible to the boiler to facilitate venting and pressure testing. A suitably rated gate valve is recommended for this purpose.

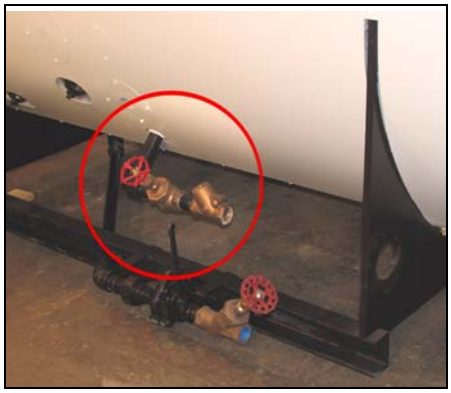


Figure 2-7 Feedwater Inlet

Feedwater is introduced through the piping assembly installed on the side of the boiler vessel. A stop valve and check valve are optional equipment (**Figure 2-7**).

The feedwater supply should provide sufficient pressure to meet minimum flow requirements.

Cleaver-Brooks offers blowdown piping and valves as an option for CFH boilers. Whether supplied by Cleaver-Brooks or others, blowdown equipment is required for all steam boilers.

A qualified boiler and piping installer should make all boiler waterside connections.

⚠ 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 this warning could result in serious personal injury or death.

2.7-Electrical Connections & Wiring Diagrams

Refer to **Figure 2-8** for CFH wiring and cable connections.

A qualified electrician or service technician must make the electrical connections to the boiler; all local electrical and building codes should be adhered to.

Main power and any remote wiring should be brought to the left side of the control panel and terminated at the appropriate terminals provided.

For specific information on your boiler electrical control system see **Figure 2-9** or refer to the Cleaver-Brooks wiring diagram provided with the boiler.

Notice

The blower signal wiring must be isolated from the blower power wiring and the high voltage ignition cables.

Figure 2-8 CFH wiring and cable connections

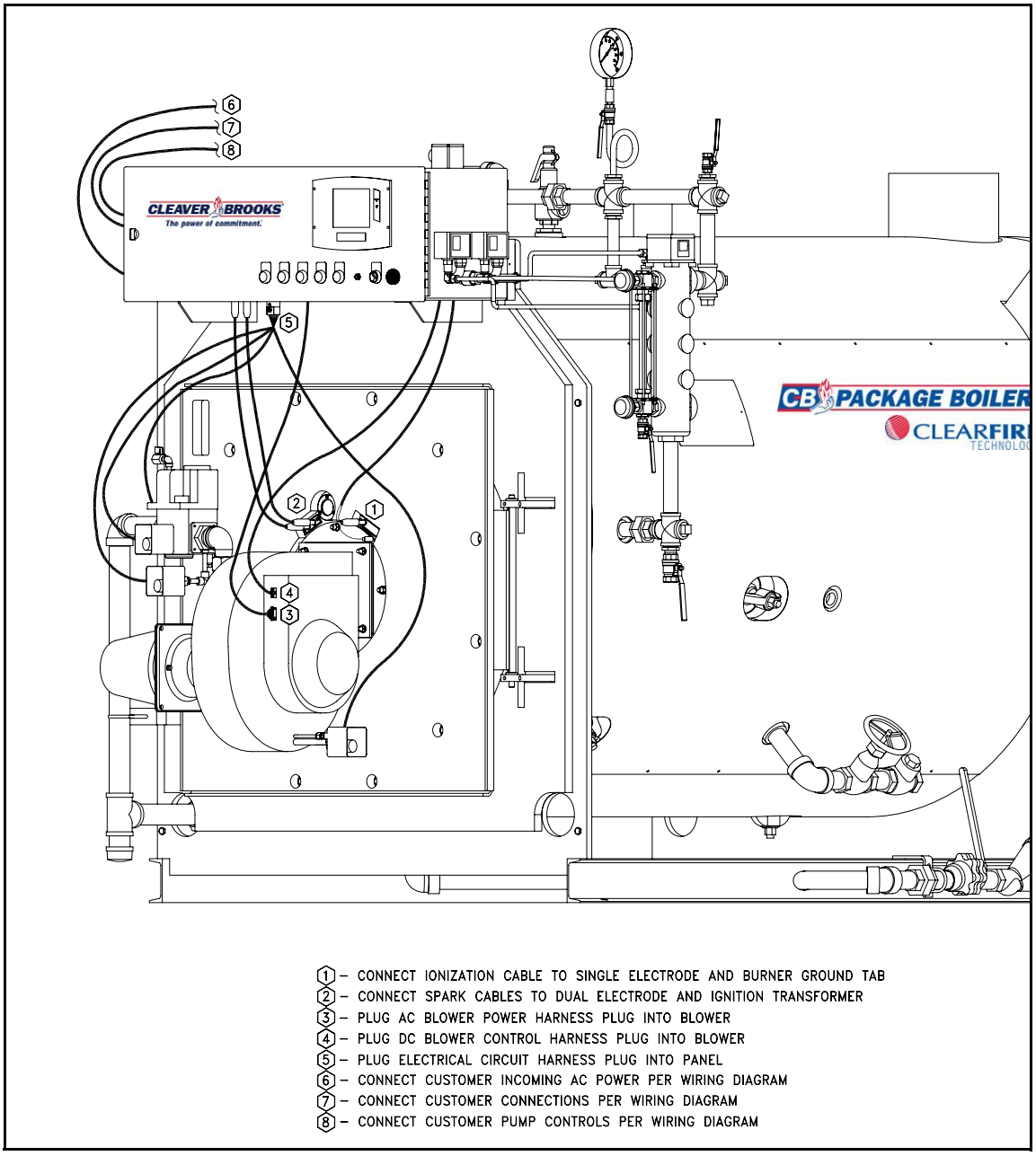


Figure 2-9 CFH Wiring Diagram, typical

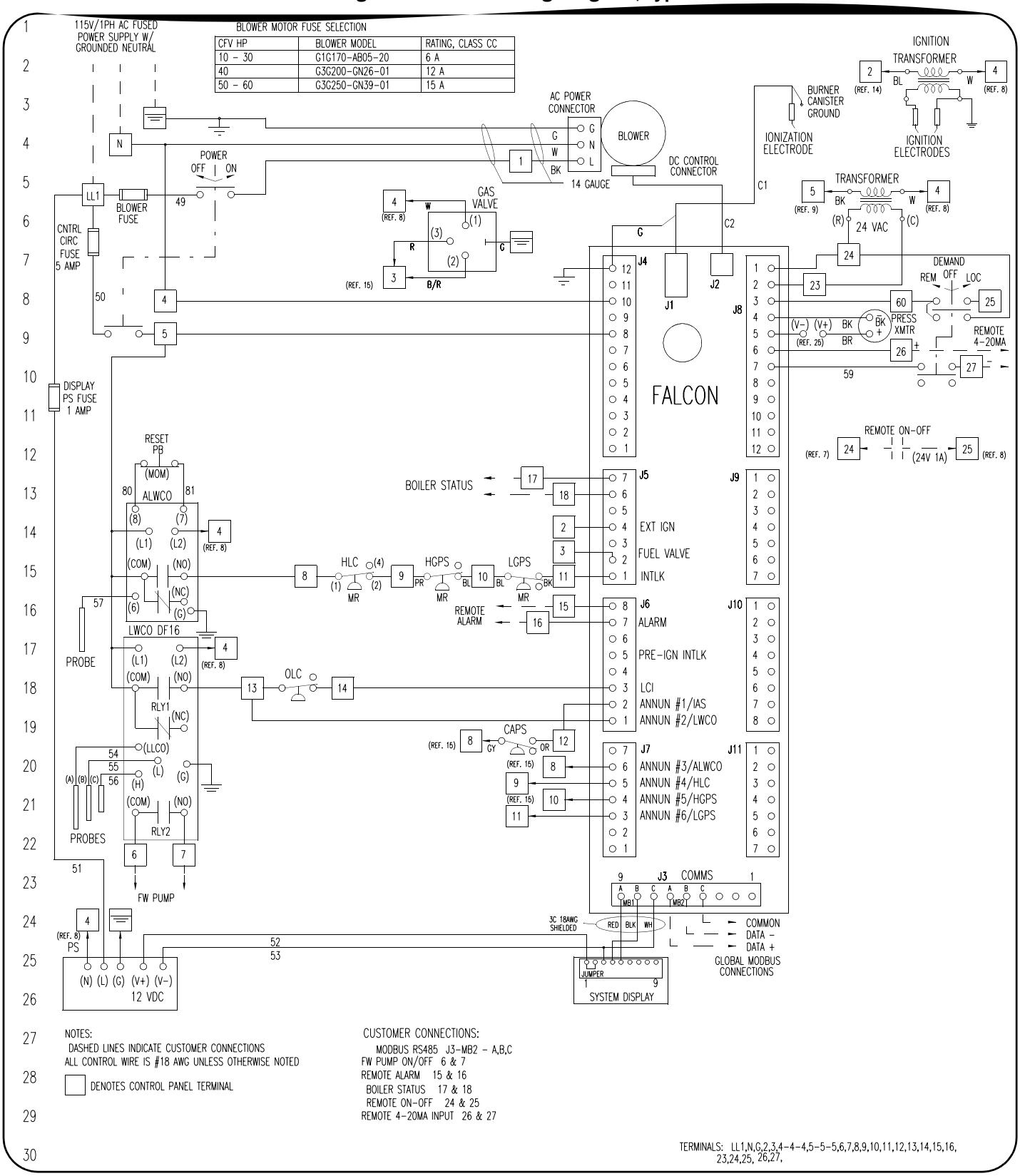
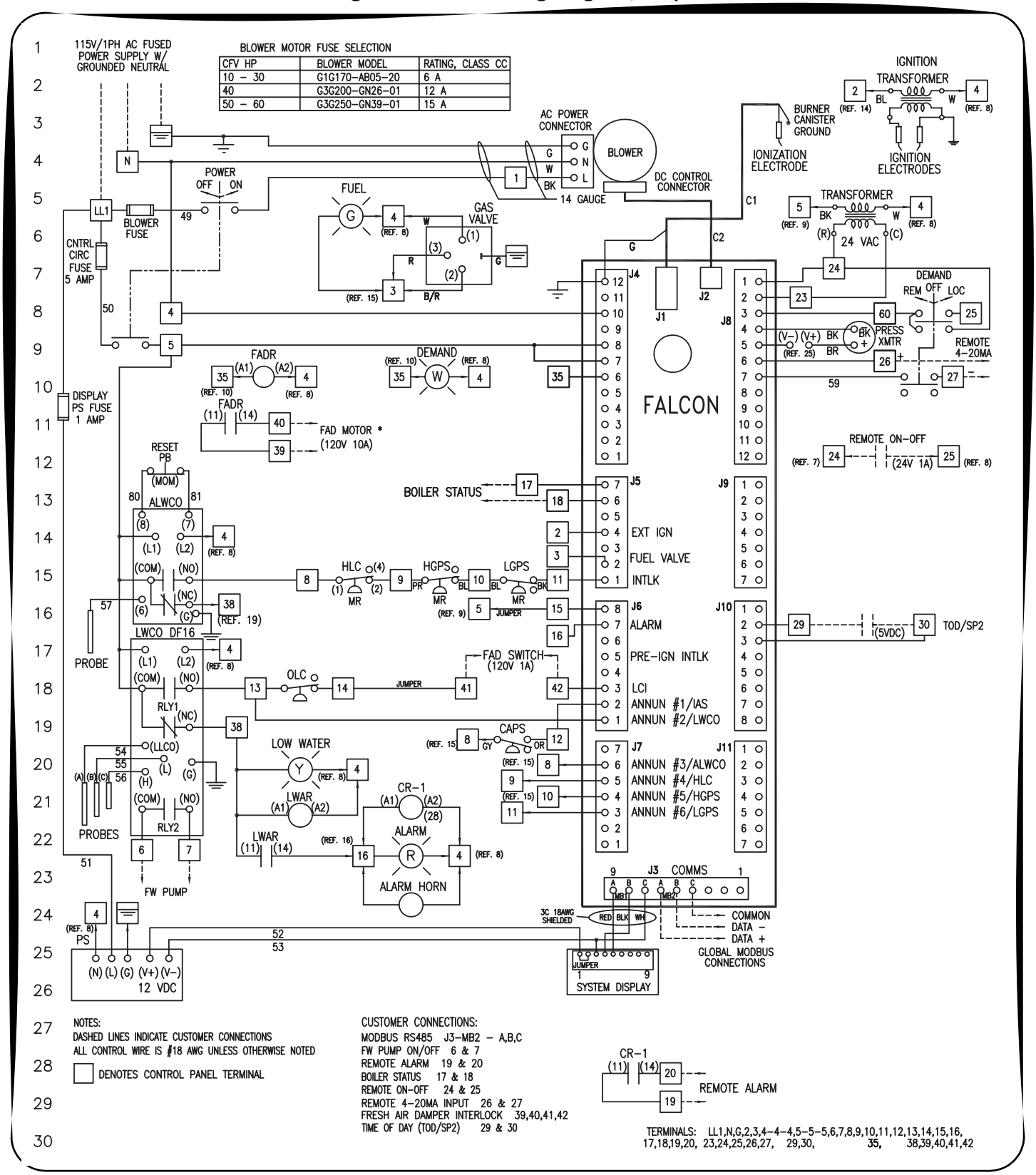


Figure 2-9 CFH Wiring Diagram, w/options



Chapter 3

Stack and Intake Vent Sizing and Installation

3.1-Venting Connections — General

Proper installation of flue gas exhaust venting is critical for the efficient and safe operation of the ClearFire boiler.

Definition of Appliance Categories

Boilers are divided into four categories based on the pressure and temperature produced in the exhaust stack and the likelihood of condensate production in the vent.

- Category I. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category II. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
- Category III. A boiler which operates with a positive vent pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category IV. A boiler which operates with a positive vent pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

The ClearFire-H should be considered a Category III boiler. Depending on the application, the specifying engineer may dictate alternative category flue venting as deemed appropriate.

Notice

For additional information on boiler categorization, see latest edition standard of National Fuel Gas Code or in Canada, the latest edition of CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

⚠ Warning

Contact the manufacturer of the vent material if there is any question about the boiler categorization and suitability of a vent material for application on a Category III vent system. Using improper venting materials can result in personal injury, death or property damage.

Notice

During winter months check the vent cap and make sure no blockage occurs from build up of snow or frozen condensate.

3.2-Vent Stack

The vent should be supported to maintain proper clearances from combustible materials.

Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

3.3-Vent Terminal Location

Give special attention to the location of the vent termination to avoid possibility of property damage or personal injury.

1. Combustion gases can form a white vapor plume in the winter. The plume could obstruct a window view if the termination is installed in close proximity to windows.
2. Prevailing winds could cause freezing of condensate and water/ ice buildup on building, plants or roof.
3. The bottom of the vent terminal and the air intake shall be located at least 24 inches above grade, including normal snow line.
4. Un-insulated single-wall metal vent pipe shall not be used outside in cold climates for venting combustion gas.
5. Through-the-wall vents for Category II and IV appliances and non-categorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of other equipment. Where local experience indicates that condensate is a problem with Category III appliances, this provision shall also apply.
6. Locate and guard vent termination to prevent accidental contact by people and pets.
7. DO NOT terminate vent in window well, alcove, stairwell or other recessed area, unless previously approved by local authority.
8. DO NOT terminate above any door, window, or gravity air intake. Condensate can freeze causing ice formations.
9. Locate or guard vent to prevent condensate from damaging exterior finishes. Use a 2' x 2' rust resistant sheet metal backing plate against brick or masonry surfaces.
10. DO NOT extend exposed stack pipe outside of building. In winter conditions condensate could freeze and block stack pipe.
11. Multiple direct stack installations require a four (4) foot clearance between the stack caps, center to center.

U.S. Installations- Refer to latest edition of the National Fuel Gas Code.

Vent termination requirements are as follows:

1. Vent must terminate at least four (4) feet below, four (4) feet horizontally, or one (1) foot above any door, window or gravity air inlet to the building.
2. The vent must not be less than seven (7) feet above grade when located adjacent to public walkways.
3. Terminate vent at least three (3) feet above any forced air inlet located within ten (10) feet.
4. Vent must terminate at least four (4) feet horizontally, and in no case above or below unless four (4) feet horizontal distance is maintained, from electric meters, gas meters, regulators, and relief equipment.
5. Terminate vent at least six (6) feet away from adjacent walls.
6. DO NOT terminate vent closer than five (5) feet below roof overhang.

Canada Installations- Refer to the latest edition of CAN/CGA-B149.1 and B149.2

A vent shall not terminate:

1. Directly above a paved sidewalk or driveway which is located between two single family dwellings and serves both dwellings.
2. Less than 7 ft. (2.13m) above a paved sidewalk or paved driveway located on public property.
3. Within 6 ft. (1.8m) of a mechanical air supply inlet to any building.
4. Above a meter/regulator assembly within 3 ft. (900mm) horizontally of the vertical center-line of the regulator.
5. Within 6 ft. (1.8m) if any gas service regulator vent outlet.
6. Less than 1 ft. (300mm) above grade level.
7. Within 3 ft. (1m) of a window or door which can be opened in any building, any non-mechanical air supply inlet to any building to the combustion air inlet of any other appliance.
8. Underneath a verandah, porch or deck, unless:
   A. The verandah, porch or deck is fully open on a minimum of two sides beneath the floor.
   B. the distance between the top of the vent termination and the underside of the verandah, porch or deck is greater than 1 ft. (30cm)

Note: For sealed vent installations where the air is piped in from outside, a protective screen on the air inlet termination elbow must be used to act as an inlet screen.

⚠ Warning

Examine the venting system at least once a year Check all joints and vent pipe connections for tightness, corrosion or deterioration.

Venting Installation Tips

Support piping:

- horizontal runs- at least every five (5) feet.
- vertical runs - use braces:
- under or near elbows

⚠ Caution

Observe the following to avoid personal injury or property damage:

- To cut nonmetallic vent pipe, use a fine-toothed hacksaw (34 teeth per inch).
- Do not use nonmetallic vent pipe or fittings that are cracked or damaged.
- Do not use nonmetallic vent fittings if they are cut or altered.
- Do not drill holes, or use screws or rivets, in nonmetallic vent pipe or fittings.

3.4-Horizontal Thru-Wall Venting Inside Air (Category III)

For boilers connected to gas vents or chimneys, vent installations shall be in accordance with Part 7, Venting of Equipment, of the latest edition of National Fuel Gas Code, or in Canada, the latest edition of CAN/CGA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

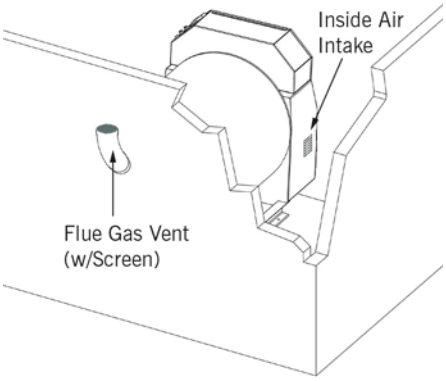


Figure 3-1 Horizontal Venting Thru-Wall Using Inside Air For Combustion

These installations utilize the boiler-mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed horizontally through the wall to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CGA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment.

The direct vent cap is not considered in the overall length of the venting system.

The vent must be installed to prevent the flue gas leakage. Care must be taken during assembly to insure that all joints are sealed properly and are airtight.

The vent must be installed to prevent the potential accumulation of condensate in the vent pipes. It is recommended that:

1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the vent terminal.
2. The vent be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

1. The vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In this case, an approved condensate trap must be installed per applicable codes.
2. The vent be insulated through the length of the horizontal run.

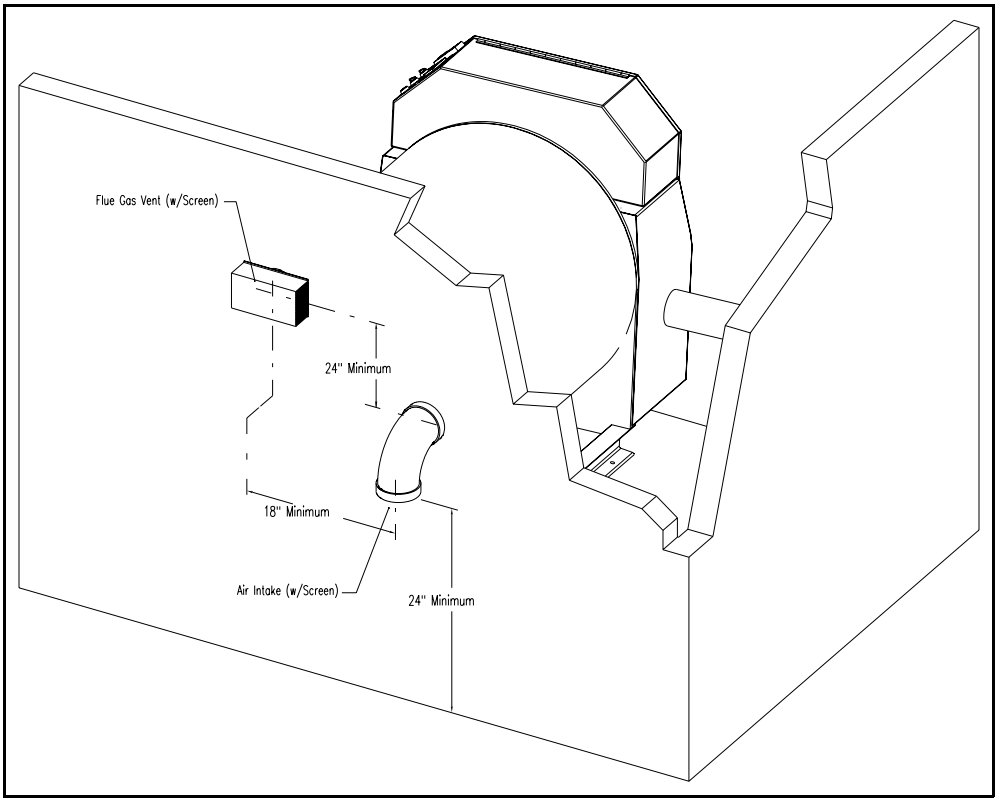


Figure 3-2 Horizontal Thru-wall Direct Venting System Category III Installation (Sealed Combustion Air/Stack Venting)

3.5-Horizontal Thru-wall Direct Vent

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion gases to the outside.

The sealed combustion air vent cap is not considered in the overall length of the venting system.

Care must be taken during assembly that all joints are sealed properly and are airtight for both the combustion air intake and the exhaust stack piping system.

The stack vent must be installed to prevent the potential accumulation of condensate in the stack pipes. It is recommended that:

1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the stack terminal.
2. The stack vent is to be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

1. The stack vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In

this case, an approved condensate trap must be installed per applicable codes.

2. The stack vent is to be insulated through the length of the horizontal run.

3.6-Horizontal Thru-wall Stack Vent Termination

The stack vent cap MUST be mounted on the exterior of the building. The stack vent cap cannot be installed in a well or below grade. The stack vent cap must be installed at least one (I) foot above ground level and above normal snow levels.

Multiple stack vent caps should be installed in the same horizontal plane with a three (3) foot clearance from the side of one stack cap to the side of the adjacent stack vent cap(s).

Combustion air supplied from outside must be free of particulate and chemical contaminants. To avoid a blocked flue condition, keep all the vent caps clear of snow, ice, leaves, debris, etc.

⚠ Caution

Multiple direct stack vent caps MUST NOT be installed with a combustion air inlet directly above a stack vent cap. This vertical spacing would allow the flue products from the stack vent cap to be pulled into the combustion air intake installed above. This type of installation can cause non warrantable problems with components and poor operation of the unit due to the recirculation of flue products.

3.7-Vertical Venting Inside Air

(Category III) Central Heating

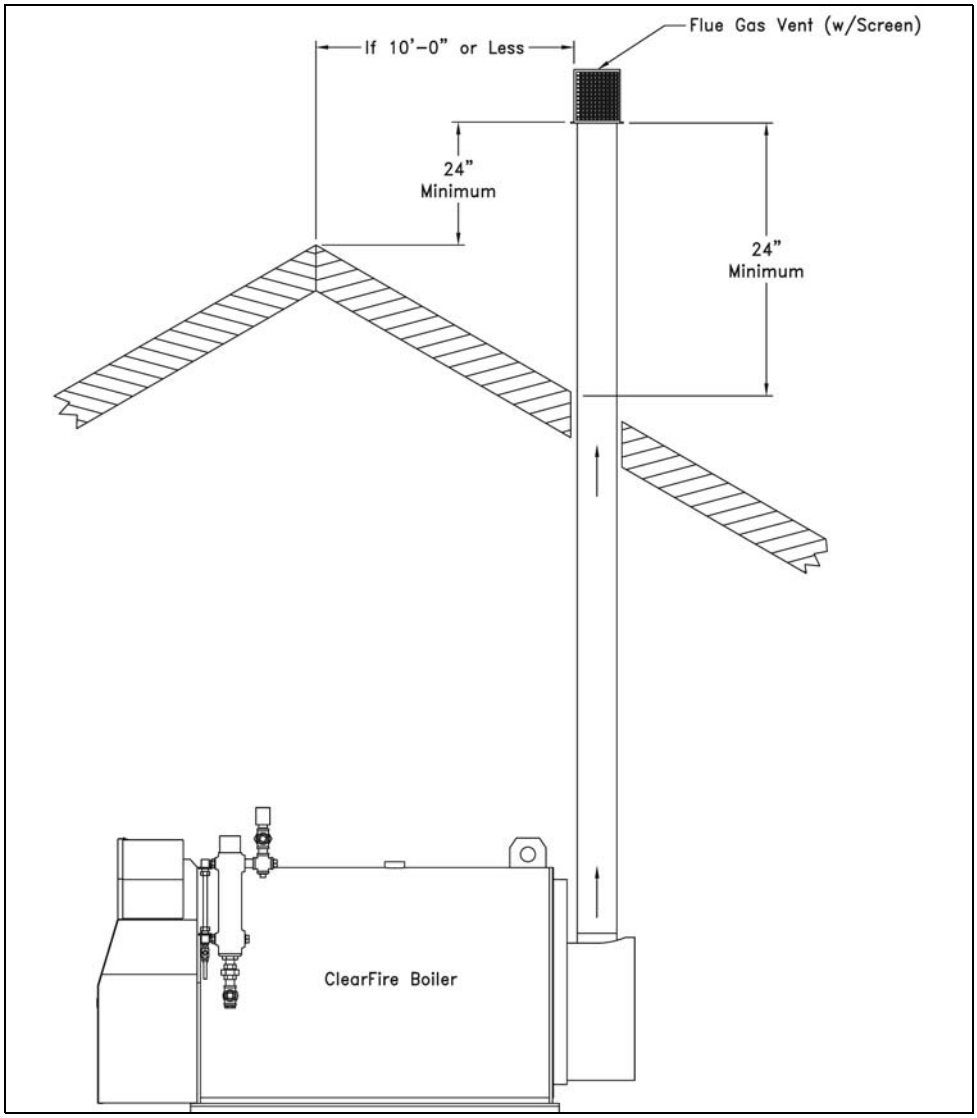


Figure 3-3 Vertical Stack with Inside Combustion Air

These installations utilize the boiler mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed vertically through the roof to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CGA-B 149.1 AND.2. Installation Code for Gas Burning Appliances and Equipment.

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run and an approved condensate trap must be installed per applicable codes.

⚠ Warning

The Stainless Steel non-restricted direct vent cap must be furnished in accordance with AGA/CGA requirements.

No substitutions of flue pipe or vent cap material are allowed. Such substitutions would jeopardize the safety and health of inhabitants.

3.8- Vertical Venting Direct Vent (Category III)

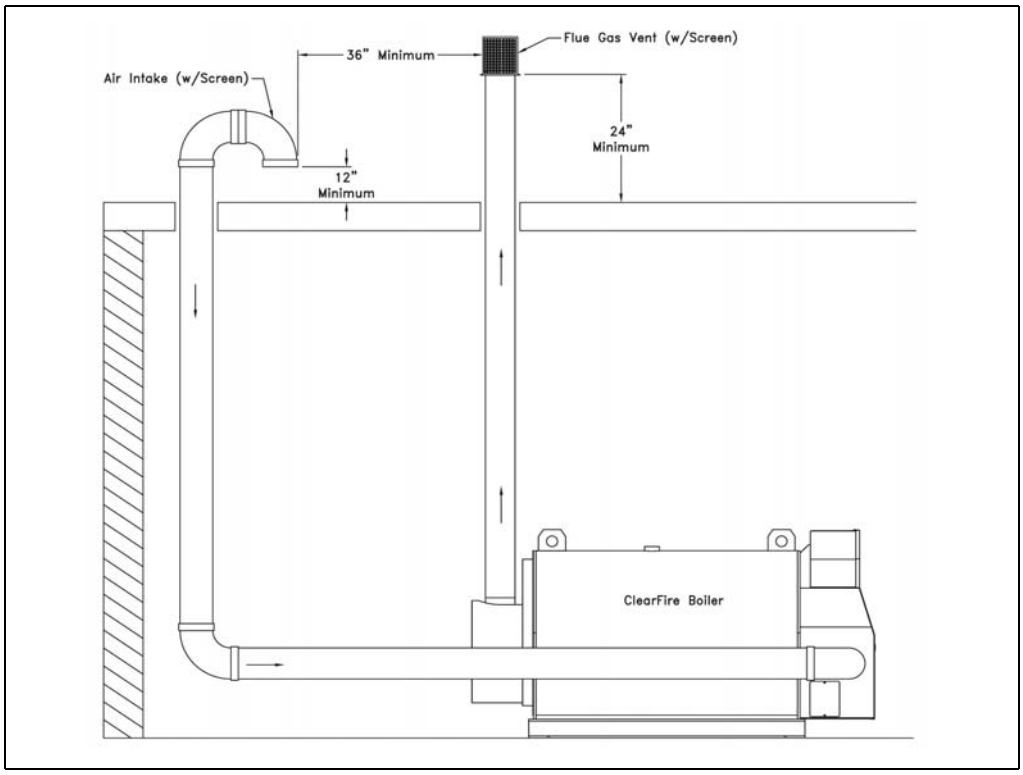


Figure 3-4 Vertical Stack with Direct Vent Combustion Air

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion products to the outside. A positive pressure venting system is required

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run; an approved condensate trap must be installed per applicable codes.

⚠ Warning

When using direct vent combustion in cold climates, special care must be taken to observe combustion air temperature limits. *Failure to follow this precaution may lead to equipment damage or unsafe operation.* See also 4.1 - Operating Conditions.

3.9-Combustion Air Requirements

The CFH burner must be supplied with an adequate volume of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust, or other contaminants that may be detrimental to the burner or boiler heating surfaces.

Combustion air can be supplied by means of conventional venting, that is, with combustion air drawn from the area immediately surrounding the boiler (boiler room is neutral or slightly positive pressure), or with a direct vent to outside the boiler room where air is drawn directly from the exterior of the building. Regardless of the method, all installations must comply with NFPA54 (the National Fuel Gas Code - NFGC) for U.S. installations and CAN/CSA B149.1 and B149.2 for Canadian installations.

Note: A boiler room exhaust fan is not recommended as this type of device can cause a negative pressure in the boiler room if using conventional air intake.

In accordance with NFPA 54, the required volume of indoor air shall be determined in accordance with the "Standard Method" or "Known Air Infiltration Rate Method". Where air infiltration rate is known to be less than 0.40 Air Changes per Hour, the Known Air Infiltration Rate Method shall be used (see the NFPA Handbook for additional information).

All Air From Inside the Building - If combustion air is drawn from inside the building (the mechanical equipment room does not receive air from outside via louvers or vent openings and the boiler is not equipped with direct vent) and the boiler is located in an unconfined space, use the following guidelines:

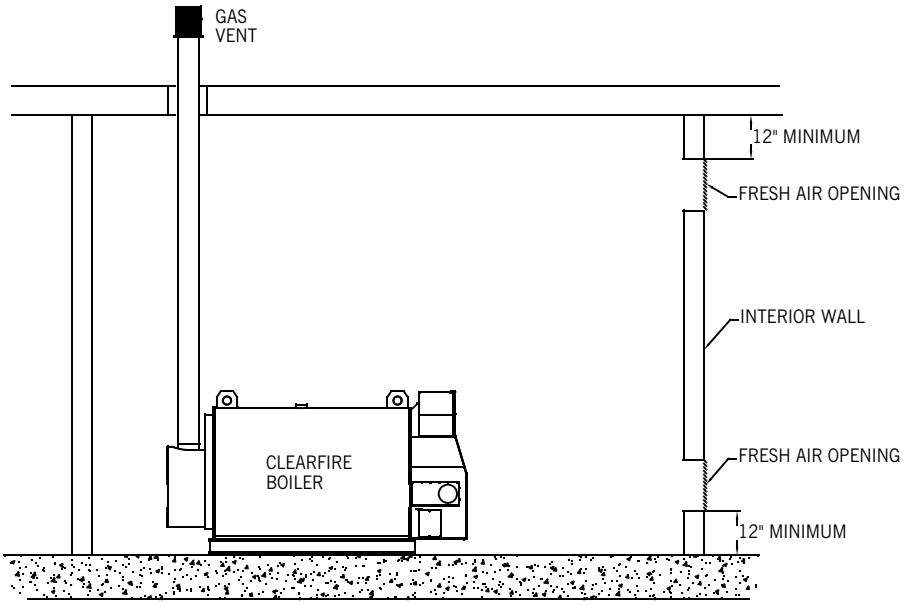
The mechanical equipment room must be provided with two permanent openings linked directly with additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50 cubic feet per 1,000 Btu per hour of aggregate input rating of all appliances installed in that space.

Each opening must have a minimum free area of one square inch per 1,000 Btu per hour of the total input rating of all gas utilizing equipment in the mechanical room.

One opening must terminate within twelve inches of the top, and one opening must terminate within twelve inches from the bottom of the room.

See Figure 3-5; refer to the NFGC for additional information.

Figure 3-5. Inside Air - Two Opening Method



All Air From Outdoors - If all combustion air will be received from outside the building (the mechanical room is linked with the outdoors), the following methods can be used:

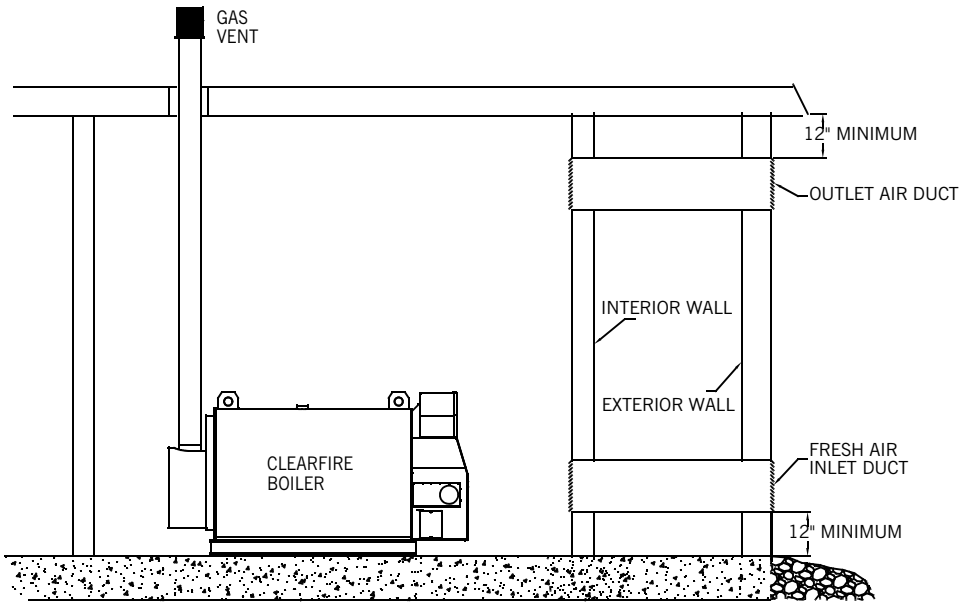
Two Opening Method (Figure 3-6) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

A. The opening must be linked directly or by ducts with the outdoors.

B. Each opening must have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the room, when the opening is directly linked to the outdoors or through vertical ducts.

C. The minimum free area required for horizontal ducts is one square inch per 2,000 Btu per hour of total input rating of all the equipment in the room.

Figure 3-6. Two Opening Ducted Method



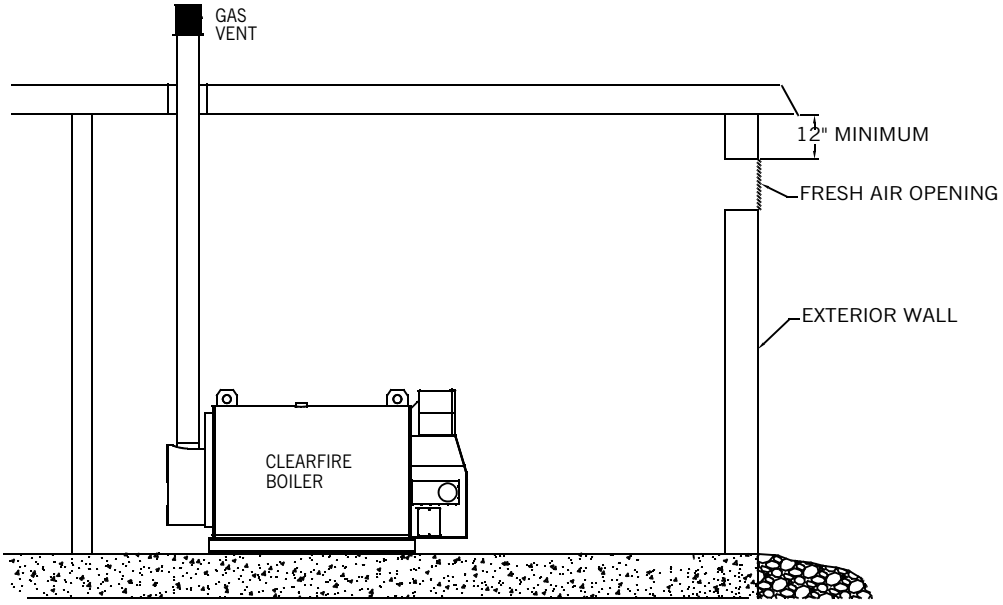
One Opening Method (Figure 3-7) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

A. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.

B. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 Btu's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the unconfined space.

C. Refer to the NFGC for additional information.

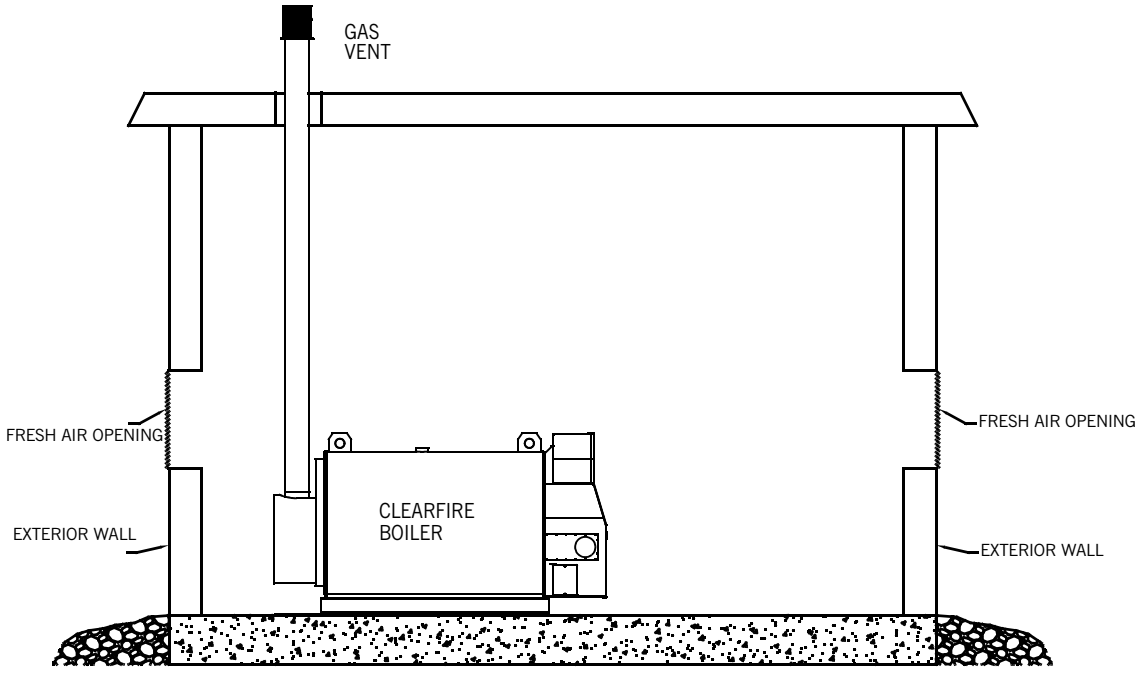
Figure 3-7. One Opening Method



Engineered Design - When determining boiler room air requirements for an unconfined space the "Engineered Design" method may be used. Following this method, consideration must be given to the size of the room, airflow and velocity of air as follows:

A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler (see Figure 3-8).

Figure 3-8. Engineered Method



B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.

C. A vent fan in the boiler room is not recommended as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.

D. It is forbidden to have the total area of the air supply openings at less than one square foot.

E. Size the openings by using the formula (Area in $ft^2 = cfm_a/fpm_a$), where cfm_a = cubic feet per minute of air; fpm_a = feet per minute of air.

F. Amount of air required (cfm):

1. Combustion Air = Maximum boiler horsepower (bhp) times 8 cfm.
2. Ventilation Air = Maximum boiler horsepower (bhp) times 2 cfm.
3. Total Air = 10 cfm per bhp (up to 1000 feet elevation, add 3% more per 1000 feet of added elevation).

G. Acceptable air velocity in the boiler room (fpm):

1. From floor to 7 feet high = 250 fpm.
2. Above 7 feet from boiler room floor = 500 fpm.

Example of required air openings (Engineered Method):

Determine the area of the boiler room air supply openings for (2) 60 horsepower Model CFH boilers at 750 feet elevation. The air openings will be 5 feet above the floor level.

Total boiler horsepower (bhp): 60 x 2 = 120 bhp

From F.3 above, total air required = 120 bhp x 10 = 1200 cfm.

Air Velocity: From G.1 above = 250 fpm.

Area required: From the formula in E above, 1200cfm/250fpm = 4.8 square feet total.

Area/Opening: 4.8 divided by 2 = 2.4 ft^2 per opening (2 required).

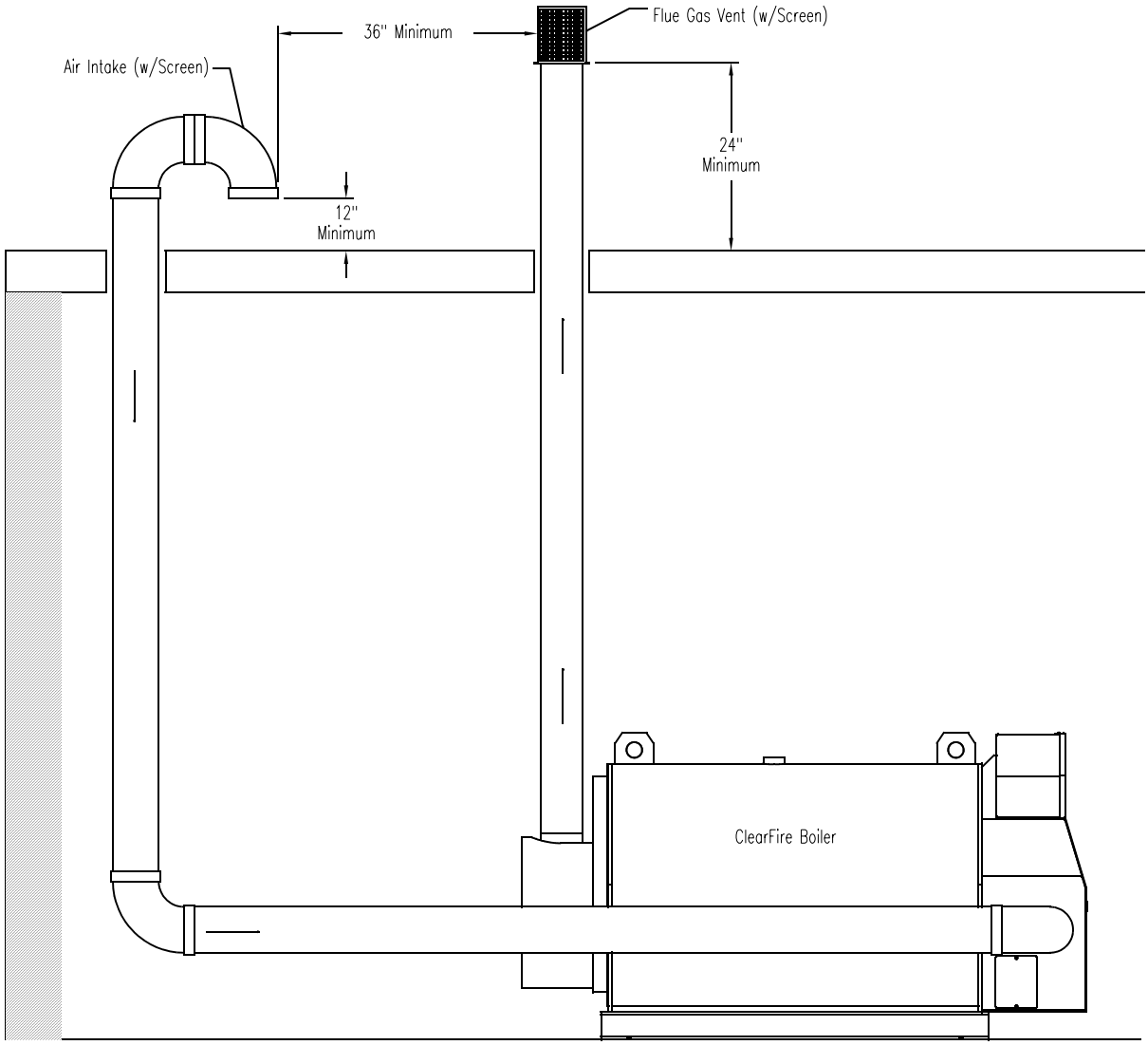
Notice

Consult local codes, which may supersede these requirements.

Direct Combustion Air - If combustion air will be drawn directly from the outside (sometimes referred to as "sealed combustion") by means of a duct connected directly to the burner air intake, use the following guidelines:

1. Install combustion air duct in accordance with local codes and the boiler operating and maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. Duct material can be PVC or metallic vent material. It should be air tight to prevent in leakage of air during operation.
4. Maximum pressure drop for the duct shall not exceed 0.25" w.c. negative. If this pressure drop is exceeded a larger size duct is recommended.
5. Multiple boilers may be connected to a single duct with take-offs to each boiler.
6. If the duct will run horizontally to an outside wall, it is recommended that the duct have a slight downward slope away from the burner intake to prevent collected moisture from draining into the burner connection.
7. If the outside air is dust-laden or the installation is near a heavily traveled roadway, it is recommended that an air filter be installed to prevent intake of contaminants that could accumulate on the burner canister.

Figure 3-9. Direct Vent Combustion



3.10-Maximum Vent Lengths

Boiler Size HP	Stack Connection - Flue diameter (in)	Combustion Air Duct diameter (in)	Maximum Flue Length (ft)	Maximum Air Intake Length (ft)
10	6	4	150	150
15	6	4	80	80
20	6	4	80	80
25	6	4	70	70
30	8	6	100	100
40	8	6	40	40
50	10	8	60	60
60	10	8	60	60

Chapter 4
Commissioning

⚠ Warning

The boiler and its gas connection must be leak tested before placing the boiler in operation.

⚠ Warning

When using direct vent combustion in cold climates, special care must be taken to observe combustion air temperature limits. *Failure to follow this precaution may lead to equipment damage or unsafe operation.*

4.1-Operating Conditions

- The installation site should be as free as possible from vibration, dust, and corrosive media
- The controllers should be located as far as possible from sources of electromagnetic fields, such as frequency converters or high-voltage ignition transformers
- Control panel must be connected to earth ground.

Boiler room ambient conditions	
Relative humidity	≤ 85-90%
Ambient temperature range	0 °C to 50 °C / 32°F to 122°F
Storage temperature range	-20 °C to 60 °C / -4°F to 140°F
Combustion Air Temperature	0 °C to 50 °C / 32°F to 122°F

NOTE: If hydrostatic testing is required on site, use water at 70 deg. F. Remove the safety valve prior to testing and replace when finished.

4.2-Filling Boiler

Open the vent valve and fill the boiler slowly to allow entrapped air to escape. Do not close the vent valve until water is visible in the gauge glass. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed.

4.3-Control Setpoints

Preliminary settings of the burner/boiler controls are necessary for the initial starting of the boiler. After the burner has been properly set, minor adjustments to these controls may be necessary for the particular installation. For initial starting, set the following controls accordingly:

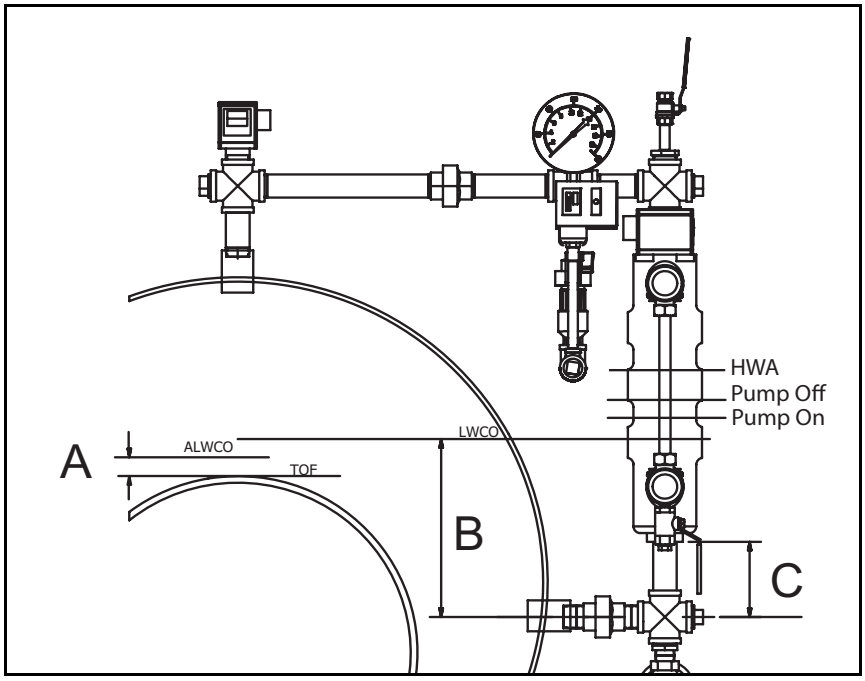
1. Operating and High Limit Controls - Set the dial @ maximum.
2. Combustion Air Proving Switch - Set the dial @ minimum.
4. Low Gas Pressure Switch - Set the dial @ minimum.
5. High Gas Pressure Switch - Set the dial @ maximum.

Depress all manual reset buttons for all controls prior to starting.

4.4-Water Level Controls

The LWCO/pump control and ALWCO control boards are located in the boiler control panel. The LWCO control is connected to conductance probes mounted within the external water column. This column has 4 probes used for the following functions: low water cut-off, pump on, pump off, and high water alarm (optional). The ALWCO control is connected to a conductance probe(s) in either a vessel-mounted probe head or optional external column. The ALWCO includes a panel mounted manual reset/test switch.

Figure 4-1 Control circuitry LWCO and ALWCO



	15# Steam				150# Steam			
	10-15 HP	20-25 HP	30-40 HP	50-60 HP	10-15 HP	20-25 HP	30-40 HP	50-60 HP
A	1 1/16" +1/16"; - 0"	1 1/16" +1/16"; - 0"	1 1/16" +1/16"; - 0"	1 1/16" +1/16"; - 0"	3 1/16" +1/16"; - 0"	3 1/16" +1/16"; - 0"	3 1/16" +1/16"; - 0"	3 1/16" +1/16"; - 0"
B	9"	10 1/16"	10 1/16"	11 3/4"	11"	12 1/16"	12 1/16"	13 3/4"
C	3 1/4" ± 1/16"	4 1/4" ± 1/16"	4 1/4" ± 1/16"	6" ± 1/16"	5 1/4" ± 1/16"	6 1/4" ± 1/16"	6 1/4" ± 1/16"	8" ± 1/16"

Probe Length Chart

15# Steam

	10-15Hp	20-25hp	30-40hp	50-60HP
Pump Off (Term "C")	8.25"	8.25" REF	8.25" REF.	8.25" Ref.
Pump On (Term "B")	9.25"	9.25" REF	9.25" REF.	9.25" Ref.
LWCO (Term "A")	10.5"	10.5" REF	10.5" REF.	10.5" Ref.
High Water Alarm (Term "D")	6.75"	6.75" REF	6.75" REF.	6.75" Ref.
ALWCO	16.125"	16.625" REF	19.25" REF.	18.5" Ref.

150# Steam

	10-15Hp	20-25hp	30-40hp	50-60HP
Pump Off (Term "C")	8.25"	8.25"REF.	8.25" REF.	8.25" Ref.
Pump On (Term "B")	9.25"	9.25"REF.	9.25" REF.	9.25" Ref.
LWCO (Term "A")	10.5"	10.5"REF.	10.5" REF.	10.5" Ref.
High Water Alarm (Term "D")	6.75"	6.75"REF.	6.75" REF.	6.75" Ref.
ALWCO	TBD at Test	TDB at Test	TBD at Test	TBD BY TEST

CFH Probe and WC Levels

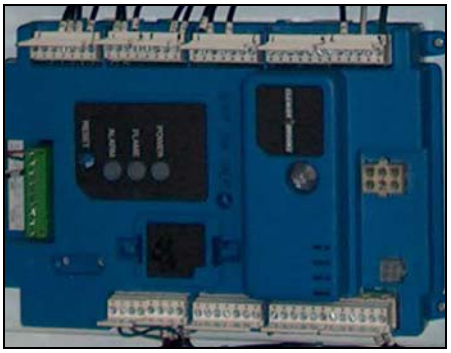


Figure 4-2 CB Falcon Controller

4.5-Model CFH Boiler / Burner Controls

The Model CFH boiler uses the CB Falcon boiler control system. Primary controller functions include:

- Flame supervision
- Burner sequencing
- PID Modulation control
- Operating LImit Control

Additional features include:

- User-friendly touchscreen interface
- Modbus communication capability
- Alarm/lockout messaging with history (last 15 messages)
- Annunciation
- Password protection of configurable parameters
- Time of Day (dual setpoint) control
- Remote reset
- (3) configurable pump relays
- Remote modulation/remote setpoint

Please review the tables within this Commissioning section to familiarize yourself with the functions and parameters of the Controller. Also see Appendices A and B for details on control configuration and operation.

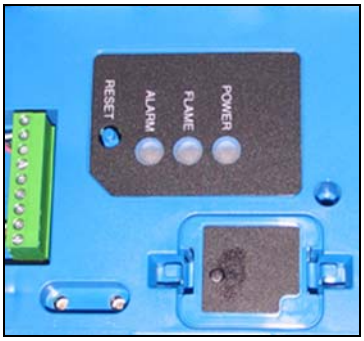


Figure 4-3 Controller status LEDs and reset button

⚠ Warning

The Model CFH is factory tested. Nevertheless, all burner safety controls should be checked upon installation, prior to initial firing. **Failure to verify burner control functioning could result in severe bodily injury or death.**

4.6-CB Falcon Display/Operator Interface

The CB Falcon display/operator interface is mounted at the right side of the control panel for convenient access to all operating controls.

Figure 4-4 CB Falcon Display/ Operator Interface

4.6.1 Display Setup

When power is turned on (Control Circuit-Blower Switch is ON), the Home page will appear on the CB Falcon display.

The boiler control icon should appear on this page with indication of current status of the control.

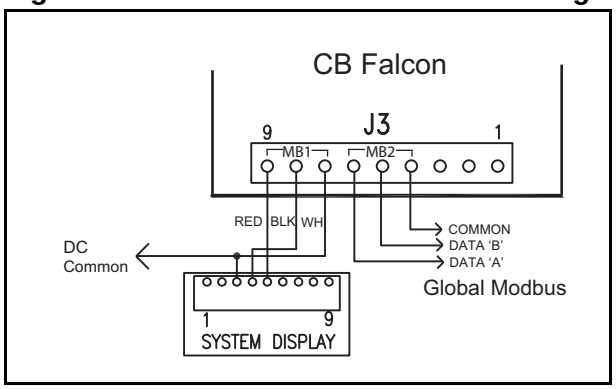
If no icon appears when the display is powered up:

- Verify that the controller is receiving power (open control panel and check the 'POWER' LED).
- Check the communication wiring between the controller and display; verify the following connections (also see Figure 4-5):

Falcon Controller (Terminal J3)	Display
MB1 A (RED)	Terminal 5
MB1 B (BLACK)	Terminal 4
MB1 C (WHITE)	Terminal 3

- Once communication is established, the display will synchronize with the controller.

Figure 4-5 Falcon communications wiring



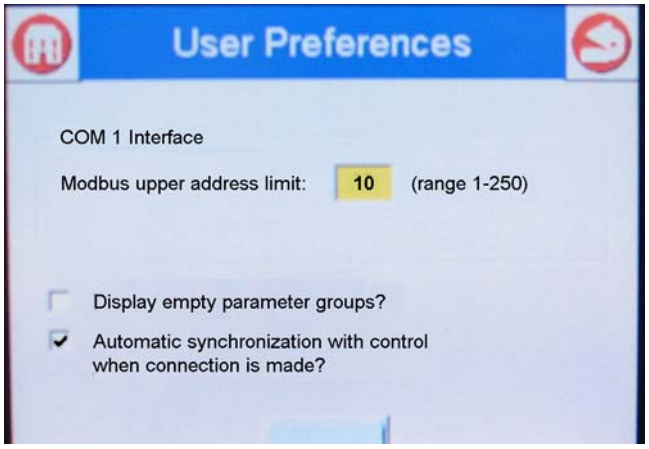
To access Advanced Setup options:

1) Press <Setup> on the Home Page.

2) Press <Advanced Setup> on the Setup Page.

After powering up the system for the first time it is recommended to change the following settings under Advanced Setup>User Preferences:

- Change "Modbus upper address limit" to 10.
- Check the "Automatic Synchronization" box. This will allow the display and controller to synchronize on power-up.



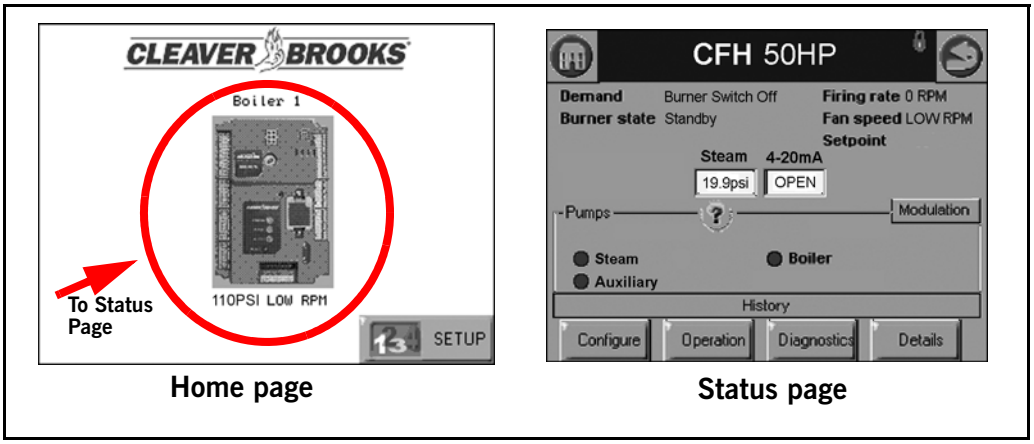
After making changes, press <Save> and cycle power to the controller.

Note: The "Home" icon at the upper left of the display screen always returns to the Home Page.

The "Back" icon at the upper right displays the previous screen.

4.6.2 Boiler Status

Pressing the Falcon icon on the Home Page takes the user to the Status page, which summarizes boiler status and allows navigation to the configuration, operational, and diagnostic areas of the CB Falcon interface.



Home page **Status page**

The **Demand** display will show one of the following:

Burner switch off
Off (burner switch on but no demand)
Steam

Burner state shows the currently active step in the burner operating sequence.

The central portion of the display can be toggled between the following:

Pumps shows the status of the pump/auxiliary relay contacts
Modulation shows fan speed RPM settings for Demand, Limited, and Override rates
Setpoints shows the ON, Modulation, and OFF setpoints.

The History banner is located near the bottom of the screen. Lockouts,Alerts, and Hold conditions will be annunciated here. Pressing the banner allows access to the Lockout and Alert history logs. In the case of a lockout alarm, the lockout can be cleared by navigating to the Lockout History and pressing <Clear Lockout>.

Note: Before clearing a lockout, first identify and correct the condition that caused the lockout.

The steam pressure modulation setpoints can be changed from the Status page by pressing the current displayed value. A numeric keypad will pop up, allowing entry of new values.

4.6.3 Boiler-Burner Operation

The Operation page displays the CB Falcon running operation, including setpoint and firing rate values. From this page the user can change setpoints, manually control the boiler's firing rate, manually turn pumps on, and view annunciation information. If a password is required to change any of the settings on this page, the user can press the Login button to enter the password.

The burner is enabled from this page by turning the <Burner switch> screen button ON (see Figure 4-5).

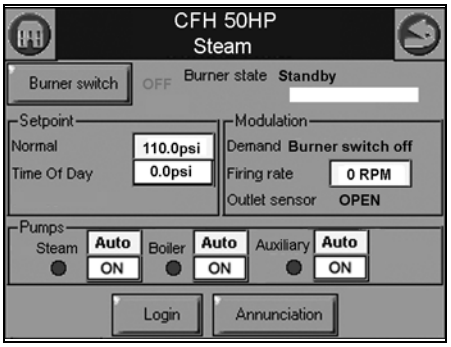
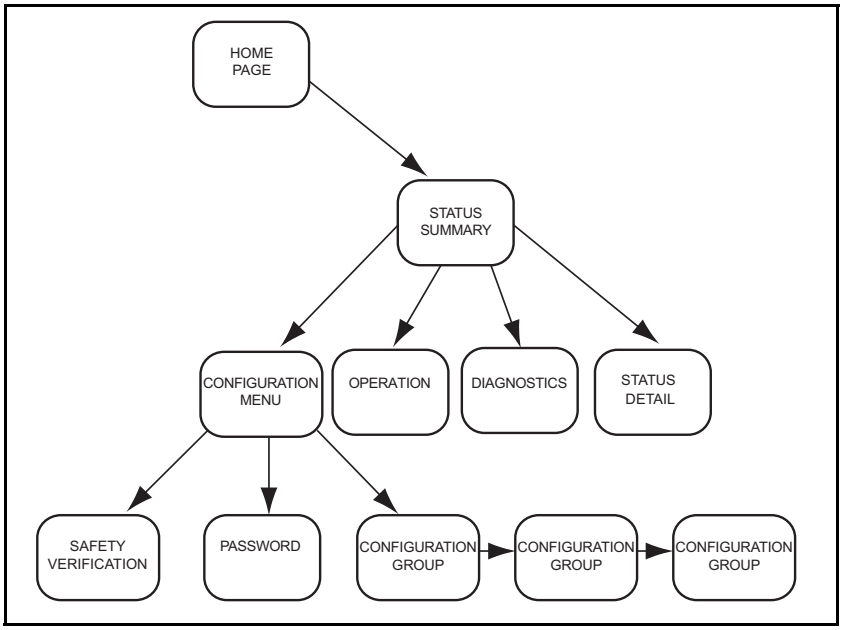


Figure 4-6 Operation Page



Falcon Display/Interface page flow

4.6.4 Lockouts, Holds, and Alerts

The CB Falcon implements two kinds of faults: lockouts and alerts. The Falcon will also annunciate hold conditions which automatically clear when the condition is removed or satisfied.

Lists of fault codes and alerts can be found in Appendix A, CB Falcon Control.

LOCKOUT

- A lockout causes the boiler control to shutdown and requires manual or remote reset to clear the lockout.
- Always causes alarm contacts to close.
- Logged in lockout history in controller non-volatile memory.

ALERT

- Any fault condition that is not a lockout is an alert. Examples include boiler control abnormal conditions, faults from non-safety functions, etc.
- Alerts never require manual intervention to reset them; they are for informational use only. Normal operation continues.

- Alerts are logged in a 15-item volatile alert history sorted in chronological order. Only one instance of each alert code occurs in the history, corresponding to the most recent occurrence of that alert.

HOLD

- A hold prevents the boiler from continuing until the hold condition is satisfied.
- Holds are not alarm conditions and are not logged in memory.

See also Chapter 5, Section E - **Troubleshooting**.

4.7-Controller Configuration

The CB Falcon controller should be factory configured for the specific CFH boiler model. Prior to starting the boiler, verify that the factory default settings are correct for your application. Please refer to CB default settings, Table 4-1, and make any changes at this time if needed.

The CB Falcon steam control parameter settings are organized into the following parameter groups:

- System ID & access
- Steam configuration
- Modulation configuration
- Pump configuration
- Statistics configuration
- Stack limit (future)
- Annunciation
- Burner control interlocks
- Burner control timings & rates
- Burner control ignition
- Burner control flame failure
- System configuration
- Fan configuration
- Lead lag configuration (future)

Table 4-1 CB Falcon factory parameter settings - Model CFH

Parameter Group	Parameter Name	Access	Min. Range	Default Setting	Max. Range	Parameter Units	Installation Setting
System ID & Access	Boiler Name	Service		Boiler 1			
System ID & Access	Installation data	Service		MB00xxxx			
System ID & Access	Installer password	Service		9220			
System ID & Access	Modbus address	Service	0	1	250		
System ID & Access	Factory data	Read Only					
Steam Configuration	Steam enable	User		Enabled			
Steam Configuration	Steam demand source	OEM		Sensor & Stat terminal			
Steam Configuration	Steam setpoint	User	0	10 or 100	150	psi	
Steam Configuration	Steam TOD setpoint	Service	0	0	142.5	psi	
Steam Configuration	Minimum steam pressure	Service	0	0	142.5	psi	
Steam Configuration	Steam off hysteresis	Service	0	3	60	psi	
Steam Configuration	Steam on hysteresis	Service	0	0	60	psi	
Steam Configuration	Steam hysteresis step time	Service	0	0	15	minute	
Steam Configuration	Steam P gain	Service	0	50	400		
Steam Configuration	Steam I gain	Service	0	50	400		
Steam Configuration	Steam D gain	Service	0	0	400		
Steam Configuration	Steam 4-20mA remote control	Service		Modulation			
Modulation Configuration	Maximum mod. rate	Service	2000	SEE TABLE 4-2	6500	RPM	
Modulation Configuration	Minimum mod. rate	Service	800	SEE TABLE 4-2	3000	RPM	
Modulation Configuration	Steam forced rate time	Service	0	0	240	minutes	
Modulation Configuration	Steam forced rate	Service	1000	2000	6500	RPM	
Modulation Configuration	Analog input hysteresis	Service	0	0.1	20	mA	
Modulation Configuration*	Burner switch	User		Off			
Modulation Configuration*	Firing rate control	User		Auto			
Modulation Configuration*	Manual firing rate	User	800	2000	6500	RPM	
Pump Configuration	Auxiliary pump control	Service		Auto			
Pump Configuration	Auxiliary pump on when	Service		CH pump is on			
Pump Configuration	Auxiliary pump output	Service		Pump A			
Pump Configuration	Boiler pump control	Service		Auto			
Pump Configuration	Boiler pump output	Service		No assignment			
Pump Configuration	Boiler pump overrun time	Service	0	1	480	minute	
Pump Configuration	CH pump control	Service		Auto			
Pump Configuration	CH pump output	Service		Pump C			
Pump Configuration	CH pump overrun time	Service	0	1	480	minute	
Pump Configuration	System pump control	Service		Auto			
Pump Configuration	System pump output	Service		No assignment			
Pump Configuration	System pump overrun time	Service	0	1	480	minute	
Pump Configuration	Pump exercise interval	Service	0	0	480	minute	
Pump Configuration	Pump exercise time	Service	0	0	30	days	
Statistics Configuration	Burner cycle count	Read Only	0		999,999		
Statistics Configuration	Burner run time	Read Only	0		999,999		
Statistics Configuration	CH pump cycle count	Read Only	0		999,999		

Table 4-1 CB Falcon factory parameter settings - Model CFH (Continued)

Statistics Configuration	System pump cycle count	Read Only	0		999,999		
Statistics Configuration	Boiler pump cycle count	Read Only	0		999,999		
Statistics Configuration	Auxiliary pump cycle count	Read Only	0		999,999		
Stack Limit	Stack limit enable	Service		Disabled			
Stack Limit	Stack limit delay	Service	0	5	15	minutes	
Stack Limit	Stack limit response	Service		Lockout			
Stack Limit	Stack limit setpoint	Service	32	Unconfigured	266	°F	
Annunciation Configuration	Annunciator 1 location	OEM		Other			
Annunciation Configuration	Annunciator 1 short name	OEM		IAS			
Annunciation Configuration	Annunciator 1 long name	OEM		Interrupted AIR SWITCH			
Annunciation Configuration	Annunciator 2 location	Service		LCI			
Annunciation Configuration	Annunciator 2 short name	Service		A2			
Annunciation Configuration	Annunciator 2 long name	Service		LOW WATER			
Annunciation Configuration	Annunciator 3 location	OEM		ILK			
Annunciation Configuration	Annunciator 3 short name	OEM		A3			
Annunciation Configuration	Annunciator 3 long name	OEM		AUX LOW WATER			
Annunciation Configuration	Annunciator 4 location	OEM		ILK			
Annunciation Configuration	Annunciator 4 short name	OEM		A4			
Annunciation Configuration	Annunciator 4 long name	OEM		HIGH LIMIT			
Annunciation Configuration	Annunciator 5 location	OEM		ILK			
Annunciation Configuration	Annunciator 5 short name	OEM		A5			
Annunciation Configuration	Annunciator 5 long name	OEM		HIGH GAS PRESSURE			
Annunciation Configuration	Annunciator 6 location	OEM		ILK			
Annunciation Configuration	Annunciator 6 short name	OEM		A6			
Annunciation Configuration	Annunciator 6 long name	OEM		LOW GAS PRESSURE			
Annunciation Configuration	Annunciator 7 location	Service		Unused			
Annunciation Configuration	Annunciator 7 short name	Service		A7			
Annunciation Configuration	Annunciator 7 long name	Service		Annunciator7			
Annunciation Configuration	Annunciator 8 location	Service		Unused			
Annunciation Configuration	Annunciator 8 short name	Service		A8			
Annunciation Configuration	Annunciator 8 long name	Service		Annunciator8			
Annunciation Configuration	PII short name	OEM		PII			
Annunciation Configuration	PII long name	OEM		Pre-Ignition ILK			
Annunciation Configuration	LCI short name	OEM		LCI			
Annunciation Configuration	LCI long name	OEM		LCI - Limit Circuit Input			
Annunciation Configuration	ILK short name	OEM		ILK			
Annunciation Configuration	ILK long name	OEM		ILK - Lockout Interlock			

Table 4-1 CB Falcon factory parameter settings - Model CFH (Continued)

Burner Control Interlocks	PII enable	Service		Disabled			
Burner Control Interlocks	LCI enable	Read Only		Enabled			
Burner Control Interlocks	Interrupted air switch (IAS) enable	Read Only		Enable during purge & ignition			
Burner Control Interlocks	ILK/IAS open response	Read Only		Lockout			
Burner Control Interlocks	Purge rate proving	OEM		Fan speed			
Burner Control Interlocks	Lightoff rate proving	OEM		Fan speed			
Burner Control Timings & Rates	Prepurge rate	OEM	3000	4000	6500	RPM	
Burner Control Timings & Rates	Prepurge time	OEM	30	30	900	seconds	
Burner Control Timings & Rates	Run stabilization time	Service	0	5	900	seconds	
Burner Control Timings & Rates	Standby rate	Service	0	1500	3000	RPM	
Burner Control Timings & Rates	Postpurge rate	Service	1000	2000	6500	RPM	
Burner Control Timings & Rates	Postpurge time	Service	15	15	900	seconds	
Burner Control Ignition	Pilot test hold	Service		OFF			
Burner Control Ignition	Lightoff rate	Service	1000	SEE TABLE 4-2	3000	RPM	
Burner Control Ignition	Preignition time	Service	0	0	900	seconds	
Burner Control Ignition	Flame threshold	OEM	0.5	0.8	5	V or A	
Burner Control Ignition	Pilot Flame Est. Period (PFEP)	Read Only		4		seconds	
Burner Control Flame Failure	Ignite failure delay	Service		0		seconds	
Burner Control Flame Failure	Ignite failure response	Service		Lockout			
Burner Control Flame Failure	Ignite failure retries	Service		Unknown			
Burner Control Flame Failure	Run flame failure response	Read Only		Lockout			
System Configuration	Modulation Output	Read Only		Fan PWM			
System Configuration	Temperature units	Service		Fahrenheit			
System Configuration	Antishort cycle time	Service	0	1	480	minutes	
System Configuration	Alarm silence time	Service	0	0	60	minutes	
System Configuration	Inlet sensor type	OEM		0-15 or 0-150 psi			
System Configuration	Stack sensor type	Service		Unconfigured			
System Configuration	4-20mA sensor type	Service		4-20mA			
Fan Configuration	Absolute max. fan speed	Read Only	2000	6500	6500	RPM	
Fan Configuration	Absolute min. fan speed	Read Only	800	900	3000	RPM	
Fan Configuration	Fan gain up	Service	0	30	100		
Fan Configuration	Fan gain down	Service	0	30	100		
Fan Configuration	Fan min. duty cycle	Service	5	10	100	%	
Fan Configuration	Pulses per revolution	Read Only	2	3	3		
Fan Configuration	PWM frequency	Read Only	1000	3000	4000	Hz	
Fan Configuration	Slow down ramp	Service	0	0	1000	RPM/sec	
Fan Configuration	Speed up ramp	Service	0	0	1000	RPM/sec	
Lead Lag Configuration	Lead Lag slave enable	Service		Disabled			
Lead Lag Configuration	Fan rate during off cycle	Service	900	1500	6500	RPM	

* Modulation parameters that are located on "OPERATION" screen.

** Shaded parameters are Safety Parameters and require Verification and manual reset of the control prior to operation. Please see below, "Changing parameter settings".

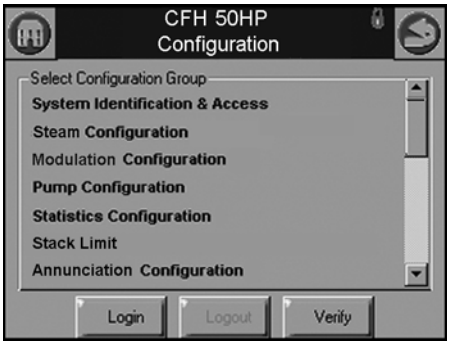


Figure 4-7 Configuration Menu

4.7.1 Changing Parameter Settings

To access the CB Falcon configuration menu, press <Configure> on the Status page.

From the Configuration Menu (Figure 4-6), select the parameter group to be changed.

Some parameters require a password entry before allowing changes. The <Login> button will appear when any password-protected parameter is displayed on the screen. The default service level password is **9220**.

Press <Login> to display the alphanumeric keyboard. Enter password and press <OK>

Change parameter settings by selecting the parameter on the page. A dialog box appears with controls allowing the user to change the selected value. Press <Clear> to clear the current value. Enter the new value and press <OK> (press <Cancel> to leave the parameter unchanged).

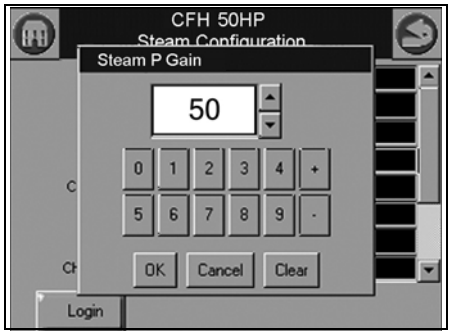


Figure 4-8 Parameter change dialog

Safety Parameters

When configuring safety parameters an additional verification step is required to confirm the changes.

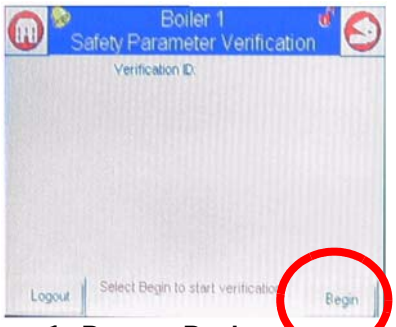
1. When a safety parameter is changed, the Safety Parameter Verification page will appear. Press <Begin> to continue.
2. The affected parameter group will be displayed, showing current parameter values and a prompt, “Are these parameters set to proper values?”. Press <Yes> to continue.
3. The screen will indicate RESET DEVICE NOW. Open the control panel and press the RESET button on the CB Falcon controller (press and hold for 3 seconds).

RESET must be pressed within 30 seconds to save changes.

Note: When changing multiple safety parameters, the verification steps do not need to be completed immediately.

See Appendix for complete instructions on using the CB Falcon Display/Interface.

Confirming Safety Parameter changes



1. Press <Begin>

3. Reset CB Falcon

2. Press <Yes>

4.7.2 Program Module

CB Falcon parameter information (non-safety parameters only) can be uploaded/downloaded using the optional Program Module. When the Program Module is installed, its features are accessible from the Falcon Setup page. See Appendices for instructions.

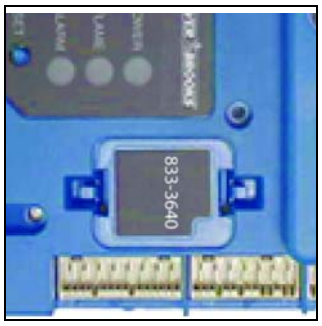


Figure 4-9 Falcon Program Module

4.8-Burner Sequence

In addition to providing modulation control, the CB Falcon is responsible for flame supervision and burner sequencing.

The CFH boiler uses direct spark ignition (no gas pilot) to light the main flame. Flame sensing is accomplished with a flame rod, or ionization electrode.

Basic burner sequencing:

1. Heat request detected (Setpoint minus On Hysteresis); LCI limits and steam demand detected (terminals J6 3 and J8 3).
2. The CH pump is switched on (relay contact closes).

3. After a system Safe Start Check, the Blower (combustion air fan) is started
4. After the ILK input is energized - 10 sec. allowed for IAS input (combustion air proving) to energize - and the purge rate proving fan RPM is achieved, prepurge time is started.
5. When 30 sec. purge time is complete, the fan RPM is changed to the lightoff speed.
6. As soon as the fan-rpm is equal to the light-off RPM , the Trial for Ignition or Pre-Ignition Time is started (depending on configuration). If enabled, Pre-Ignition Time will energize the ignitor and check for flame prior to TFI.
7. Trial for Ignition (4 sec).
8. The ignitor and the gas valve are energized.
9. The ignitor is turned off at the end of the direct burner ignition period.
10. The fan is kept at the lightoff rate during the stabilization time.
11. If either CH Forced Rate or Slow Start is enabled and the water is colder than the threshold, the fan is switched to minimum RPM before the release to modulation.
12. Release to modulation.
13. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new CH-request may be blocked temporarily for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time (if enabled).
16. At the end of the pump overrun time the pump will be switched off.

4.9-Fan Speed Settings

The boiler firing rate is determined by the combustion air fan speed. Accordingly, fan speed settings may have to be modified for the particular application, for high altitudes, or when using direct vent combustion. **Table 4-2** provides the default fan speed settings in typical applications for the various boiler sizes. To allow safe modulation through the firing range, these parameters should be initially set to the recommended speeds. Please contact your authorized Cleaver-Brooks representative for proper settings in high altitude and direct vent combustion applications.

Table 4-2 Fan Speed Settings

Configuration Group	Parameter	10HP	15HP	20HP	25HP	30HP	40HP	50HP	60HP
Modulation	Max. Speed - High Fire	5800	6200	4800	5500	5700	5500	4800	4800
Modulation	Min. Speed - Low Fire	1900	1500	1200	1400	1500	1100	1000	1000
Burner Control Ignition	Ignition Fan Speed (Light-off Rate)	2400	2400	2000	2200	2200	1800	1800	1800

4.10-Operating and High Limit Controls

The operating (OLC) and high pressure limit (HLC) controls are externally mounted to the control panel. The setting of the OLC should be slightly higher than the configured set point plus the hysteresis off value set in the CB Falcon control. The setting of the HLC should be slightly higher than the OLC. For example:

CB Falcon set point = 100.0 psig, Hysteresis Off = 5.0 psi

OLC could be set to 110 psig, HLC set to 120 psig

Specific settings are determined by application and system control scheme.

After all settings are verified and with boiler controls at proper settings, the boiler can be connected to power and burner commissioning can begin.

Figure 4-10 Limit Controls

4.11-Initial start-up procedure

4.11.1 Gas Train and Piping

The ClearFire burner is equipped with a combination servo-regulated gas valve and venturi mixing unit. The gas valve consists of a single body with dual solenoid shut off valves, filter screen, and a built-in constant pressure gas/air servo controller. The blower speed is controlled by the CB Falcon with airflow directly proportional to the speed of the fan. The airflow creates a drop in pressure due to the venturi effect. The modulating controller of the valve actuator senses air pressure change and brings about a change in the gas flow proportional to the air flow. The gas follows the airflow in a set ratio, so that fuel always matches the air as the burner firing rate increases or decreases.

Warning

Before initial startup, check for blockages in the flue venting or vent terminations. Inspect the burner and furnace for any contamination or blockages.

Note: To measure supply pressure at the CFH gas valve, use the test port on the valve inlet flange. Do not use the leak test cocks to measure gas pressure.

1. Check the gas delivery system to be sure it is properly piped and wired. Refer to gas piping guidelines in Installation section.
2. Review available gas pressure to assure it is compatible with the main gas regulators upstream of the Model CFH gas train. **Note:** The maximum rated inlet pressure to the CFH gas train is 1 psig (28" WC). An upstream regulator and overpressure protection are required if building supply gas pressure is greater than 1 psig.
3. To bleed air from the supply pipe, open the manual gas shut off valve upstream of the burner gas train and bleed air from the piping by loosening the union in the upstream piping or opening the inlet gas test cock.
4. The burner and its gas connection must be leak tested before placing the boiler into operation.
5. Gas Pressure Regulator - Using the adjusting screw on the main gas regulator, adjust the inlet pressure to the recommended levels in **Table 4-3**.

Figure 4-11 Blower Housing, Gas Valve & Mixing Venturi

Table 4-3 Model CFH Gas Pressure Requirements

Gas Train Pressure	Min. (“WC)	Max. (“WC)
10HP	7.2”	28”
15HP	7.3”	28”
20HP	7.5”	28”
25HP	7.7”	28”
30HP	8.8”	28”
40HP	11.0”	28”
50HP	9.5	28”
60HP	10.0	28”

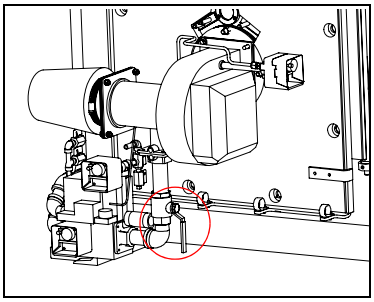


Figure 4-13 Manual Gas Shut-Off (downstream)

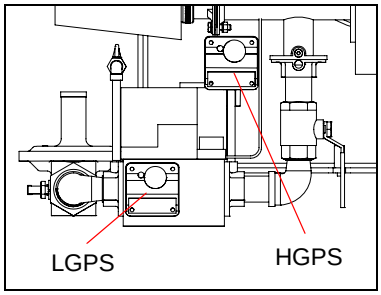


Figure 4-14 Low and High Gas Pressure Switches

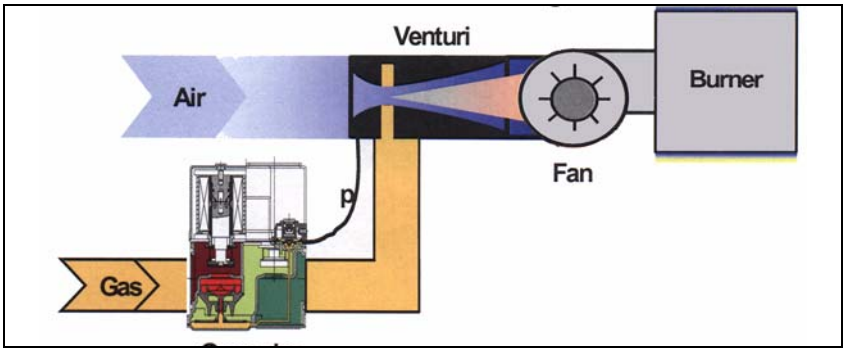


Figure 4-12 Premix Burner Technology - Full Modulation

4.11.2 Power-Up

1. Ensure blower motor is properly wired for the available power supply.
2. Verify the voltage (control voltage is 115V-1Ph.-60Hz) to ensure it is within specifications.
3. To power the control and blower circuits, turn the CC-Blower switch to the “ON” position.
4. When the control and blower circuits are powered, commissioning may begin. Turn the Demand switch to the “LOC” (Local) position. On the Operation page, the Demand status should indicate “Steam”. The boiler will now start if the LCI and ILK circuits are satisfied and the steam pressure is below the current On point.

4.11.3 Operation Check: Gas Valve, Gas Pressure Switches, and Combustion Air Proving Switch

Before initial firing of the burner, the gas valve, Low Gas Pressure Switch (LGPS), High Gas Pressure Switch (HGPS), and Combustion Air Proving Switch (CAPS) should be checked for proper operation.

- Before proceeding, review **Section 4.3 - Control Setpoints** for initial LGPS, HGPS, and CAPS settings.

Note: Close the downstream manual gas shut-off valve before checking pressure switches and CAPS.

While performing the following safety checks, use the CB Falcon Annunciation screen to monitor the status of the circuits involved. Press <Annunciation> on the Operation page to access this screen.

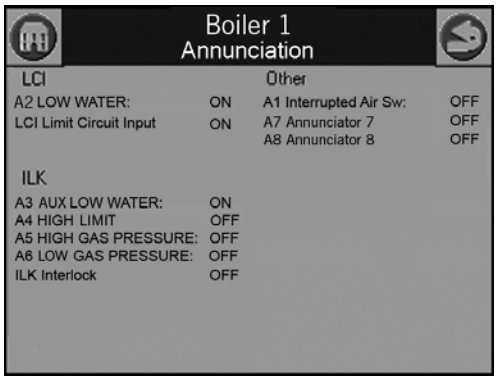


Figure 4-15 Annunciation Screen

LGPS

1. To check the Low Gas Pressure Switch, first close the upstream manual shutoff valve (both manual shutoff valves should now be closed).
2. Start the burner and wait 10 seconds during purge for CAPS to be made.
3. Turn the LGPS setting to maximum.
4. Open the test cock to bleed the gas line.
5. The controller should lock out. The screen will indicate **Lockout 67 ILK OFF**.
6. Reset the controller and change the LGPS setting back to minimum to proceed.

CAPS (Interrupted Airflow Switch)

1. Initiate burner sequence.
2. During purge cycle, set Combustion Air Proving Switch to its maximum setting.
3. The CB Falcon should lock out on an airflow failure. The display will show **Lockout 65 Interrupted Airflow Switch OFF**.

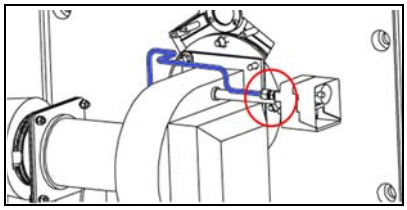


Figure 4-16 CAPS low pressure connection

Note: If the CAPS fails to open even when set to maximum, test by disconnecting the low-pressure line to the switch and initiating burner sequence. The switch should now break during the purge cycle. Reconnect low-pressure side after a successful CAPS check.

4. Following a successful CAPS check, dial the CAPS back to its minimum setting and reset the CB Falcon.

Note: The CAPS is ignored when the boiler is in “Run” state. A CAPS test must be performed during Purge or Trial for Ignition.

HGPS and GAS VALVE

1. Open the upstream manual shutoff valve and wait a few moments for gas pressure to rise.
2. Lower the switch setting to minimum.

3. Initiate burner sequence. During the main flame establishing period, verify gas valve LEDs energize, indicating both safety shutoff valves open.
4. The CB Falcon should lock out on an interlock failure (Lockout 67).
5. Reset CB Falcon.
6. Open the downstream manual shutoff valve to clear the lockout condition.
7. Dial the HGPS back to its maximum setting and reset.

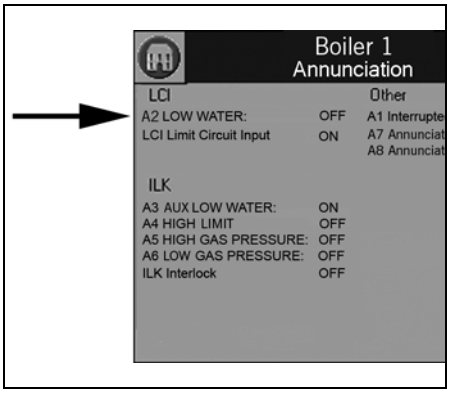


Figure 4-17 Low Water Cutoff test

IGNITION FAILURE CHECK

1. A test of the flame rod circuit can also be performed at this time. Disconnect the flame rod cable and attempt to start the burner. The CB Falcon should lock out, indicating **Lockout 109 Ignition Failure**.
2. Replace flame rod electrode and grounding tab.

After verifying proper operation of LGPS, HGPS, CAPS, and Gas Valve, re-open the downstream manual shut-off valve.

4.11.4 LWCO and ALWCO Check

- Before testing low water controls, disconnect power to the feed pump.

LWCO

1. To verify proper LWCO operation, conduct a blowdown of the water column (refer to Chapter 5, Section 5.3 - Water Column Blowdown).
2. During WC blowdown, the burner should shut off when low water level is reached.
3. Upon shutdown, check the LWCO control board in the CFH electrical panel. The LED indicator should be off, indicating that the LWCO has switched off the control circuit.

ALWCO

1. To check the ALWCO, drain the boiler (refer to Chapter 5, Section 5.2 - Blowdown).
2. Observe the ALWCO control board in the CFH electrical panel. When the ALWCO level is reached, the LED indicator should go out.
3. Close the blowdown valves, refill boiler and reset the ALWCO.

- After testing the low water controls, reconnect power to the feed pump.

4.11.5 Low and High Fire Adjustments

All CFH boilers are factory tested firing natural gas at an altitude of 1000 ft ASL. Operating under different conditions may require re-adjustment of the gas valve.

Adjustments are made using a TORX® T40 (low fire adjustment) and 3 mm hex wrench (main gas choke). The adjustment screws should initially be set to half way through each setting's range. The low fire adjustment screw is accessed by removing the slotted cap on the gas regulator using a blade screwdriver (see **Figure 4-18**). The high fire adjustment screw is accessed by removing the blue plastic cap from the valve cover (see **Figure 4-19**).

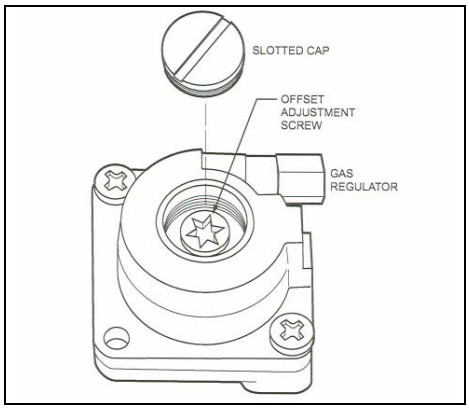


Figure 4-18 Regulating Adjusting Screw - Low Fire Offset

Turn the adjustment screw completely clockwise, counting the turns until the screw will no longer turn. Then, turn the adjustment screw counterclockwise half the number of turns counted when turning clockwise.

NOTE: When adjusting low fire offset, clockwise adjustments *increase* gas flow, and counterclockwise adjustments *decrease* gas flow.

When adjusting the main gas choke, clockwise adjustments *decrease* gas flow, and counterclockwise adjustments *increase* gas flow.

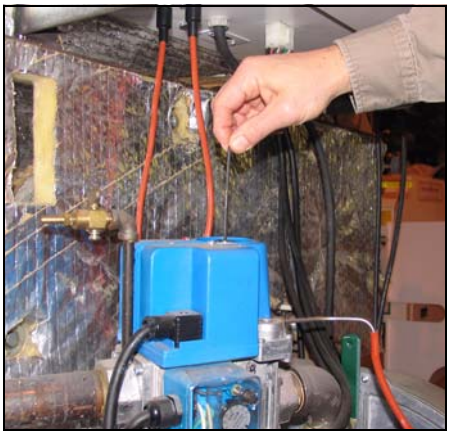


Figure 4-19 Main Gas Choke - High Fire Adjustment

Refer to Appendix A for further information on gas valve setup, operation, and testing.

4.11.6 Modulation OFF point

Prior to setting combustion, the steam pressure off hysteresis point should be adjusted upward to avoid nuisance shutdowns while the burner is under manual control. This parameter is located under Steam Configuration.

4.11.7 Setting Combustion

Note: A Combustion Analyzer is required to properly set-up the Model CFH burner. Do not attempt to fire and adjust the burner without this equipment.

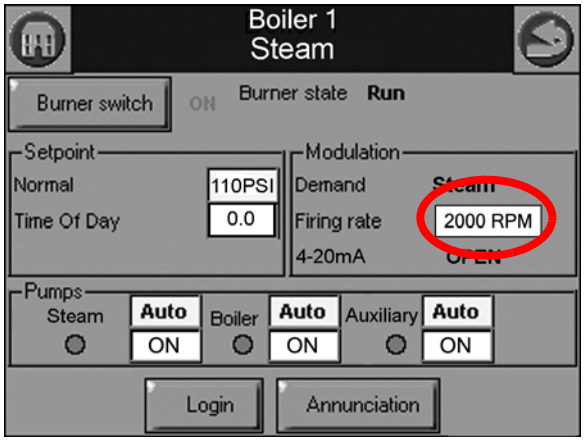
Note: Ensure boiler is filled with water prior to burner startup.

NOTE: Install the combustion analyzer probe as close as possible to the boiler vent connection. Sampling too far from the boiler vent can produce false readings due to air leakage diluting the flue gas.

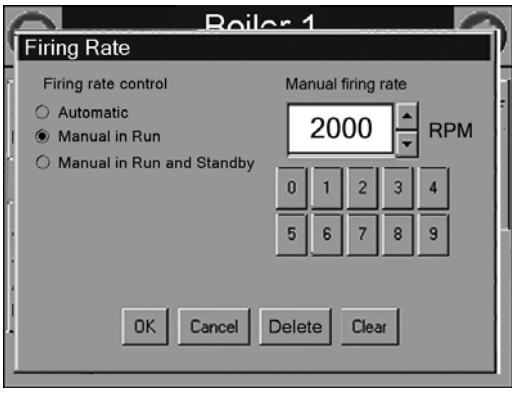
The burner does not have need of linkages for fuel/air adjustment, nor is a separate manual-auto switch provided for burner positioning. All firing rate adjustments are accomplished via the CB Falcon Control. Setting combustion will require manually modulating the burner via the CB Falcon from low fire to high fire to ensure a consistent air/fuel ratio.

To enable the burner, go to the Operation screen and press the <Burner switch> button at the upper left. *The burner will not operate* if this button is in the "OFF" state.

Manual Modulation - use the procedure below to change the burner firing rate manually.



1. On the CB Falcon **Operation** screen, press the **Firing rate** display in the **Modulation** section.



2. A numeric keypad will appear, showing the current firing rate and operating mode.*

3. Under **Firing rate control** select **Manual in Run**.

4. Press <Clear> to clear the current RPM value.

5. Enter the desired RPM setting using the numeric keypad (refer to **Table 4-2**, Fan Speed Settings, for upper and lower limits).

6. Press <OK>. The display will return to the Operation screen and the burner will modulate to the chosen firing rate.

*Use **Manual in Run** for normal manual operation. In **Manual in Run and Standby** mode, the burner will not operate. Use this mode for testing blower operation without firing the boiler.

To set combustion:

1. Check inlet gas pressure and reset low gas pressure switch.
2. At Operation screen set firing rate to low fire. Review burner sequence before proceeding.
3. Turn Demand switch to LOCAL.
4. Initiate burner firing sequence. The burner switch is accessed via the CB Falcon Operation page (Figure 4-14). If the burner does not ignite, adjust choke counterclockwise slightly until you can see a slight yellow flame at the burner during ignition. Clockwise adjustments to the low-fire offset screw may also be tried. Check that gas pressure to gas valve inlet is sufficient to fire burner (see Table 4-3 for gas pressure requirements).
5. After burner lights, maintain in low fire position. At low fire, using main choke on gas valve and a combustion analyzer set O2 level within 3-8% O2.
6. Manually modulate the burner to high fire. Adjust the gas choke if necessary to obtain desired O2% (6.0% - 7.0% for optimum combustion).
7. Modulate to low fire and fine tune offset screw to obtain desired O2% (6.0% - 7.0%).

Verify adjustments by modulating back and forth between low and high fire.

While setting combustion observe gas pressure at low fire and at high fire. Ensure pressure is within limits shown in Table 4-3.

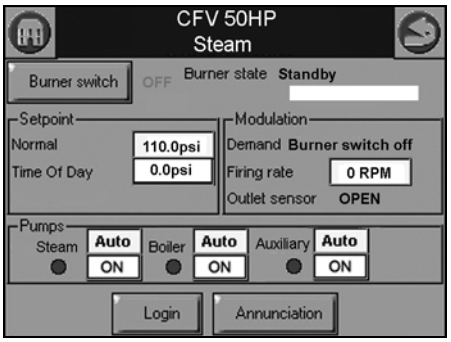


Figure 4-20 Operation screen

4.11.8 Limit Controls Check

The OLC and HLC can be tested while the boiler is producing steam by adjusting the switch setting downward. A lockout should result when the switch setting is at or just below the current steam pressure.

Readjust each switch (and reset HLC) after testing. Refer to **Section 4.10, Operating and High Limit Controls**.

4.12-Boil-Out of a new unit

The inside of a new boiler may contain oil, grease, or other contaminants which, if not removed, could adversely affect system performance. New units should be cleaned by boil-out before use.

Recommended boil-out procedure is as follows:

1. Determine boiler water capacity (see **Table 4-4**). Have sufficient cleaning material on hand to complete the job.
2. When dissolving dry chemicals, slowly introduce the chemical into warm water in a suitable container. Stir constantly until the chemical is completely dissolved.

⚠ Caution

Observe caution in the treatment, handling, and disposal of boilout residue. Refer to Material Safety Data Sheets for recommended safe procedures.

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 can be used for this purpose.
4. Water relief valves and steam safety valves must be removed before adding the boilout solution to avoid contaminating the valves. Use caution when removing and reinstalling these devices.
5. All valves in the piping leading to or from the system must be closed to prevent cleaning solution from getting into the system.
6. Fill the boiler vessel with enough clean water to cover the tubes. Add the cleaning solution, then fill to the top. The water used in the initial fill should be at ambient temperature.
7. Fire the boiler intermittently at a low rate, sufficient to hold solution just at the boiling point. Boil for at least five hours. Do not produce steam pressure.
8. Allow a small amount of fresh water into the boiler. This will 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.
11. Remove hand-hole plates and wash the waterside surfaces thoroughly using a high pressure hose.
12. Inspect the surfaces. If they are not clean, repeat boil-out procedure.
13. After closing the handholes and reinstalling 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.

Table 4-4 CFH Boiler Water Capacity

		Boiler Horsepower				
		10-15 HP	20-25 HP	30 HP	40 HP	50-60 HP
Normal water volume	15# Steam	110 gal	137 gal	204 gal	237 gal	301 gal
	150# Steam	121 gal	149 gal	221 gal	256 gal	323 gal
Water volume flooded		140 gal	170 gal	260 gal	300 gal	386 gal

4.13-Post start-up checkout procedure

1. After verifying correct water level, fire the boiler in manual low fire.
2. Ensure the control valves will not shut off flow to the boiler.
3. Set high gas pressure switch to 50% higher than operating gas pressure at low fire. Set low gas pressure switch to 50% lower than operating gas pressure at low fire.
4. Verify the ability of the flame system to detect and respond to a loss of flame. This can be done by removing the ionization

electrode (flame rod) cable. For a successful test the boiler should shut down and the gas safety shutoff valve close with the display indicating a lockout condition. Reconnect the ionization cable to the electrode.

5. Adjust gas choke for high fire combustion to desired excess air level (6-7% O2 recommended). Using offset screw, set low fire O2 same as high fire O2.
6. Check the draft on the outlet stack on each boiler, compare to acceptable limits (-.25 to +.25“ W.C.) and record in start up form.
7. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
8. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
9. If boiler is equipped with a High Air Pressure Switch, check switch operation.
10. Verify with customer that softened water is being used and that a proper water treatment program is in place.
11. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.

4.14-Falcon Control Functions and Customer Interface

Following is a brief overview of the Falcon control features on ClearFire steam boilers. Please refer to the Falcon Control operating instructions in Appendix A for more detailed explanations.

- Set Point
- Time-of-Day (TOD) Set Point
- Hysteresis On and Hysteresis Off
- PID modulation control
- Remote Enable and Remote 4-20mA Input
- Remote Modulation
- Remote Set Point
- Configurable pump/auxiliary relay contacts
- Annunciator
- Diagnostics
- Alert/Lockout History
- Trend Analysis
- Modbus communications

Set Point, TOD Set Point, Hysteresis On, Hysteresis Off, and PID load control

The set point is the value that the boiler’s PID load control attempts to maintain in order to meet the steam demand. The modulating set point can be adjusted at the Operation page or under the Steam Configuration parameter group. No password is required to change the set point. To change the set point at the Operation page, press

the set point value next to “Normal”. Clear the current value and enter the new value. Press <OK> to establish the new set point.

The Time-of-Day (TOD), or setback, set point is an alternative set point that is enabled when a remote contact connected to terminals J10-2 & J10-3 is closed (refer to Figure 2-8 CFH Wiring Diagram). When the circuit is open, the boiler control reverts back to the normal set point. The TOD set point can be adjusted at either the Operation page or under the Steam Configuration parameter group. Service level password login is required to change this parameter.

The hysteresis on and hysteresis off points can only be changed under the Steam Configuration parameter group and require a login with the Service level password. Hysteresis on is the differential below the current set point at which the boiler will restart following an off cycle. Hysteresis off is the differential above the current set point at which the boiler will cycle off – effectively the boiler’s operating limit. These two parameters apply to both the normal and TOD set points. To minimize the frequency of cycling the boiler on and off, the values of either, or both, of these settings may be increased. Default settings for Hysteresis on and off are 0 and 3 psi, respectively.

The PID (Proportional-Integral-Derivative) load control operates to generate the demand source’s modulation rate. Under Steam configuration, the PID gain values can be adjusted to match the desired modulation response. The default gain value settings of P=50, I=50 & D=0 have proven to work well with typical steam boiler applications.

Remote Enable and Remote 4-20mA Input

Remote enable and Remote 4-20mA input allow the boiler to be sequenced and/or controlled from a separate boiler room controller or building management system. The 3-position Demand switch at the front of the control panel determines whether the boiler is off, in local, or under remote control. When in the “LOC” (local) position, the boiler operates on its own set point and ignores any remote signal connections. When in the “REM” (remote) position, the boiler can be enabled and modulated by remote discrete and analog (4-20mA) inputs, respectively. When in the “OFF” position, the boiler will not operate.

Refer to boiler wiring diagrams for remote enable and remote 4-20mA input connections (example WDs are given in Chapter 2). For simple remote on-off sequencing, only terminals 24 and 25 (Falcon J8-1 & J8-3) need to be connected to dry enable contacts at the remote controller. When terminal 25 (steam demand input) is energized, the steam demand is enabled. The boiler operates on its local set point and PID modulating control settings.

For remote modulation (firing rate) control, both the remote enable and remote 4-20mA input connections must be made. The default setting for the 4-20mA remote input is “Modulation”. This setting should be verified under the Falcon control’s Steam configuration group, “Steam 4-20mA remote control”. To avoid nuisance

operating limit shut downs of the boiler, the Falcon's normal operating set point should be adjusted to a value that is greater than the system header set point.

With steam demand present and completion of a successful trial for ignition sequence, the boiler will modulate according to the 4-20mA input signal provided: 4mA = minimum modulation rate (low fire); 20mA = maximum modulation rate (high fire). The boiler will continue to modulate until the steam demand is removed, the operating limit is reached, LCI is opened (e.g. low water condition), or a Falcon lockout alarm occurs (e.g. ILK opens on a High Limit trip).

To configure the boiler for remote set point control, navigate to the Falcon control's Steam configuration group. Change the setting of "Steam 4-20mA remote control" to "Set Point". Next, the span of the 4-20mA needs to be established. The steam set point determines the value for 20mA; "minimum steam pressure" determines the value for 4mA.

Depending on the quality of the remote input signal, the modulation rate or operating set point may fluctuate unnecessarily because of small changes in the measured current signal. Under the Modulation configuration group, the "4-20mA input Hysteresis" setting may need to be adjusted to avoid undesired fluctuations in the either the modulation rate or operating set point. The default setting is 0.1mA and can be increased to essentially filter out small fluctuations of the input signal. It may take some trial and error to establish the optimum input hysteresis setting for a particular system.

If at any time the remote 4-20mA input signal is disconnected, the Falcon control will indicate "OPEN" under the 4-20mA input value at the operation screen. The boiler will then operate on its local set point and PID modulation control. Once the 4-20mA signal is reestablished, the boiler will resume operation under remote control.

Configurable Pump/Aux. Relay Contacts

Three configurable relays are available for auxiliary boiler room functions. These functions may include combustion air damper or exhaust fan interlocks, feed pump on/off (for constant running pump with modulating feedwater valve), etc. Contact your CB representative for further information; also see Appendix A, Falcon manual.

Annunciator

The Falcon features an annunciator to monitor boiler safety controls and to provide first-out lockout annunciation. The annunciator status screen is accessed from the boiler operation screen.

Two additional annunciator inputs are available for custom configuration. Contact your CB representative or see Falcon manual in appendix.

Diagnostics

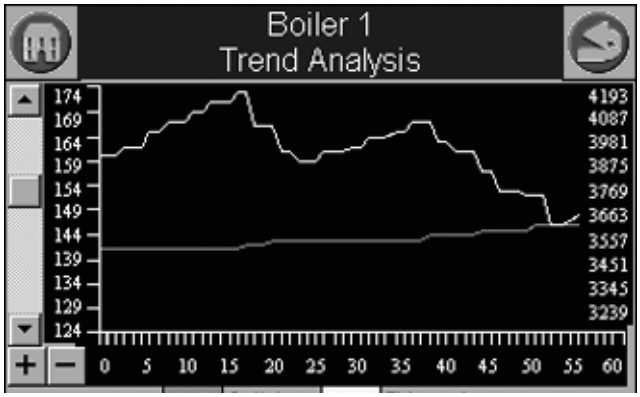
The Falcon diagnostic screens show the status of the controller's digital and analog inputs/outputs. Digital I/O are displayed as on (green)/off (red) indicators and analog I/O as bar graphs.

Alert/Lockout History

Alerts and lockouts are stored in user-accessible lists and identified by burner cycle count, fault code, and a brief description. Selecting an individual item in the lockout history will show additional details, including burner sequence stage, run-time hours, annunciation status, etc. Lockouts can be acknowledged and cleared from the Lockout History screen.

Trend Analysis

The Falcon is able to display real-time trend graphs for up to four user-selectable status variables. Status value is displayed on the Y-axis and time on the X-axis. Time axis can be scaled between one minute (in one second intervals), 15 minutes (15 second intervals), and 24 hours (one hour intervals).



Modbus Communication

The CB Falcon uses the Modbus RTU protocol for communication with a Building Management System or other devices. Modbus register mapping for CFH steam boilers is given below.

Modbus for CFH Steam

Hex	Decimal	Parameter	R/W	Format	Description
0002	0002	Digital I/O	R	U16	Bit map:
					15=Safety relay
					14=Time of Day
					13=STAT (Demand)
					12=High Fire Switch (HFS)
					11=Low Fire Switch (LFS)
					10=Load Control Input(LCI)
					9=Pre-ignition interlock (PII)
					8=Interlock (ILK)
					7=Alarm
					6=Main valve
					5=Pilot valve
					4=External ignition
					3=Blower motor/HIS
					2=Pump C
					1=Pump B
					0=Pump A
0003	0003	Annunciation I/O	R	U16	Only applicable when Annunciation is enabled Bit map: 15-14=Reserved (always 0) 13=STAT2 12-8=Reserved (always 0)
					7=Annunciator 8 - unused
					6=Annunciator 7 - unused
					5=Annunciator 6 - Low Gas Pressure
					4=Annunciator 5 - High Gas Pressure
					3=Annunciator 4 - HAPS (HW) / High Limit(ST)
					2=Annunciator 3 - Auxiliary Low Water
					1=Annunciator 2 - Low Water
					0=Annunciator 1 - Interrupted Air Switch
0008	0008	Firing rate	R	U16	Actual firing rate (% or **RPM**).
0009	0009	Fan speed	R	U16	RPM
000A	0010	Flame signal	R	U16	0.01V or 0.01A precision (0.00-50.00V)
0013	0019	Register Access Status	R	U16	Register data write access status:
					0=No register writes allowed,
					1=Installer register writes allowed,
					2=OEM register writes allowed.
					3=All register writes allowed.
0014	0020	Steam pressure	R	U16	0-150 psi (0.1 psi precision)
0015	0021	Analog remote input	R	U16	0=No signal, 4-20 mA (0.1 mA precision)
0016	0022	Active Steam pressure setpoint	R	U16	0-150psi (0.1psi precision)
		BURNER CONTROL STATUS			
0020	0032	Burner control status	R	U16	0=Disabled, 1=Locked out, 2-3=Reserved, 4=Anti-short cycle, 5=Unconfigured safety data, 6-33=Reserved, 34=Standby Hold, 35=Standby Delay, 36-47=Reserved, 48=Normal Standby, 49=Preparing, 50=Firing, 51=Postpurge, 52-65535=Reserved
					0=Disabled

Modbus for CFH Steam (Continued)

					1=Locked out
					4=Anti-short cycle
					5=Unconfigured safety data
					34=Standby Hold
					35=Standby Delay
					48=Normal Standby
					49=Preparing/Pre-purge
					50=Ignition
					51=Firing
					52=Postpurge
0021	0033	Burner control state	R	U16	Burner control sequence (I/O) state. Different states exist between residential & commercial models (see tables 10 & 11). Model type determined by register 176.
					0=Initiate
					1=Standby Delay
					2=Standby
					3=Safe Startup
					4=Prepurge - Drive to Purge Rate
					5=Prepurge - Measured Purge Time
					6=Perpurge - Drive to Lightoff Rate
					7=Preignition Test
					8=Preignition Time
					9=Pilot Flame Establishing Period (Main Trial for Ignition with DSI)
					10=Main Flame Establishing Period (Not used with DBI)
					12=Run
					13=Postpurge
					14=Lockout
					255=Safety Processor Offline
0022	0034	Lockout code (Active)	R	U16	0=No lockout, 1-4096 (refer to Table 44, Falcon Lockout and Hold Codes)
0024	0036	Annunciator first out	R	U16	Source for annunciator first out:
					0=None or undetermined
					1=ILK
					2=PII
					11=Annunciator 1
					12=Annunciator 2
					13=Annunciator 3
					14=Annunciator 4
					15=Annunciator 5
					16=Annunciator 6
					17=Annunciator 7
					18=Annunciator 8
0025	0037	Annunciator hold	R	U16	Source for burner control hold condition (see Hold code):
					0=None or undetermined
					1=ILK
					2=PII
					3=LCI
					11=Annunciator 1
					12=Annunciator 2

Modbus for CFH Steam (Continued)

					13=Annunciator 3 14=Annunciator 4 15=Annunciator 5 16=Annunciator 6 17=Annunciator 7 18=Annunciator 8
0026	0038	Sequence time	R	U16	Running time for timed burner control operation (seconds)
0027	0039	Delay time	R	U16	Running delay time (seconds). Applicable when burner control in delayed or hold state.
0028	0040	Hold code	R	U16	Reason for burner hold (same codes as lockout, see Table 44)
0029	0041	Burner control flags	R	U16	Bit map: 15-1=Reserved (always 0) 0= Flame detected
0049	0073	Active Steam pressure on hysteresis	R	U16	0-150psi (0.1psi precision)
004A	0074	Active Steam pressure off hysteresis	R	U16	0-150psi (0.1psi precision)
		STATISTICS			
0080-0081	0128-0129	Burner cycle count	R/W	U32	0-999,999
0082-0083	0130-0131	Burner run time	R/W	U32	Hours
		SYSTEM CONFIGURATION			
00B7	0183	Burner name	R/W		Variable length string (up to 20 characters)
00B8	0184	Installation data	R/W		Variable length string (up to 20 characters)
		MODULATION CONFIGURATION			
00C1	0193	CH maximum modulation rate	R/W	U16	RPM or %
00C3	0195	Minimum modulation rate	R/W	U16	RPM or %
00C5	0197	Lightoff rate	R/W	U16	**SAFETY parameter:** RPM or %
00C6	0198	Postpurge rate	R/W	U16	**SAFETY parameter:** RPM or %
00C7	0199	CH forced rate	R/W	U16	RPM or %
00C8	0200	CH forced rate time	R/W	U16	0-64800 seconds (18 hours), 0xFFFF=Not configured
00CB	0203	Burner switch	R/W	U16	0=Off, 1=On. Used to enable/disable burner control.
00CC	0204	Firing rate control	R/W	U16	0=Auto, 1=Manual in Run, 2=Manual in Run&Standby
00CD	0205	Manual firing rate	R/W	U16	Firing rate used when control is set to manual (% or RPM)
00DC	0220	Steam pressure setpoint	R/W	U16	0-150psi (0.1psi precision)
00DD	0221	Steam pressure on hysteresis	R/W	U16	0-150psi (0.1psi precision)
00DE	0222	Steam pressure off hysteresis	R/W	U16	0-150psi (0.1psi precision)
00DF	0223	CH/Steam 4-20mA remote control	R/W	U16	0=Disable remote control, 1=Setpoint control, 2=Modulation control
021D	0541	Steam minimum pressure	R/W	U16	0-150psi (0.1psi precision)
021E	0542	CH time of day pressure setpoint	R/W	U16	0-150psi (0.1psi precision)
021F	0543	Analog input hysteresis	R/W	U16	0-10.0mA (0.1mA precision)
		LEAD LAG CONFIGURATION			
0220	0544	Lead Lag slave enable	R/W	U16	0=Lead/Lag slave disabled, 1=Lead/Lag simple slave enabled for EnviraCom master, 2=Lead/Lag simple slave enabled for Global Modbus master,

Modbus for CFH Steam (Continued)

					3=Lead/Lag full slave enabled for Global Modbus master
0235	0565	Slave command	R/W	U16	Bit map: 15=Slave demand request, 14=Slave suspend startup, 13=Slave run fan request, 12=Turn on System pump with overrun, 11=Turn on System pump with no overrun, 10=Turn on Auxiliary pump, 9=Reserved (always 0), 8=Commanded rate is binary fraction % , 7-0=Commanded rate

Modbus for CFH Steam (Continued)

		EXTENDED CH CONFIGURATION			
0240	0576	CH modulation backup sensor	R/W	U16	Alternative modulation sensor when primary CH sensor is bad: 0=No backup sensor, 1=Header sensor
0241	0577	CH Modbus STAT	R/W	U16	Modbus call for heat (see register 209): 0=No call for heat, 1=Call for heat with no timeout, 2=Call for heat with 20 min timeout
0242	0578	CH setpoint source	R/W	U16	Source for CH setpoint: 0=Local setpoint parameters (registers 211, 212, etc.), 1=Modbus setpoint (register 579), 2=4-20mA remote control (register 21)
0243	0579	CH Modbus setpoint	R/W	U16	-40°-130° (0.1°C precision)
0244	0580	CH modulation rate source	R/W	U16	0=Local modulation (sensor), 1=Modbus binary fraction , 2=Modbus modulation step, 3=4-20mA modulation (register 21)
0245	0581	CH Modbus rate	R/W	U16	Commanded CH modulation rate when source is Modbus (see register
0360-0370	0864-0880	LOCKOUT HISTORY Lockout history record 1	R	0-1 byte	Most recent lockout. See Table 4.
0371-0381	0881-0897	Lockout history record 2	R	0-1 byte	2nd newest lockout. See Table 4.
0382-0392	0898-0914	Lockout history record 3	R	0-1 byte	3rd newest lockout. See Table 4.
0393-03A3	0915-0931	Lockout history record 4	R	0-1 byte	4th newest lockout. See Table 4.
03A4-03B4	0932-0948	Lockout history record 5	R	0-1 byte	5th newest lockout. See Table 4.
03B5-03C5	0949-0965	Lockout history record 6	R	0-1 byte	6th newest lockout. See Table 4.
03C6-03D6	0966-0982	Lockout history record 7	R	0-1 byte	7th newest lockout. See Table 4.
03D7-03E7	0983-0999	Lockout history record 8	R	0-1 byte	8th newest lockout. See Table 4.
03E8-03F8	1000-1016	Lockout history record 9	R	0-1 byte	9th newest lockout. See Table 4.
03F9-0409	1017-1033	Lockout history record 10	R	0-1 byte	10th newest lockout. See Table 4.
040A-041A	1034-1050	Lockout history record 11	R	0-1 byte	11th newest lockout. See Table 4.
041B-042B	1051-1067	Lockout history record 12	R	0-1 byte	12th newest lockout. See Table 4.
042C-043C	1068-1084	Lockout history record 13	R	0-1 byte	13th newest lockout. See Table 4.
043D-044D	1085-1101	Lockout history record 14	R	0-1 byte	14th newest lockout. See Table 4.
044E-045E	1102-1118	Lockout history record 15	R	byte	Oldest lockout
0460-	1120-	ALERT LOG			
0465	1125	Alert log record 1	R	U16	Most recent alert (see Table 8).
0466-046B	1126-1131	Alert log record 2	R	U16	2nd newest alert.
046C-0471	1132-1137	Alert log record 3	R	U16	3rd newest alert.
0472-0477	1138-1143	Alert log record 4	R	U16	4th newest alert.
0478-047D	1144-1149	Alert log record 5	R	U16	5th newest alert.
047E-0483	1150-1155	Alert log record 6	R	U16	6th newest alert.
0484-0489	1156-1161	Alert log record 7	R	U16	7th newest alert.
048A-048F	1162-1167	Alert log record 8	R	U16	8th newest alert.
0490-0495	1168-1173	Alert log record 9	R	U16	9th newest alert.
0496-049B	1174-1179	Alert log record 10	R	U16	10th newest alert.

Modbus for CFH Steam (Continued)

049C-04A1	1180-1185	Alert log record 11	R	U16	11th newest alert.
04A2-04A7	1186-1191	Alert log record 12	R	U16	12th newest alert.
04A8-04AD	1192-1197	Alert log record 13	R	U16	13th newest alert.
04AE-04B3	1198-1203	Alert log record 14	R	U16	14th newest alert.
04B4-04B9	1204-1209	Alert log record 15	R	U16	Oldest alert.

Chapter 5
Service And Periodic Maintenance

5.1-GENERAL

A well-planned maintenance program will help avoid unnecessary downtime or costly repairs, and will promote safety and aid boiler inspectors. It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly, and yearly maintenance activities will help to obtain economical and lengthy service from the equipment.

Only trained and authorized personnel should be permitted to operate, adjust, or repair the boiler and 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.

Be alert to unusual noises, improper gauge readings, leaks, etc. Any leaks - fuel, water, steam, exhaust gas - should be repaired promptly and with attention to safety. Preventive measures, such as regularly checking the tightness of connections, should be included in regular maintenance activities.

Insurance regulations and local laws normally require periodic inspection of the pressure vessel by an authorized inspector. Inspections are usually, though not necessarily, scheduled for periods of normal boiler downtime, such as an off season. This period can be used to accomplish maintenance, replacement, or repairs that cannot easily be done at other times.

NOTE: To insure proper operation, use only Cleaver-Brooks parts for replacement.

While the inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, the inspection period provides operators with an opportunity for a detailed check of all boiler components including piping, valves, gaskets, refractory, etc. Comprehensive cleaning, spot painting, and replacement of expendable items should be planned for and taken care of during this time.

Cleaver-Brooks recommends common replacement parts be on hand during inspection and maintenance. Please refer to the Recommended Spare Parts List In the Parts section of this manual.

5.2-BLOWDOWN

Water treatment alone can never completely eliminate unwanted solids from boiler feedwater. In order to keep these substances to a minimum, blowdown should be performed at regular intervals.

Bottom blowdown fittings include a quick-opening valve (nearest the boiler) and a slow-opening valve. The quick-opening valve is opened first and closed last, with blowdown controlled using the slow-opening or downstream valve.

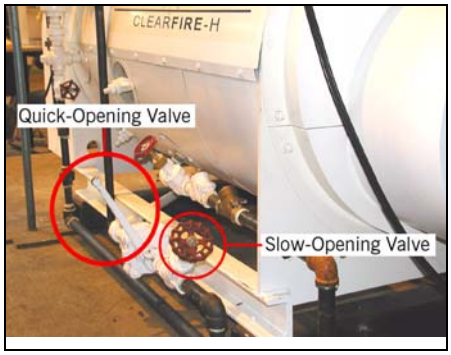


Figure 5-1 Bottom blowdown piping

Manual Blowdown Procedure

Blowdown is most effective when the boiler is under a light load, and when the water level is at the Normal Operating Water Level.

Be sure the blowdown piping is in proper operating condition. Waste should be piped to a point of safe discharge.

1. Open the quick-opening valve.
2. Crack the second or downstream valve slightly to allow the lines to warm, then continue opening slowly to its fully open position.

The duration of each blowdown should be determined by water analysis. A reduction of water level in the gauge glass by about 1/2" can often serve as a rough guide, but should not replace water analysis procedures.

3. When blowdown is complete, close the downstream (slow-opening) valve first, as quickly as possible. Then close the quick-opening valve. Finally, crack the downstream valve slightly, then close it tightly.

It is generally recommended that bottom blowdown be performed at least once in every eight-hour period. Actual frequency may vary depending on water conditions and boiler operating conditions. Consult the appropriate water treatment personnel regarding blowdown scheduling.

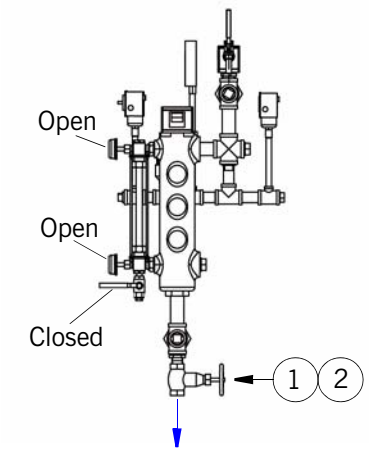
⚠ Caution

During blowdown, do not pump the lever action valve open and closed. Equipment damage may result.

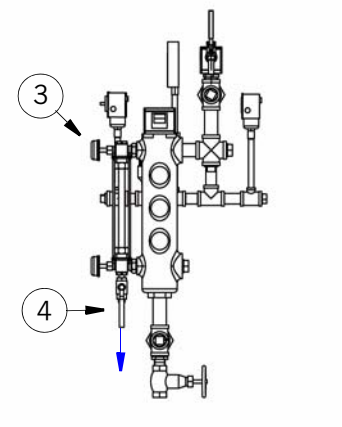
Under no circumstances should a blowdown valve be left open. Never leave the boiler unattended during blowdown.

5.3-WATER COLUMN BLOWDOWN

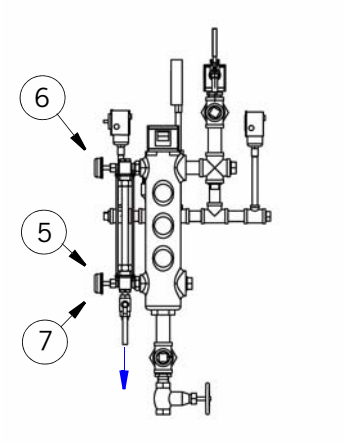
Free flow of water through the water column and gauge glass is essential to obtaining accurate boiler water level indication and control. It is recommended that the water column and gauge glass be blown down every shift to remove accumulated solids. Regular blowdown of the water column will help maintain the integrity of the water level probes and will help to ensure trouble-free operation of the boiler. See **Figure 5-2** for procedure.



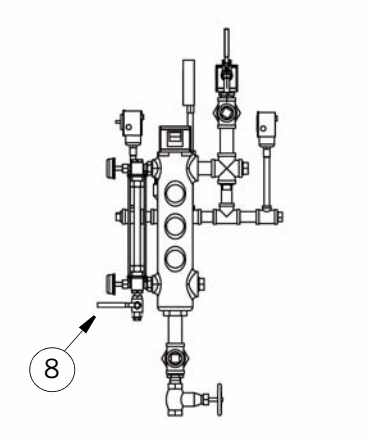
1. Open Water Column blowdown valve (5 to 10 sec.) to discharge water from WC.
2. Close WC blowdown valve.



3. Close upper gauge glass isolation valve.
4. Open gauge glass blowdown valve to discharge water from gauge glass.



5. Close lower gauge glass isolation valve.
6. Open upper gauge glass isolation valve.
7. Open lower gauge glass isolation valve to discharge steam from gauge glass.



8. Close gauge glass blowdown valve.

Figure 5-2 Water Column and Gauge Glass Blowdown

Periodic replacement of the water gauge glass should be part of a regular maintenance program. A broken or discolored glass should be replaced at once.

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

Figure 5-3 Water column gauge glass

5.4-FIRESIDE CLEANING PROCEDURE/ DISASSEMBLY

1. Locate the manual shutoff gas valve for the gas supply to the burner and turn it to the closed or shut position.

2. Disconnect all electrical power to the control panel at the primary switch box or breaker box supplying power to the boiler.

3. Remove the front casing enclosure and set aside.

4. Disconnect power and signal harnesses from blower.

5. Disconnect the ignition cables and flame sensor cable from the electrodes.

6 a. If using room combustion air, remove air filter. Inspect and clean as necessary.

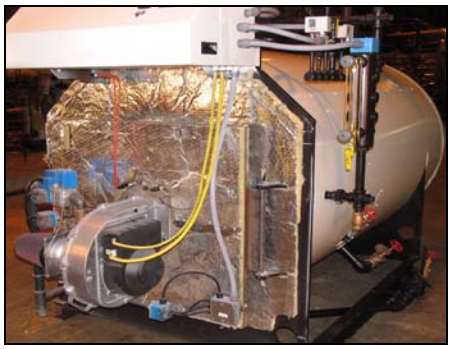


Figure 5-4 Front burner access panel removed

NOTE: Do not discard the air filter. It may be cleaned and re-used. Contact Cleaver-Brooks for cleaning kits.

b. Remove the air combustion piping at the inlet to the fan air intake, if supplied with direct vent combustion.

7. Disconnect the burner gas train from the gas supply piping.

8. Unscrew the hold down bolts securing the burner door to the pressure vessel.

9. The burner door, burner head, blower motor and assembly can now be swung open providing access to the burner head and combustion chamber.

With the burner head assembly swung open, the burner parts and combustion chamber can be inspected.

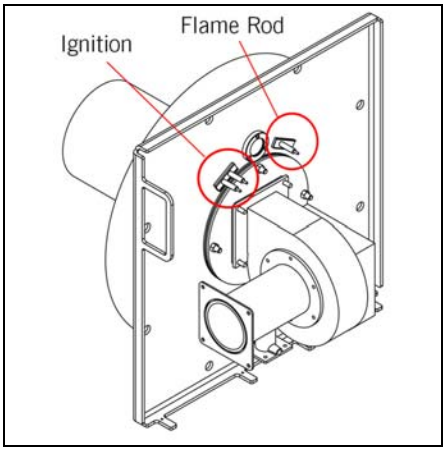


Figure 5-5 Electrode connections

Figure 5-6 Burner assembly open

A. Check ignition and ionization electrodes for deposits and proper gap. Clean or replace as required. Refer to Fig. 5-9 and Fig. 5-10

B. Check the burner canister for any damage, burn marks, or perforations. Replace if damaged. If the canister is in good condition, clean out any dirt or dust with a vacuum cleaner or low-pressure air hose.

C. Inspect door refractory and patch any cracks.

D. Inspect the pressure vessel and combustion chamber area for any damage or residue. If dirt or contaminants are found, it is recommended that the tube sheet and tubes be washed with a high-pressure power washer.

E. Replace the burner door gasket. New gasket should be properly situated in door gasket seat.*

Figure 5-7 Burner door gasket

If any adverse conditions are observed during operation or inspection, contact your authorized Cleaver-Brooks service representative.

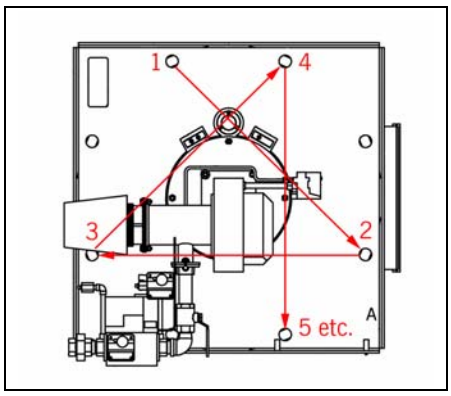


Figure 5-8 Fastening burner door

When inspection and servicing are completed, reassemble the burner in reverse order. When re-fastening burner door:

1) Coat bolt threads with anti-seize compound.

2) Tighten bolts gradually in a diagonal pattern to ensure a secure fit (see Figure 5-8). It may take several cycles of the pattern to reach uniform tightness.

3) Torque bolts to 11 ft-lbs (132 in-lbs).*

Ensure that all connections are tight and secure before reconnecting power or fuel supply. After turning the gas supply on, reset the gas pressure switches.

NOTE: A gas valve leak test is recommended during fireside inspection. See Appendix A for leak test procedure.

***NOTE**: Re-torque door bolts 7-10 days after replacing burner door gasket.

5.5-ELECTRODES AND FLAME ROD

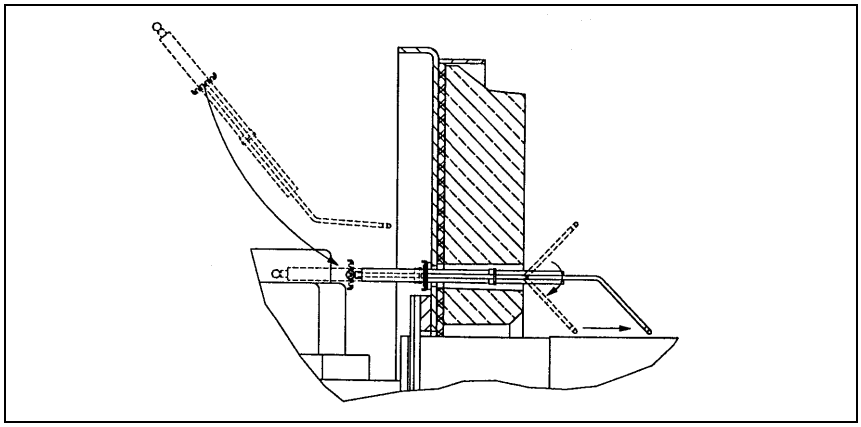


Figure 5-9 Electrode Setup

The ignition and ionization electrodes should be checked on an annual basis or as needed if ignition problems are encountered. Replacement should be accomplished as shown in **Figure 5-9** with the electrode turned toward the burner mantle/canister after it is inserted into the burner head.

⚠ Caution

The dimensions on both the Ignition Electrodes and the Flame Rod are not easily adjustable. Bending the rods can cause damage to the insulating material. In addition, a bent electrode will have a tendency to return to its original shape when heated. If the electrodes are out of specification, replacement is generally recommended.

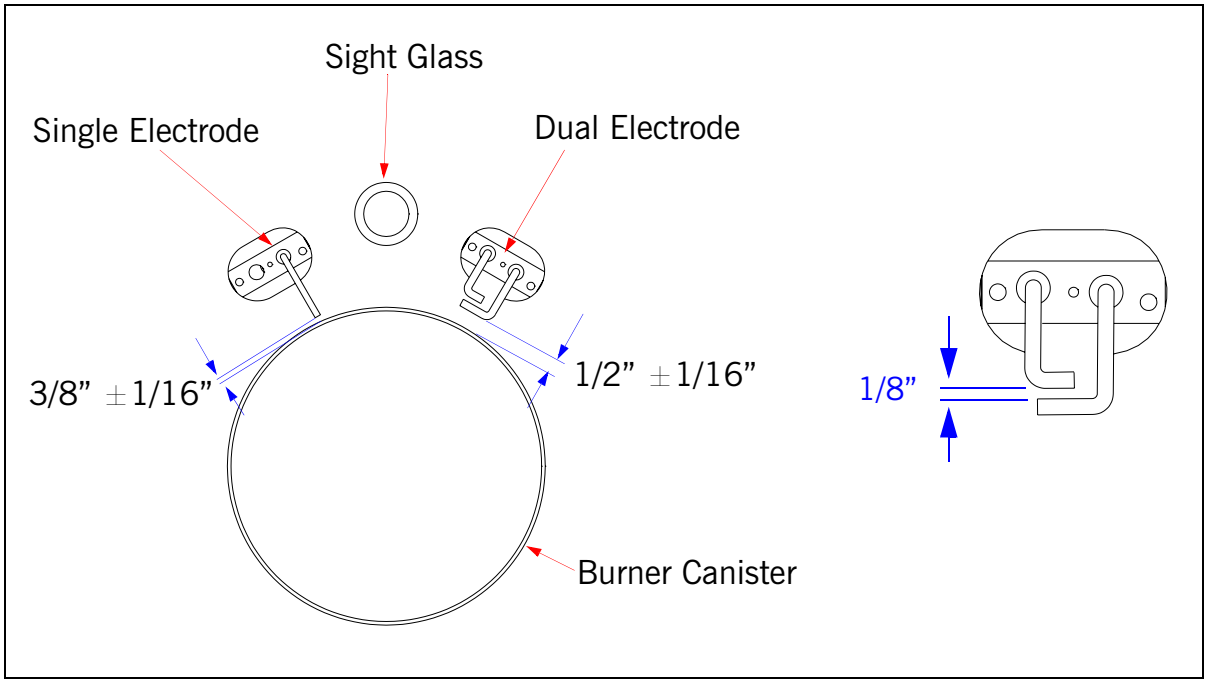


Figure 5-10 Electrode spacing

5.6-WATERSIDE INSPECTION/CLEANING

Waterside inspection frequency may depend upon the local jurisdiction and inspector but it is recommended that after the first year of operation, a waterside inspection take place.

To inspect the boiler on the waterside, first shut off the electric power to the burner. Close all waterside stop and shutoff valves. Close the manual gas shutoff valve. After allowing the boiler to cool, open the bottom blowdown valve, crack the air vent valve, and drain the boiler. While the boiler is draining, note the condition of the water.

When the water has drained from the boiler, remove the handhole covers and examine the waterside surfaces. Use a good flashlight and, where necessary, a swivel mirror with an extension. Discuss any scale, sludge or other buildup on the surfaces with the water treatment company or technician.

Remove the equalizing piping plugs, remove all probes, and inspect. Clean as necessary, being sure to remove any debris or blockages.

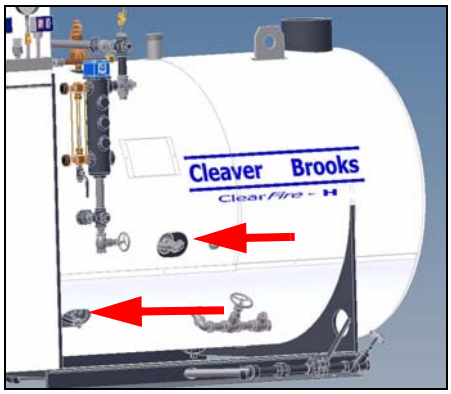


Figure 5-11 Handholes

Important

Clean probes are essential to proper boiler operation. Always ensure that probes remain free of debris and buildup.

If a waterside sludge buildup is noticed, flush the waterside and drain. Again, consult with the water treatment company or technician on cleaning. After inspection, install new gaskets, close the handholes, replace probes, tighten plugs, and allow water to fill the boiler while keeping the air vent valve open. Close valve before placing boiler back into operation.

5.7-SAFETY VALVE

The safety valve is an 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 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 should be in accordance with sections VI and VII of the ASME Boiler and Pressure Vessel Code.

Avoid excessive operation of the safety valve; a valve that is opened too frequently can develop leaks. 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 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 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.

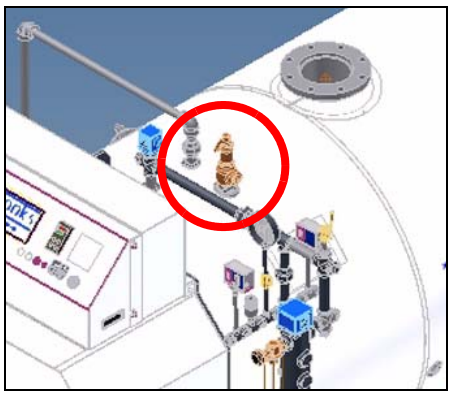
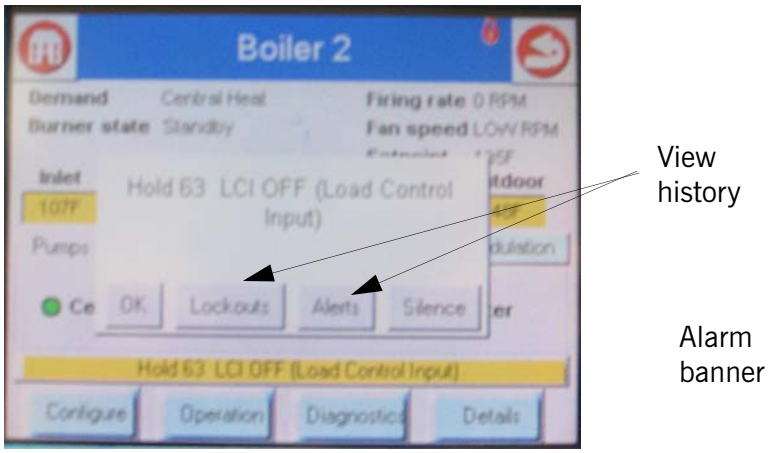


Figure 5-12 Safety Valve

5.8-TROUBLESHOOTING

The Falcon lockout and alert histories contain information which can help in determining the cause of problems. To view the lockout/alert history, first press the alarm banner, then press the appropriate button in the pop-up window.



The alert (or lockout) list will appear, showing date and time for each item. Pressing an individual item in the list will display additional information. Diagnostic information available for lockouts includes annunciator status, states of system inputs, and steam pressure at time of lockout.

For general troubeshooting information see Table 5-1 below, which lists some possible problems and suggested remedies.

Table 5-1. CFV Troubleshooting

Problem	Possible Cause	Suggested Remedy
Touch screen does not work properly; screen buttons malfunctioning	Screen out of calibration	Calibrate touch screen. From Home page, press <Setup>, <Advanced Setup>, <Diagnostics> to get to Display Diagnostics screen. Under “Touch Screen” press <Calibrate> and follow screen instructions.
Erratic display behavior	Bad electrical ground	Check grounding terminals in control panel.

Problem	Possible Cause	Suggested Remedy
Lightoff Problems (Falcon **Lockout 109**)	• Incorrect gas pressure	Check regulated gas pressure and ensure it agrees with Table 4-3. Check other equipment connected to gas main - regulator and gas supply piping sizings should be based on all appliances being ON. Check that bot gas shut-off valves are opening. Two indicator lights on the gas valve illuminate when the valves are energized. If one or both valves fail to open, check the wiring to the valve.
	• Incorrect fan speed	Increase fan speed by 100 RPM increments until successful light-off occurs.
	• Bad cable connections	Check connections.
	• Electrodes fouled or out of position	Electrodes should be cleaned and replaced annually and spacing periodically checked. See **5.5 Electrodes and Flame Rod**.
	• Dust or debris on burner canister	Precautions should be taken in dusty environments to ensure the burner canister remains free of dust particles. To clean the unit, remove the burner can and blow compressed air from the outside in. Vacuum up the residue.
	• Electrical ground problems	Check burner canister grounding tab Check control panel ground terminals

Problem	Possible Cause	Suggested Remedy
Flame loss during run (Falcon **Lockout 107**) (Falcon **Lockout 108**) A **Lockout 107** will result when the flame is lost early in the run cycle. Flame loss later in the run period will result in a **Lockout 108.**	• Combustion not properly calibrated	Check combustion settings. Verify proper air-fuel ratio throughout firing range.
	• Flame rod fouled or out of position	Check condition and placement of flame rod.
	• (Multiple boiler installations) Boilers not properly sequenced	Next boiler in sequence should not come on line while previous boiler is at low fire.

Display Diagnostics

For problems specific to the Falcon display/operator interface, diagnostic functions are available under the Advanced Setup menu. To access display diagnostics:

1. Press <Setup> on the Home Page. 

2. Press <Advanced Setup> on the Setup Page. 

3. Press <Diagnostics> on the Advanced Setup screen to access the Display Diagnostics screen. 

Date and Time

The Advanced Setup menu also allows access to system Date and Time settings. Press <Date & Time> on the Advanced Setup screen to access.

Important

Date and time settings will be lost if power to the controller is interrupted. Any time power is lost or shut off, the date and time should be reset when the system is turned back on. These settings determine the time-stamping of alerts and lockouts (alerts and lockouts already logged in history are not affected).

5.9-LAY-UP

If the boiler will be out of use for an extended period, precautions must be taken to protect fireside and waterside surfaces from deterioration due to corrosion.

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. After brushing all surfaces clean, sweep away

or vacuum any residue. The fireside may be flushed with water; however, all surfaces should be completely dried before lay-up.

Dry Lay-up

Dry lay-up is generally used when the boiler will be out of service for a lengthy time period, or where the boiler might be subject to freezing temperatures. The boiler must be thoroughly dried before dry storage, as any moisture could cause corrosion. Both fireside and waterside surfaces must be cleaned of all scale, deposits, soot, etc. A desiccant such as quick lime or silica gel should be placed in suitable containers inside the boiler vessel.

Wet Lay-up

Wet storage is generally used when a boiler may be needed on short notice or in cases where dry storage is not practical. Before wet storage the vessel should be drained, thoroughly cleaned, and refilled 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.

Whichever method of lay-up is used, a periodic re-check of fireside and waterside conditions is recommended during lay-up.

Chapter 6
Model CFH Parts

Milwaukee, Wisconsin

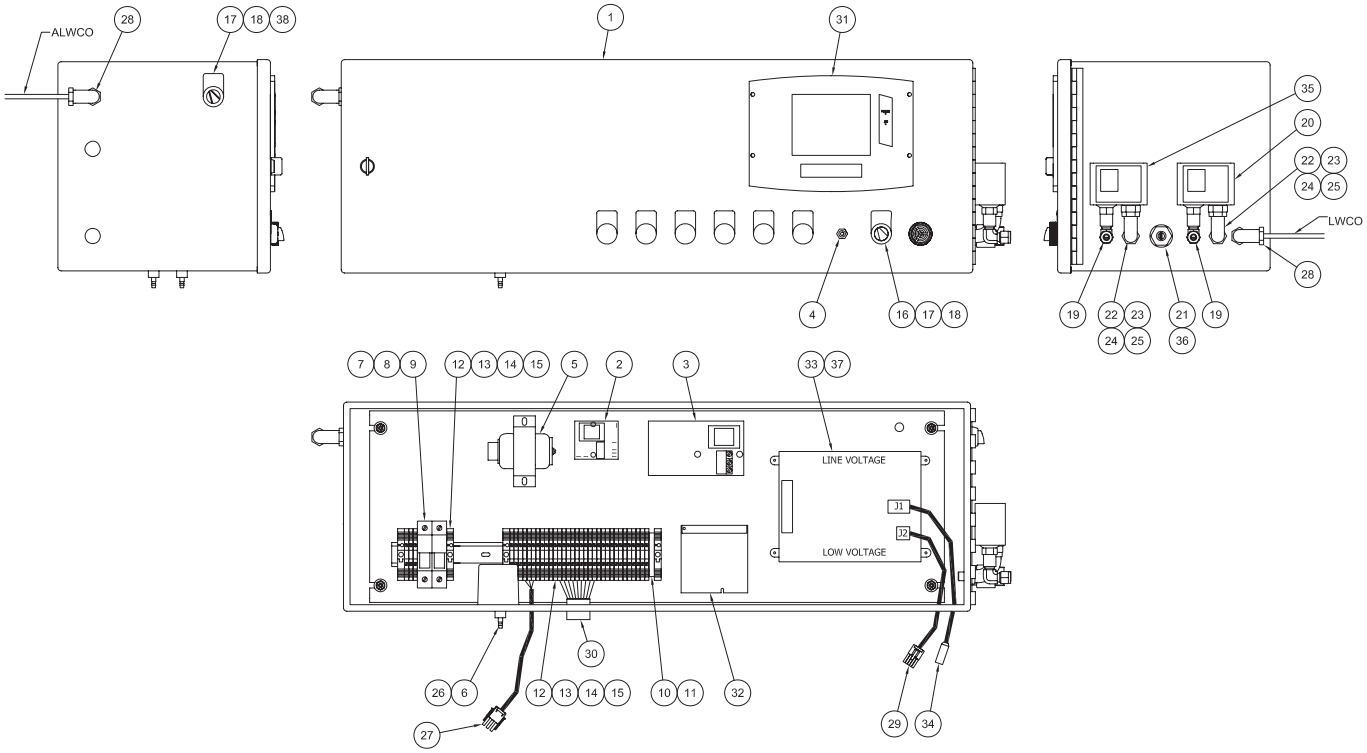
www.cleaver-brooks.com

1. Control Panel

ITEM	QTY.	PART NO.	DESCRIPTION	ITEM	QTY.	PART NO.	DESCRIPTION
1	1	119-00433-000	CABINET, ELECTRICAL W/SUBASE	21	1	SEE TABLE	SENSOR, PRESSURE TRANSMITTER
2	1	833-03547-000	CONTROLLER, ALWCO, W/ RESET BUTTON	22	2	848-00382-000	CONDUIT ELBOW, 90°
3	1	833-03130-000	LEVEL CONTROL, DUAL FUNCTION, LWCO & PUMP	23	2	848-00154-000	NIPPLE, RIGID, CONDUIT, CLOSE
4	1	836-01142-000	RESET PUSH BUTTON	24	6	848-00041-000	LOCKNUT, RIGID, CONDUIT
5	1	832-00235-000	TRANSFORMER, 120 VAC TO 24 VAC	25	2	848-00038-000	BUSHING, CONDUIT, 1/2"
6	1	832-02451-000	TRANSFORMER, IGNITION, SOLID STATE	26	2	826-00156-000	CABLE, IGNITION
7	2	848-01491-000	FUSE BLOCK, SINGLE POLE	27	1	832-02101-000	BLOWER MOTOR CABLE, AC POWER
8	1	SEE TABLE	BLOWER MOTOR FUSE	28	2	848-01490-000	CONNECTOR, SEAL TIGHT, 90 DEG.
9	1	832-01811-000	FUSE, 5 AMP, CONTROL CIRCUIT	29	1	832-02434-000	BLOWER CABLE, SIGNAL
10	1	832-02045-000	FUSE, 1 AMP	30	1	826-00163-000	CABLE HARNESS
11	1	848-01321-000	FUSE BLOCK	31	1	833-03725-000	FALCON DISPLAY (STANDARD)
12	34	832-02326-000	TERMINAL BLOCK	31	1	833-03577-000	FALCON DISPLAY (OPTIONAL)
13	3	832-02328-000	TERMINAL, GROUNDING	32	1	832-02410-000	POWER SUPPLY (INCLUDED W/SYSTEM DISPLAY)
14	4	832-02248-000	TERMINAL END RETAINING ANCHOR	33	1	833-03578-000	FALCON CONTROLLER, STEAM
15	3	832-01951-000	DIN MOUNTING RAIL	34	1	826-00157-000	FLAME ROD CABLE
16	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION	35	1	SEE TABLE	PRESSURE CONTROL, OP. LIMIT
17	2	836-01136-000	CONTACT BLOCK, SPDT	36	1	845-00783-000	FEMALE, TAPER THREAD 3/8" X 1/4"
18	2	881-00348-000	LATCH, PLASTIC	37	1	880-02343-000	PLUG CONNECTOR KIT, FALCON
19	2	845-00052-000	PARKER, MALE TAPER THREAD, FRACTIONAL TUBE 3/8" X 1/4"	38	1	836-01147-000	SWITCH, SELECTOR, 2 POSITION
20	1	SEE TABLE	PRESSURE CONTROL, HIGH LIMIT				

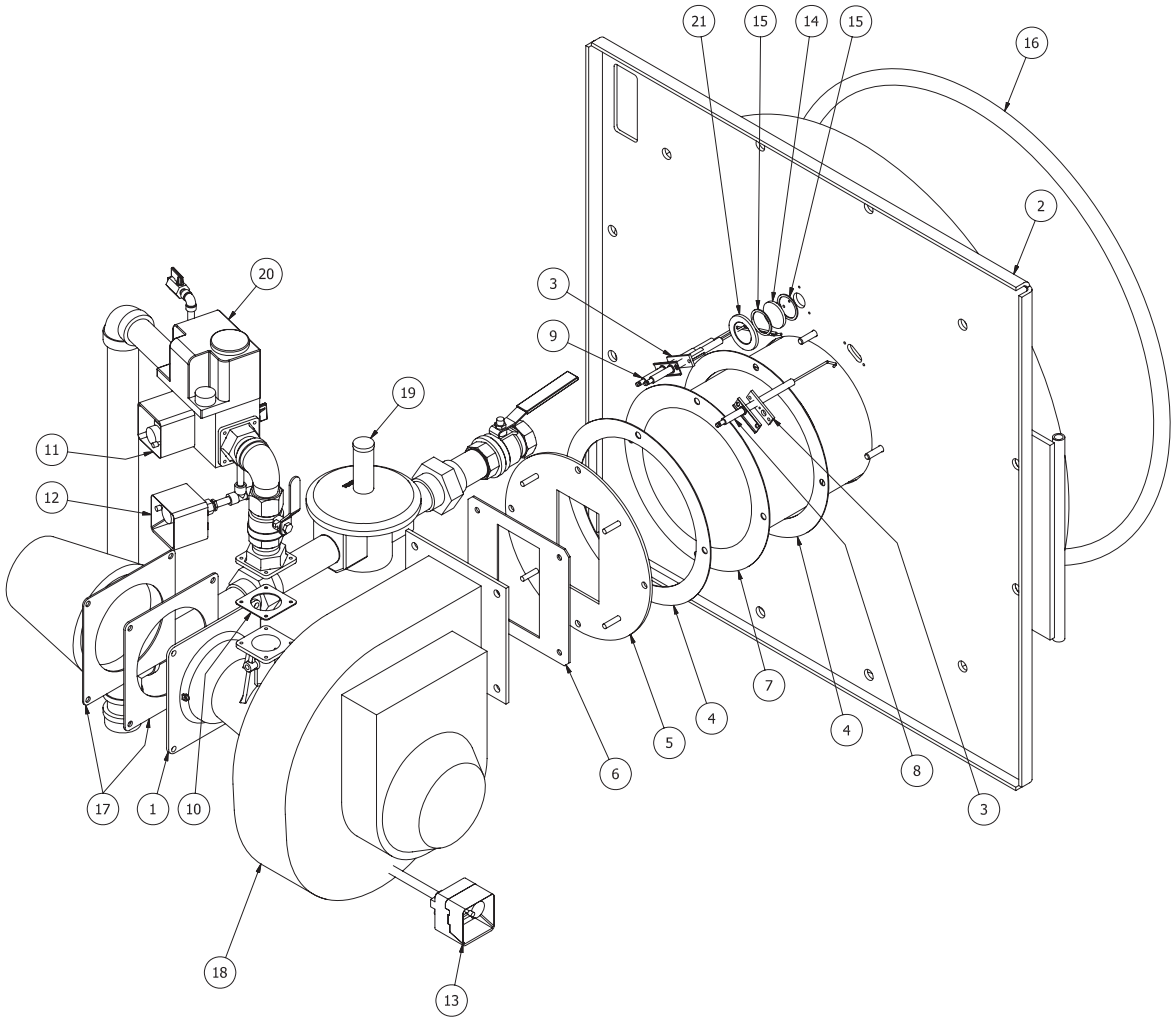
BLOWER MOTOR FUSE SELECTION (ITEM 8) 120			
CFH SIZE	BLOWER MODEL	FUSE RATING	PART NUMBER
10-30 HP	G1G170-AB05-20	CLASS CC 6A	832-01881-000
40 HP	G3G200-GN26-01	CLASS CC 12A	832-01887-000
50-60 HP	G3G250-GN39-01	CLASS CC 15A	832-01888-000

PRESSURE CONTROL TABLE		
	15# ST.	150# ST.
ITEM 20	817-04094-000	817-04092-000
ITEM 21	817-04385-000	817-04386-000
ITEM 35	817-04095-000	817-04093-000



2. Burner Assembly

ITEM	QTY	10HP PART NO.	15HP PART NO.	20HP PART NO.	25HP PART NO.	30HP PART NO.	40HP PART NO.	50HP PART NO.	60HP PART NO.	DESCRIPTION
1	1	048-00659-000		048-00655-000		048-00660-000	048-00656-000		048-00662-000	VENTURI
2	1	132-02497-000		132-02544-000	132-02490-000	132-02500-000		132-02546-000		BURNER DOOR
3	2	380-01032-000								GASKET, ELECTRODE
4	2	380-01053-000			380-01033-000	380-01034-000				GASKET, ADAPTER PLATE TO DOOR
5	1	380-01094-000	380-01052-000		380-01035-000	380-01067-000	380-01082-000	380-01036-000		PLATE, ADAPTER
6	1	380-01037-000					380-01076-000	380-01038-000		GASKET, ADAPTER PLATE TO BLOWER
7	1	380-01055-000	380-01045-000		380-01029-000	380-01030-000		380-01074-000		BURNER CANISTER
8	1	380-01062-000			380-01060-000					ELECTRODE, SINGLE, FLAME ROD
9	1	380-01061-000								ELECTRODE, DUAL, IGNITION
10	1	800-00098-000								GASKET, VENTURI
11	1	817-02414-000								SWITCH, LOW GAS PRESSURE
12	1	817-02420-000								SWITCH, HIGH GAS PRESSURE
13	1	817-03468-000								SWITCH, COMBUSTION AIR PROVING
14	1	851-00026-000								SIGHT GLASS, PYREX
15	2	853-00213-000								GASKET, SIGHT GLASS
16	1	853-00982-000 60" LG.	853-00982-000 60" LG.	853-00982-000 66" LG.	853-00982-000 66" LG.	853-00982-000 85" LG.	853-00982-000 85" LG.	853-00982-000 101" LG.	853-00982-000 101" LG.	GASKET, ROPE, DRY OVEN
17	1	880-01858-000					880-02005-000			KIT, AIR FILTER
18	1	894-04076-000					894-04111-000	894-04075-000		BLOWER
19	1	918-00032-000				918-00888-000		918-00730-000		REGULATOR, GAS PRESSURE
20	1	940-07162-000	940-07163-000		940-07164-000		940-07165-000	940-07235-000		GAS VALVE
21	1	952-00498-000								WASHER, SIGHT PORT

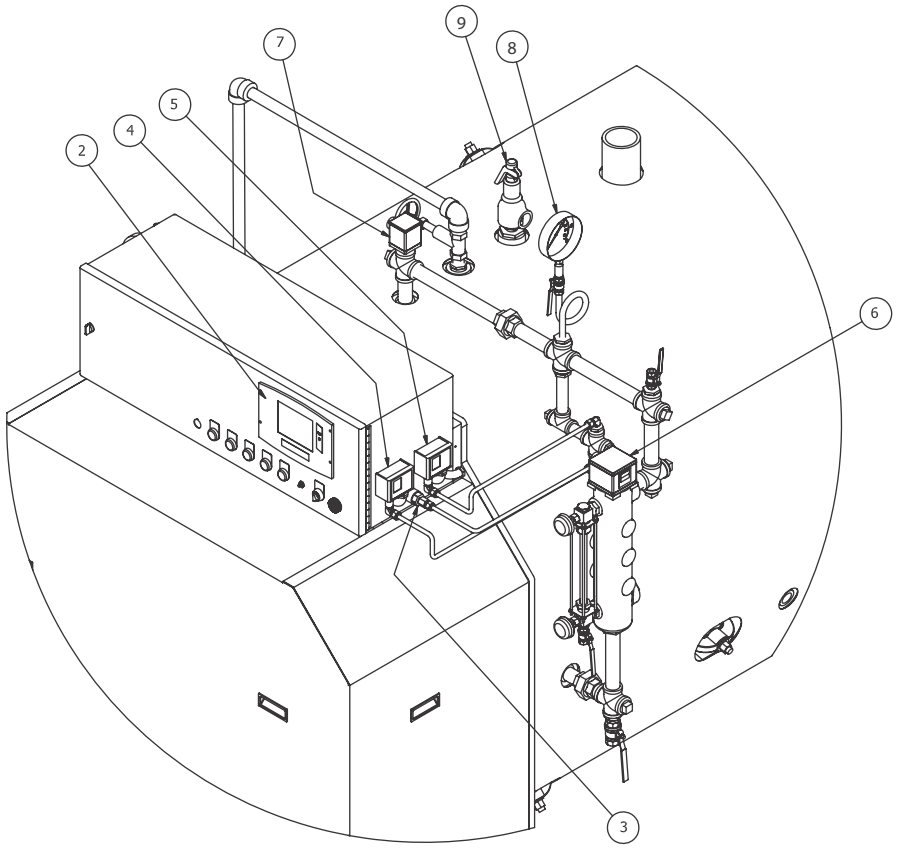


3. Boiler Controls

ITEM	15# STEAM	150# STEAM	DESCRIPTION
1	833-03725-000	833-03725-000	CB FALCON CONTROLLER, STEAM (STANDARD) - NOT SHOWN
	833-03578-000	833-03578-000	CB FALCON CONTROLLER, STEAM (OPTIONAL) - NOT SHOWN
2	833-03577-000	833-03577-000	CB FALCON DISPLAY
3	817-04385-000	817-04386-000	SENSOR, MODULATING CONTROL
4	817-04095-000	817-04093-000	PRESSURE CONTROL, OPERATING LIMIT
5	817-04094-000	817-04092-000	PRESSURE CONTROL, HIGH LIMIT, MANUAL RESET
6	833-03130-000	833-03130-000	LOW WATER CUTOFF DUAL FUNCTION CONTROL BOARD
	817-03983-000	817-03983-000	LOW WATER CUTOFF WATER COLUMN
7	833-03547-000	833-03547-000	AUX. LOW WATER CUTOFF CONTROL BOARD W/MANUAL RESET
	817-03984-000	817-03984-000	AUX. LOW WATER CUTOFF PROBE HOLDER
8	850-00243-000	850-00122-000	PRESSURE GAUGE
9	SEE TABLE		SAFETY RELIEF VALVE

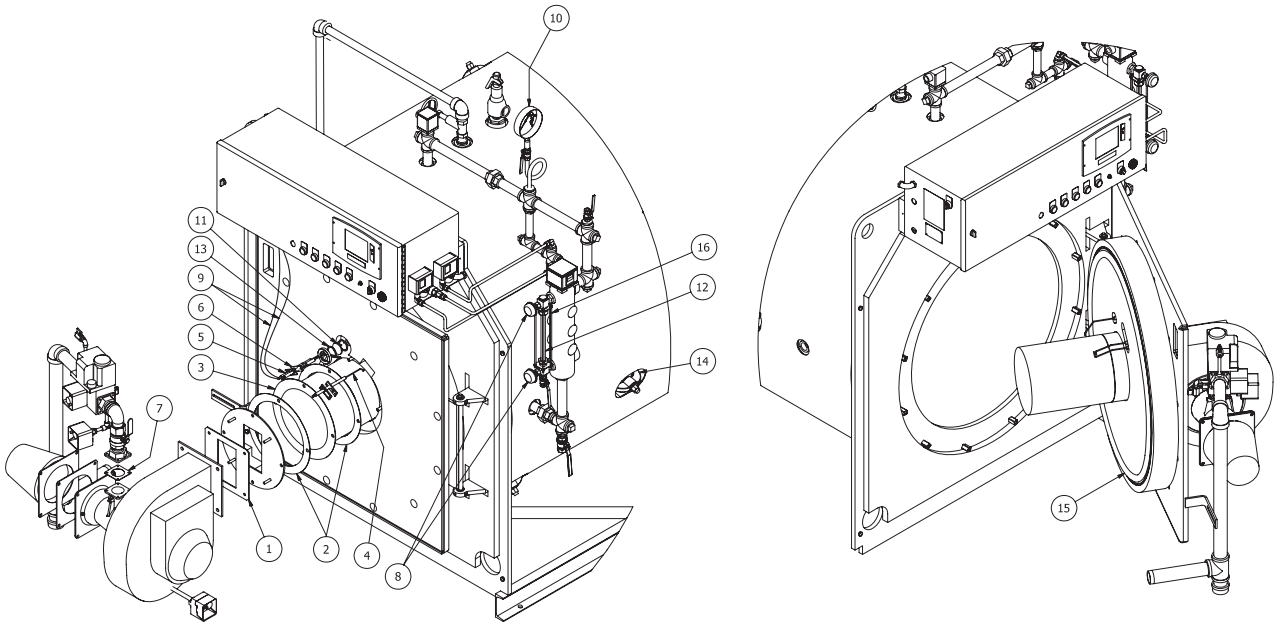
ITEM 9 - SAFETY RELIEF VALVE

	Boiler HP					
	10	15-20	25-30	40	50	60
15#	940-5073	940-5073	940-5072	940-4993	940-4993	940-5297
150#		940-5602	940-5500	940-5500	940-5453	940-5453



4. Recommended Spare Parts List

ITEM	QTY	10HP PART NO.	15HP PART NO.	20HP PART NO.	25HP PART NO.	30HP PART NO.	40HP PART NO.	50HP PART NO.	60HP PART NO.	DESCRIPTION
1	1	380-01037-000					380-01076-000	380-01038-000		GASKET, ADAPTER PLATE TO BLOWER
2	2	380-01053-000			380-01033-000	380-01034-000				GASKET, ADAPTER PLATE TO DOOR
3	1	380-01055-000	380-01045-000		380-01029-000	380-01030-000		380-01074-000		BURNER CANISTER
4	1	380-01062-000			380-01060-000					ELECTRODE, FLAME ROD
5	1	380-01061-000								ELECTRODE, DUAL, IGNITION
6	2	380-01032-000								GASKET, ELECTRODE
7	1	800-00098-000								GASKET, VENTURI
8	1	825-00132-000								VALVE SET, GAUGE GLASS
9	2	826-00156-000								CABLE, IGNITION
10A	1	850-00122-000								PRESSURE GAUGE, 0-300 PSI
10B	1	850-00243-000								PRESSURE GAUGE, 0-30 PSI
11	1	851-00026-000								SIGHT GLASS, PYREX
12	1	851-00199-000								GAUGE GLASS, PYREX, TUBULAR
13	2	853-00213-000								GASKET, SIGHT GLASS
14	4	853-00934-000								GASKET, HANDHOLE
15	1	853-00982-000 60" LG.	853-00982-000 60" LG.	853-00982-000 66" LG.	853-00982-000 66" LG.	853-00982-000 85" LG.	853-00982-000 85" LG.	853-00982-000 101" LG.	853-00982-000 101" LG.	GASKET, ROPE, DRY OVEN
16	1	912-00085-000								PROTECTOR SET, GAUGE GLASS



5. Direct Vent Combustion Kits

ITEM	QTY	PART NO.		DESCRIPTION
		20-30 HP	40-60 HP	
1	1	032A02607	032A02608	GASKET, AIR INLET FLANGE
2	1	059C07959	059C07950	PLATE, AIR INLET FLANGE
3	1	837-00171	037-00172	BOOT, RUBBER
4	4	868-00137	868-00137	CAPSCREW
5	4	952-00269	952-00269	WASHER
6	4	952-00082	952-00082	LOCKWASHER
7	4	869-00013	869-00013	NUT, HEX