CleaverBrooks®

Model CFLC

ClearFire

Condensing Boiler

4,000 - 12,000 MBTU

Operation and Maintenance Manual

750-363
11/2013

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

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

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 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

CLEAVER-BROOKS

Model CFLC

ClearFire *Packaged Boiler*

Condensing Boiler
Operation and Maintenance Manual

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

Manual Part No. 750-363
11/2013

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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Section 1
Introduction

A. CFLC FEATURES AND BENEFITS

Compact Firetube Design

The CFLC boiler is a two pass horizontally fired durable Firetube boiler. The extended heating surface tubes provide for very high levels of performance in a compact space. The boiler is designed to fire natural gas.

High Efficiency

With the extended heating surface tubes the boiler can produce fuel to water efficiency of up to 99% depending upon operating conditions.

Advanced Construction

Constructed to ASME standards, the CFLC Boiler will provide many years of trouble free service.

First pass tubes are made from SA178A Carbon Steel and are of rifle design for maximum heat transfer.

Second pass tubes are made from UNS S32101 Duplex Stainless Steel with AluFer extended heating surface inserts for maximum heat transfer.

Dual Temperature Return

Two return pipes - high and low temperature - allow condensing performance with as little as 10% return water at condensing temperature.

Ease of Maintenance

The steel enclosures are readily removable for access to all key components. A hinged burner provides access for burner maintenance and fireside inspection.

Quality Construction

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

ISO 9001 certified manufacturing process ensures the highest degree of manufacturing standards is always followed.

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 CFLC 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.

Designed For Heating Applications

The pressure vessel is constructed of durable ASTM Grade Steel and Stainless Steel materials to provide many years of operating life.

For vessel stress protection, the vessel is designed to prevent hot spots and has no minimum flow requirements.

B. STANDARD EQUIPMENT

1. The Boiler

The boiler is designed for a Maximum Allowable Working Pressure (MAWP) of 160 psig (11 Bar) in accordance with the ASME Code for Low Pressure Section IV Hot Water Boilers and is stamped accordingly. Operating pressure shall be less than 144 psig (9.9 Bar).

The vessel is mounted on a steel base with insulation & casing provided including trim and controls. Trim and controls include safety relief valve, pressure and temperature gauges, probe type low water control, and Falcon hydronic boiler control with associated sensors.

2. The Burner

Incorporating "premix" technology, the burner utilizes a venturi, dual safety shutoff gas valve, variable speed blower, and Fecralloy metal fiber burner head.

Variable speed combustion air fan provides 5:1 turndown.

Combustion canister of the burner is constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame, which provides low emissions.

At maximum firing rate, the sound level of the burner is less than 85 dBA, measured in front of the boiler at a distance of 3 feet.

Provision for direct vent combustion is furnished.

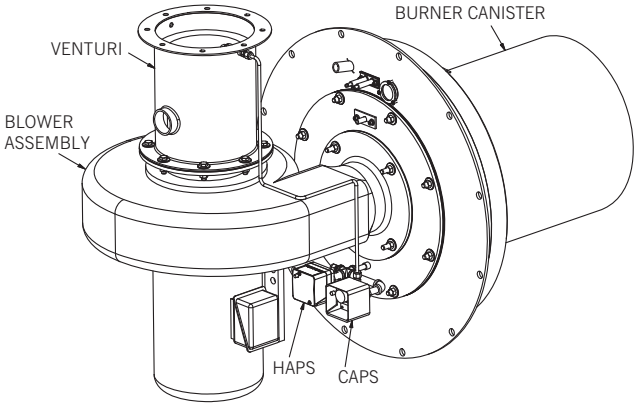


Figure 1-1 Burner Assembly

3. Burner Gas Train

The gas train assembly is provided in accordance with UL certification and complies with ASME CSD-1. The gas train assembly is factory assembled and wired, consisting of the following components:

A. Low Gas Pressure Switch - manual reset
B. High Gas Pressure Switch - manual reset
C. Gas valve with regulating actuator and safety shutoff
D. Manual Shutoff Ball Valve
E. Regulator (optional)

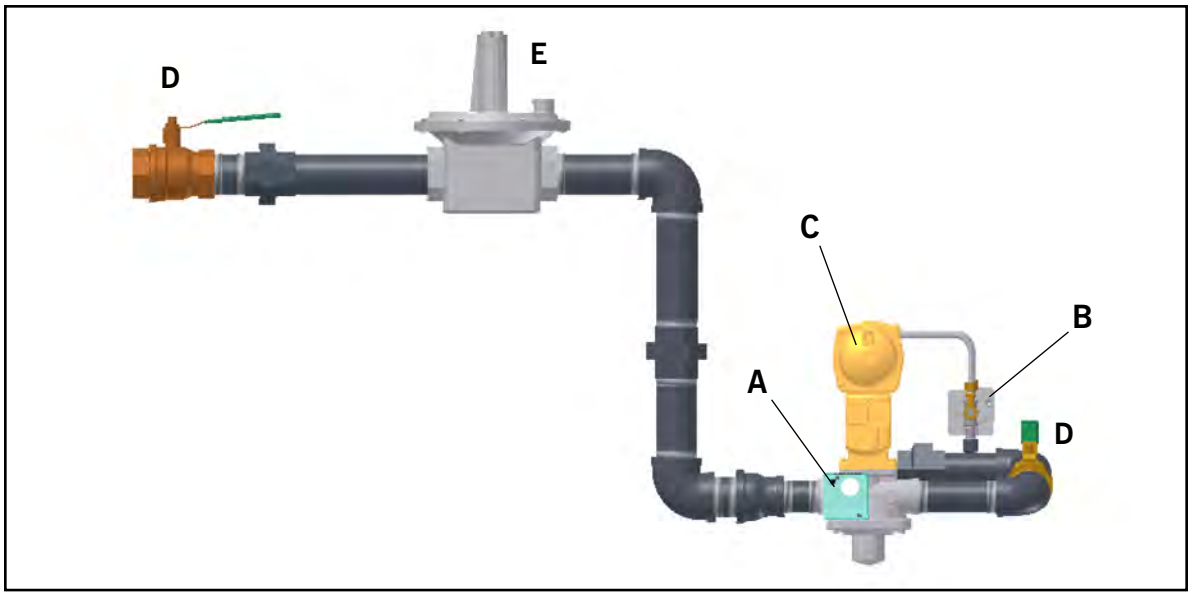


Figure 1-2 Gas Train

4. Control

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

The controller is capable of the following functions:

- Two (2) heating loops with PID load control.
- Burner sequencing with safe start check, pre-purge, pilot 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
- Lead/Lag for up to 8 boilers

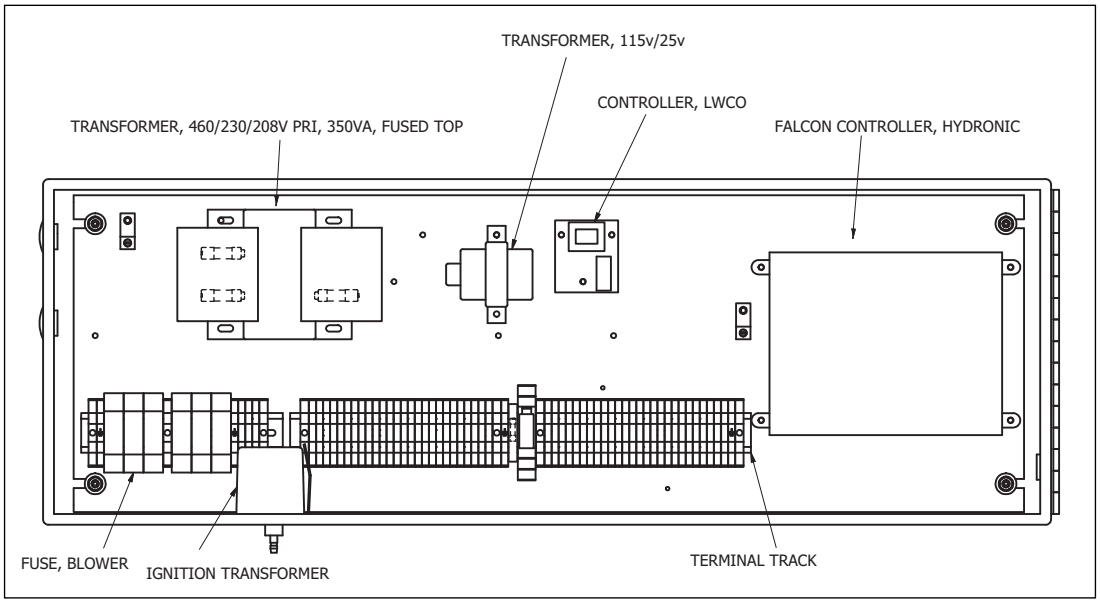


Figure 1-3 Control panel interior

5. Variable Speed Drive

Fan speed is controlled by a Variable Speed Drive mounted inside the front casing below the Falcon control panel.

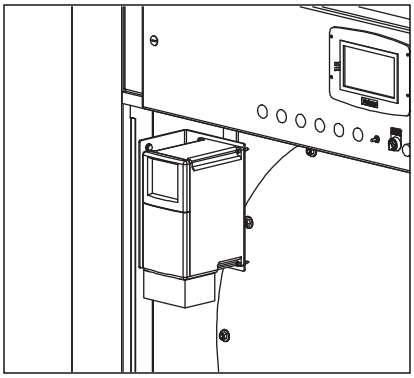


Figure 1-4 VSD (lower front casing removed)

6. Component/Connection Locations

Figure 1-5 shows the CFLC component orientation and heat flow path. The return water connections are at the lower vessel and the hot water outlet is at the top of the boiler.

Figure 1-6 shows the locations of the safety valve and air vent connections. **Figure 1-7** shows the location of the return water temperature sensor.

The stack is connected on the right side of the boiler when facing the front (**Figure 1-8**). The flue gas duct sizes may be reduced at the vent connection. See also Section 3, **Stack and Intake Vent Sizing and Installation**.

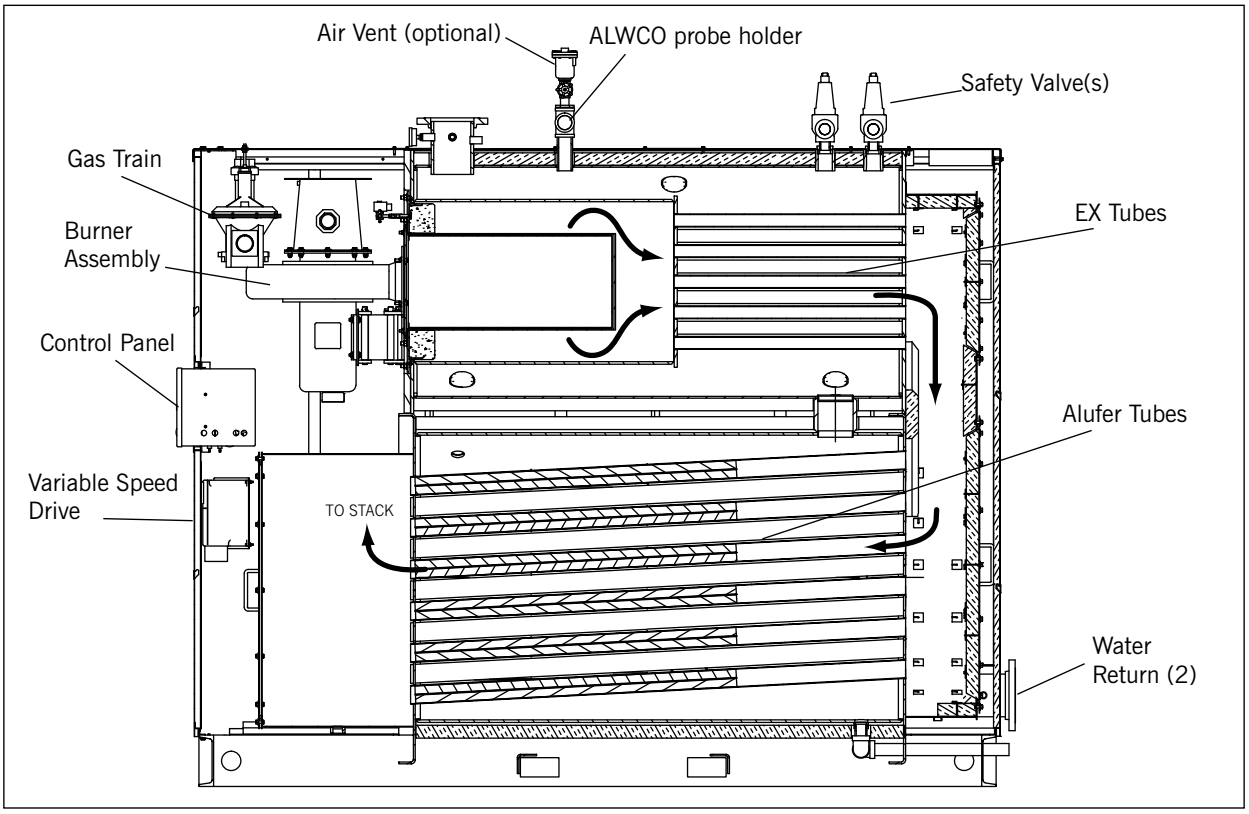


Figure 1-5 CFLC Cutaway

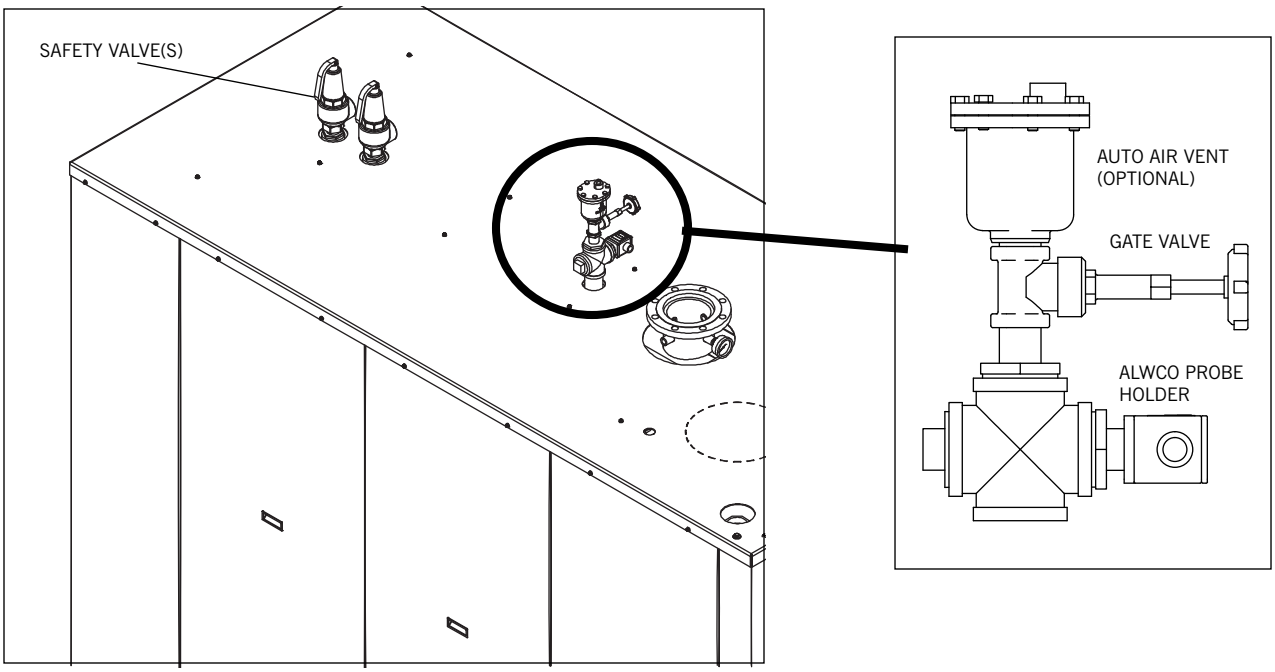


Figure 1-6 Boiler safety valve(s) & air vent

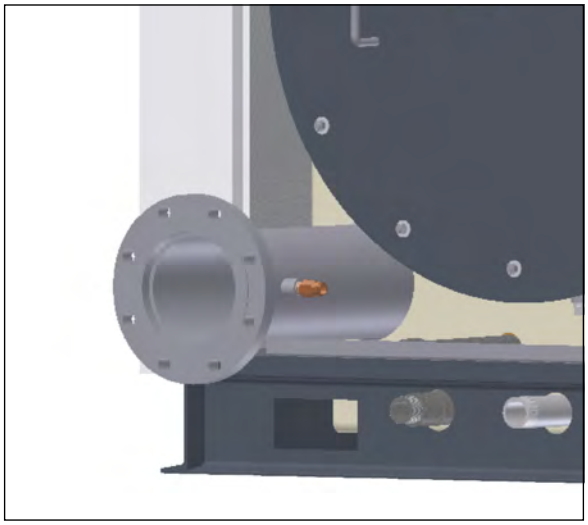


Figure 1-7 Return temperature sensor (rear casing & insulation not shown)

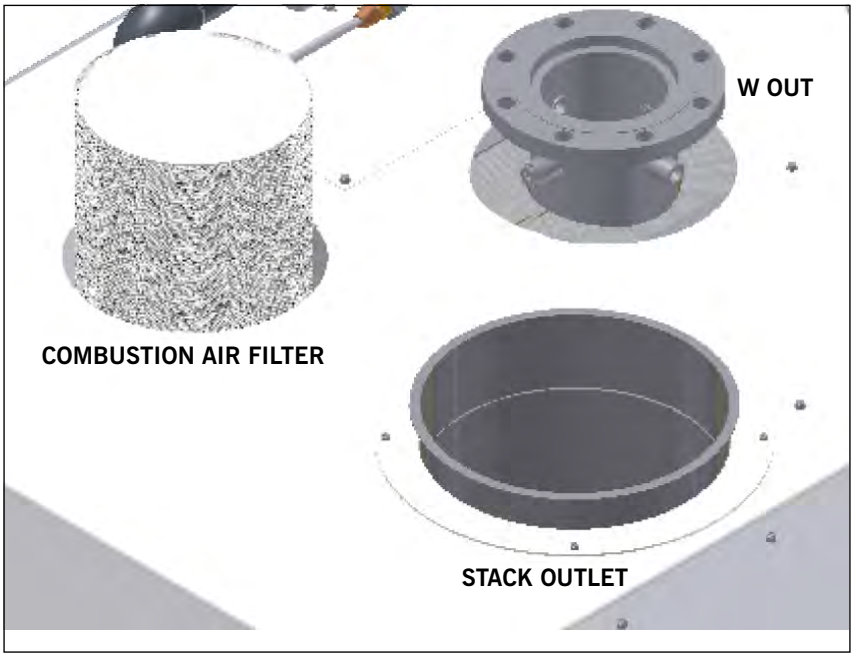


Figure 1-8 Stack Outlet

7. Optional Equipment

Certain project-specific options may have been supplied with the boiler if these options were 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 for project specifics.

These are the options that are available for the CFLC boiler from Cleaver-Brooks:

A. Condensate neutralization tank assembly - consists of neutralizing media, filter, and PVC condensate holding tank. This assembly is further described in Chapter 2.
B. Outside air intake for direct vent combustion.
C. Outdoor temperature sensor for outdoor reset, frost protection, and warm weather shutdown.
D. Header temperature sensor for multiple boiler Lead/Lag operation.
E. Alarm Horn for safety shutdown.
F. Relays for output signal for burner on, fuel valve open.
G. Stack Thermometer.
H. Stack temperature limit-sensor.
I. Auto air vent.
J. Boiler drain valve.

For options not listed, consult your authorized CB representative.

Section 2

Installation

⚠ Warning

Provisions for combustion and ventilation air must be in accordance with the National Fuel Gas Code, ANSI Z223.1, or the CAN/CSA B149 Installation Codes, or applicable provisions of the local building codes. *Failure to follow this warning could result in personal injury or death.*

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 sevice. Failure to follow this warning could result in equipment failure.

⚠ Warning

If an external electrical source is utilized, the boiler when installed must be electrically bonded to ground in accordance with the requrements of the authority having jurisdiction, or in the absence of such requirements with the National Electrical Code ANSI/NFPA 70 and/or the Canadian Electrical Code Part I CSA C22.1.

⚠ Warning

The installation must conform to the requirements of the authority having jurisdiction, or in the absence of such requirements, to the National Fuel Gas Code, ANSI Z223.1 and/or CAN/CSA B149 Installation Codes.

A. ASSEMBLY

1. Packaging

The Cleaver-Brooks Model CFLC boiler is shipped fully assembled, ready for installation.

2. Boiler placement

The boiler or boilers should be mounted in accordance with **Figure 2-1** below. Required front, rear, and side clearances are shown.

NOTE
The boiler assemblies are intended for installation in accordance with the appropriate standards of the National Fire Protection Association and the building code recommended by the American Insurance Association. ***Local codes may differ.*** Installation should provide clearances to unprotected combustible material not less than those indicated in the following: Clearances to adjacent combustible construction not less than 36 inches from control panel front, 24 inches from sides, and 36 inches above and rear. The floor beneath these units may be combustible. In all cases, the flue pipe shall not pass through any floor or ceiling or any combustible wall or partition unless suitably guarded.

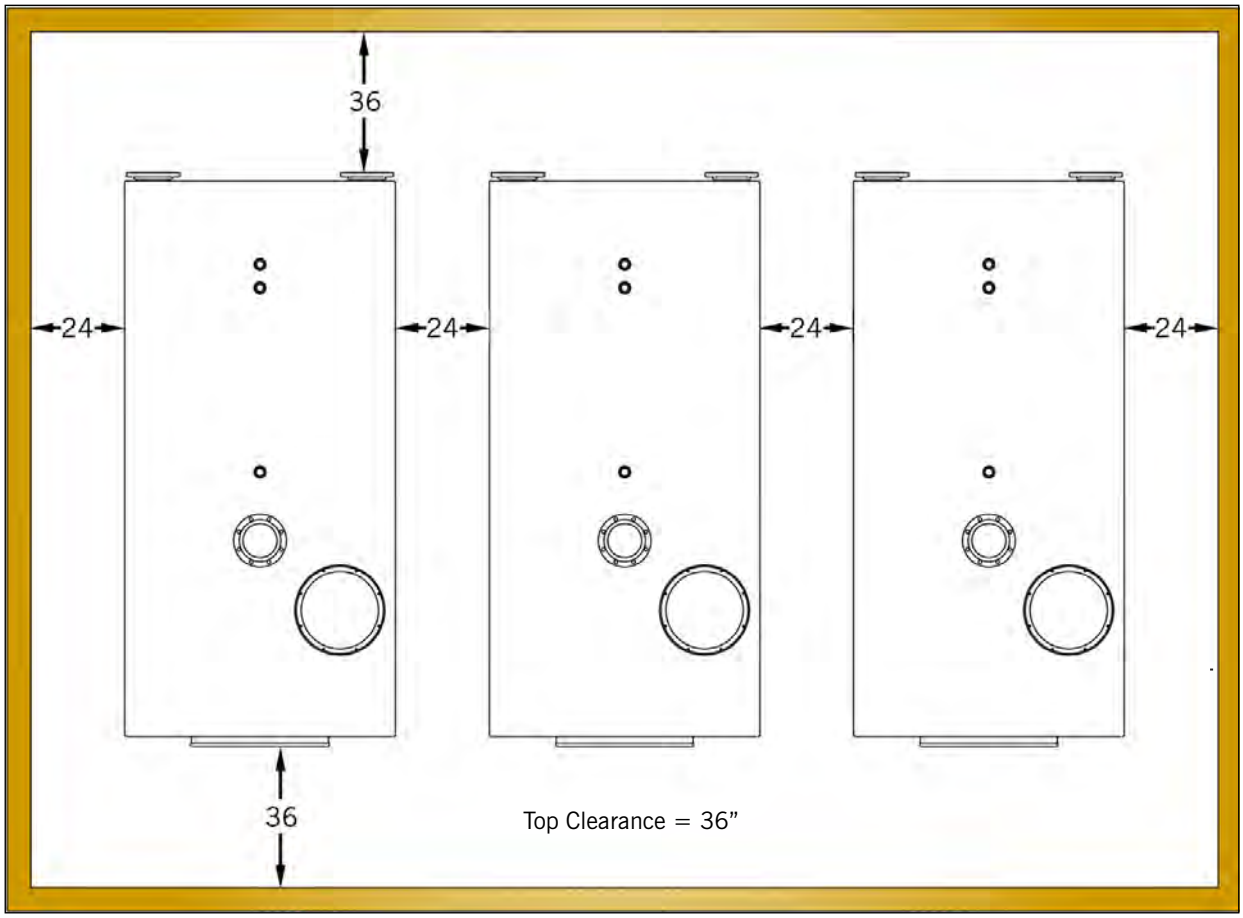


Figure 2-1 Clearance Required (inches)

B. FLUE GAS / COMBUSTION AIR CONNECTIONS

The flue gases from the Model CFLC boiler should be 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 boiler. Refer to flue piping manufacturer for proper installation and sealing instructions. See also Chapter 3 of this manual for combustion air and flue gas venting requirements.

C. WATER TREATMENT

Cleaver-Brooks ClearFire condensing boilers are suitable for heating systems without significant oxygenation capacity. Systems with continuous oxygenation capacity due to unknown or unseen leaks must be equipped with a system separation or pretreatment device.

Clean, soft water is generally the best heating medium for filling and make-up water in systems utilizing the Model CFLC. If the water available from the main system is not suitable for use, then demineralization and/or treatment with inhibitors is necessary. Treated filling and make-up water must be checked at least once a year or more frequently if so specified in the application guidelines from the inhibitor manufacturer.

Those parts of the boiler in contact with water are manufactured with both ferrous materials and corrosion-resistant stainless steel. The chloride content of the heating water must not exceed 30 ppm and the pH level should be between 8.3 to 9.5 after six weeks of operation.

To maintain the boiler's efficiency and prevent overheating of the heating surfaces, the values in **Table 2-1** should not be exceeded. Water make-up during the lifetime of the boiler should not be greater than 3 times the system volume. A water meter should be installed on the feed line to monitor makeup water volume.

Following production of the pressure vessel, the interior surfaces are cleaned and therefore a pre-start boil out of the vessel is not needed. Should the system require boil out or cleaning after installation of the CFLC, take care that no particulate matter reaches the boiler during the cleaning process. A removable filter should be used for this purpose.

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

Table 2-1 Model CFLC Water Chemistry

Parameter	Limit
pH	8.3 - 9.5
Chloride	30 ppm
Nitrates	50 ppm
Sulphates	50 ppm
Oxygen	0.1 ppm
Specific Conductivity	3500 μmho/cm
Total Hardness	<10 ppm

Table 2-2 Model CFLC Water Temperature Data (Non-Glycol)

Minimum inlet temp.	33°F
Maximum operating temp.	230°F
Maximum design temp.	250°F

D. USING GLYCOL

The Model CFLC boiler may be operated with a solution of glycol and water. Where glycols are added, the system must first be cleaned and flushed. Correct glycol selection and regular monitoring of the in-use

concentration and its stability is essential to ensure adequate, long-term freeze protection, including protection from the effects of glycol-derived corrosion resulting from glycol degradation.

Typically, ethylene glycol is used for freeze protection, but other alternatives exist, such as propylene glycol. Glycol reduces the water-side heat capacity (lower specific heat than 100% water) and can reduce the effective heat transfer to the system. Because of this, design flow rates and pump selections should be sized with this in mind.

Generally, corrosion inhibitors are added to glycol systems. However, all glycols tend to oxidize over time in the presence of oxygen, and when heated, form aldehydes, acids, and other oxidation products. Whenever inadequate levels of water treatment buffers and corrosion inhibitors are used, the resulting water glycol mixture pH may be reduced to below 7.0 (frequently reaching 5) and acid corrosion results. Thus, when pH levels drop below 7.0 due to glycol degradation the only alternative is to drain, flush, repassivate, and refill with a new inhibited glycol solution.

The following recommendations should be adhered to in applying ClearFire model CFLC boilers to hydronic systems using glycol:

1) Maximum allowable antifreeze proportion (% volume):
   50% antifreeze (glycol)
   50% water
2) Glycol minimum temperature rating 300 deg F (149 deg C).
3) The glycol concentration determines the maximum allowable firing rate and output of the boiler(s). Please refer to the firing rate limitation and corresponding high fire speed settings vs. glycol% in the charts below.
4) Maximum allowable boiler outlet/supply temperature: 200 deg F (93 deg C).
5) Minimum water circulation through the boiler:
   a) The minimum water circulation must be defined in such a way that the temperature difference between the boiler outlet/supply and inlet/return is a maximum of 40 deg F (22 deg C), defined as $\triangle$T (Delta T). A $\triangle$T Limit algorithm should be enabled in the boiler controller.
   b) Independent from the hydraulics of the heating system, constant water circulation through each boiler is required while the boiler is operating (requires a dedicated boiler pump if in a primary/secondary loop arrangement). Refer to table below for minimum boiler circulation rates.
6) Minimum over-pressure at the boiler:
   For outlet temperatures up to the maximum of 200 deg F (93 deg C), a minimum operating pressure of 30 psig (2.1 bar) is required.
7) pH level should be maintained between 8.3 and 9.5

Glycol Application Guidelines — ClearFire Model CFLC

Minimum required boiler circulation rate (gpm) at maximum firing rate				
ClearFire	System ΔT (˚F)			
Model-Size	ΔT = 10˚	ΔT = 20˚	ΔT = 30˚	ΔT = 40˚
CFLC-4000	920	460	307	230
CFLC-5000	1150	575	383	287
CFLC-6000	1380	690	460	345
CFLC-8000	1840	920	613	460
CFLC-10000	2299	1150	766	575
CFLC-12000	2759	1380	920	690

Notes/Limitations:

1. Maximum firing rate determined by ClearFire CFLC - Glycol Firing Rate Limitation chart (below).
   Maximum high fire blower speed should be set according to chart.
2. Glycol concentration limit of 25%-50%. Minimum required system operating pressure is 30 psig.
3. Maximum system operating temperature of 200 ˚F. Maximum ΔT of 40˚.
4. Circulation rates correlate with boiler output based on 92% nominal efficiency.
5. Standard altitude (<2000' ASL). Contact C-B for high altitude applications.
6. Pumps should be sized based on system design ΔT and minimum required flow rates.
7. At minimum firing rate, the minimum circulation rate should correspond to the boiler's turndown.

⚠ Warning

The boiler must not be installed on carpeting.

E. BOILER ROOM

The boiler room must comply with all building codes and regulations. An adequate supply of combustion air is required for safe operation. If the optional direct vent combustion air kit (**Figure 2-2**) is not used, ventilation must be provided to meet applicable regulations for air supply.

Note: See **Section 6, Parts,** for part numbers for the Direct Vent Combustion Air kits available.

Clean combustion air is required for optimum efficiency and boiler operation. Dust and airborne contaminants will adversely effect burner performance. If conditions dictate, a serviceable filter must be placed in the intake piping to eliminate airborne contamination to the burner. An optional air filter is available from Cleaver-Brooks. Additionally, if a direct vent combustion air intake vent is used the intake should be directed to eliminate rain or snow from entering the intake piping. The boiler must be installed so that the gas ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service.

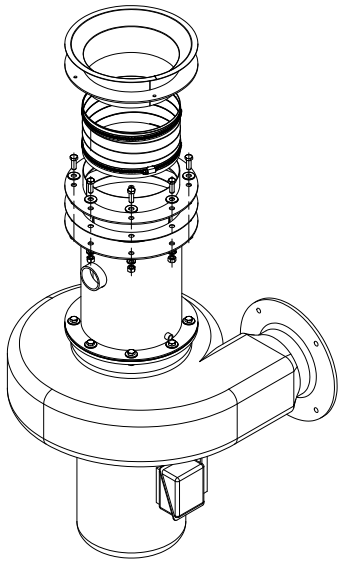


Figure 2-2 Direct Vent Combustion Air

F. GAS CONNECTIONS

1. General

The ClearFire Model CFLC gas fired condensing boilers are full modulating input units that require appropriate gas supply pressure and volume for proper operation. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and those of any local authorities having installation jurisdiction.

2. Gas Train Components

CFLC boilers are equipped with a gas train that meets the requirements of ASME CSD-1, FM and XL-GAP (formerly IRI). The gas train and its components have been designed and tested to operate for the highest combustion efficiency for the CFLC units.

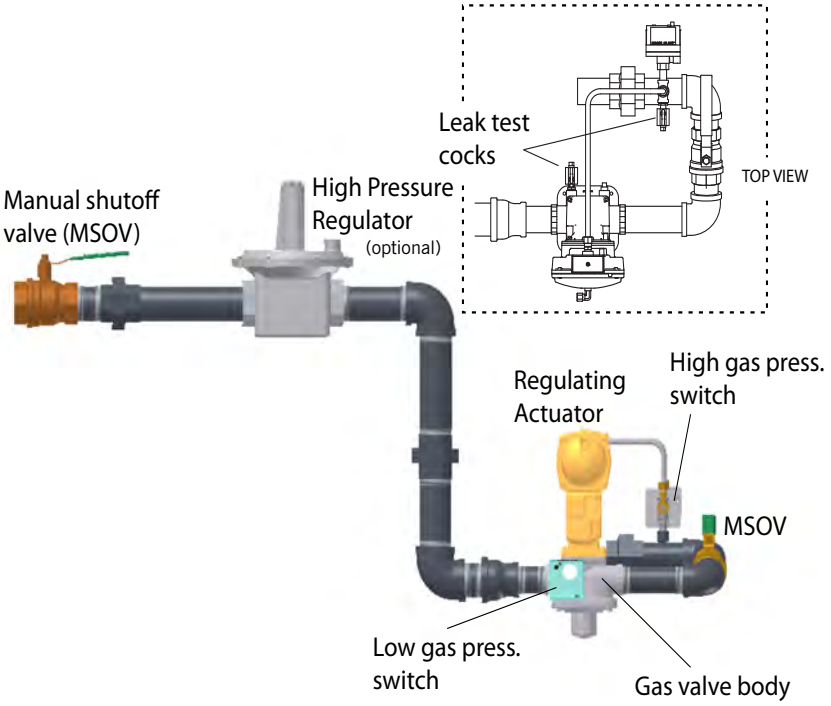


Figure 2-3 CFLC Gas Train (typical)

3. Gas Pressure Requirements

For proper and safe operation, each CFLC Series boiler requires a stable gas supply pressure. See **Table 2-3** for pressure requirements. Refer also to **APPENDIX D - GAS VALVE**.

Table 2-3 Model CFLC Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection	Max. pressure*
4000	14" WC	1.2 PSI
5000	14" WC	1.2 PSI
6000	28" WC	2 PSI
8000	28" WC	2 PSI
10000	31" WC	2 PSI
12000	31" WC	2 PSI

*Higher gas pressures will require an upstream high pressure step down regulator

Actual gas pressure should be measured when the burner is firing using a manometer at the upstream test port connection on the main gas valve. For a multiple unit installation, gas pressure should be set for a single unit first, then the remaining units should be staged on to ensure that gas supply pressure drop is not more than 1" w.c. and never below the required pressure. Fluctuating gas pressure readings could be

indicative of a faulty supply regulator or improper gas train size to the boiler. Refer to tables 2-4 and 2-5 for gas piping recommendations.

To measure pilot gas pressure, use the test port on the pilot solenoid valve.

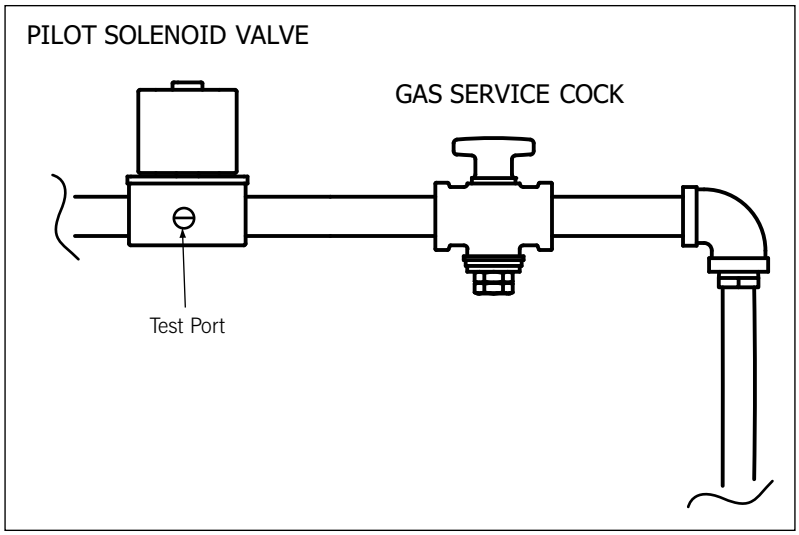


Figure 2-4 Pilot train

4. Gas Piping

If a regulator is required, do not use a common regulator to regulate pressure for a multiple unit installation. Use one high pressure regulator for each CFLC boiler.

The regulator for each boiler must be installed outside the boiler enclosure with at least 2 feet of pipe between the regulator and the boiler gas valve connection. The discharge range of the regulator must be able to maintain gas pressures as noted in **Table 2-3**.

For buildings or boiler rooms with gas supply pressure exceeding 1.2 psi (CFLC 4000/5000) or 2 psi for CFLC 6000-12000 a "full lock-up" type regulator is required as well as overpressure protection (e.g. relief valve).

In addition to the regulator, a plug type or "butterball" type gas shutoff valve must be installed upstream of the regulator for use as a service valve. This is also required to provide positive shutoff and isolate the unit during gas piping tests.

If necessary a strainer should be installed upstream of the regulator to remove debris from the gas supply.

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 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.

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.

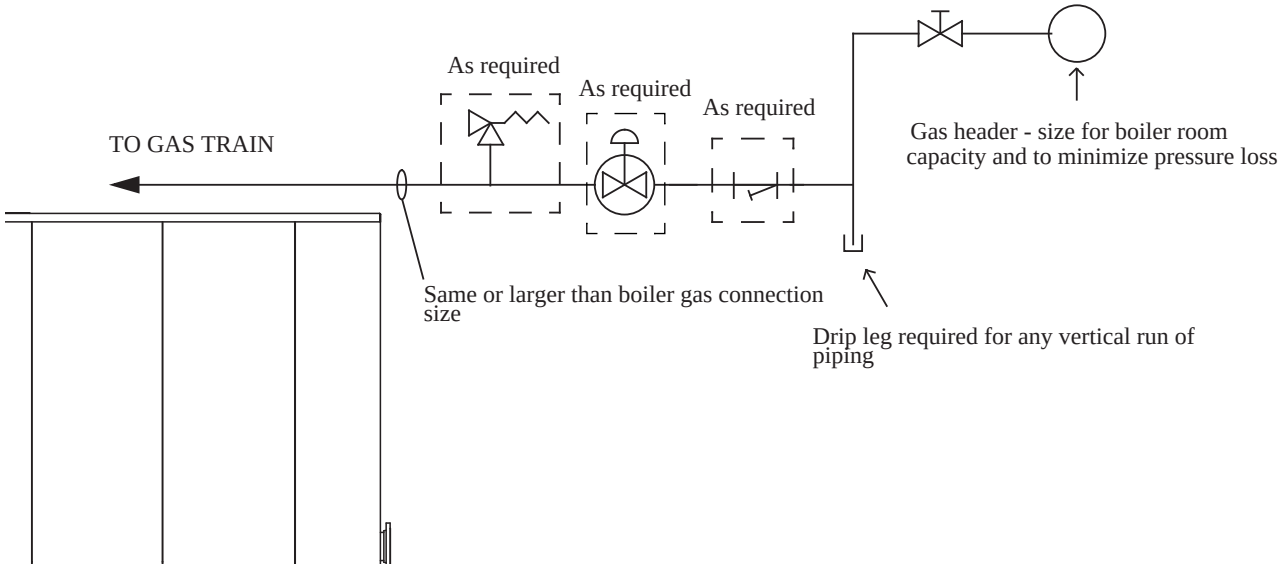
After initial startup, the inlet screen to the gas valve should be checked and cleaned of any debris buildup that may have resulted from installation.

See **Figure 2-5** for a typical piping configuration.

⚠ Caution

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).
The boiler must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 1/2 psi (3.5 kPa).

Figure 2-5 Gas Piping



5. Gas Supply Pipe Sizing

For proper operation of a single unit or a multiple unit installation, CB recommends that the gas piping 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. Higher supply pressure systems may allow for a greater pressure drop. In ALL cases, minimum supply pressures must be met for proper operation of the boiler(s). 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 (cfh) 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, see gas piping Tables **2-4** and **2-5**. 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 unit with 4,000,000 btu/hr input divided by a gas calorific value of 1060 will result in a flow of 3774 cfh. 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 2-4** that a supply pipe size of 3" should be used as a minimum.

Table 2-4: Gas Line Capacity - Schedule 40 Metallic Pipe

Pipe Size			
Nominal	2-1/2"	3"	4"
Actual I.D.	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)		
10	4,860	8,580	17,500
20		5,900	12,000
30			9,660
40			8,290
50			7,330
60			6,640
70			6,110
80			5,680
90			5,330
100			5,040
125			4,460
150			4,050
175			
200			
**Fuel: Natural Gas			
**Inlet Pressure: Less than 2.0 psi			
****Pressure Drop: 0.30" w.c.**			
**Specific Gravity: 0.60			

Table 2-5: Gas Line Capacity - Schedule 40 Metallic Pipe

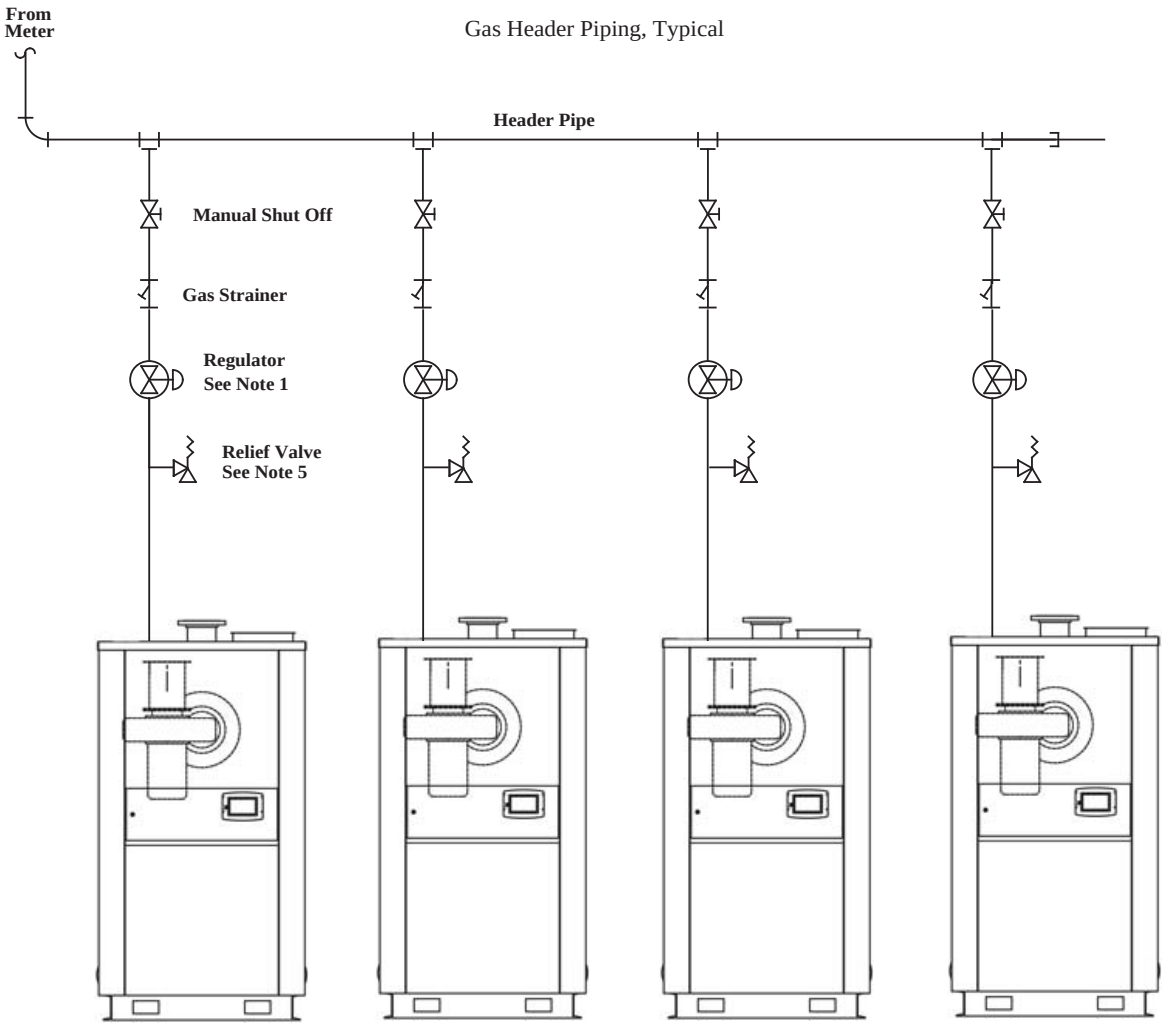
Pipe Size				
Nominal	2"	2-1/2"	3"	4"
Actual I.D.	2.067"	2.469"	3.068"	4.026"
Length in feet	**Maximum Capacity in Cubic Feet of Gas per Hour (cfh)			
10	4,020	6,400	11,300	23,100
20		4,400	7,780	15,900
30			6,250	12,700
40			5,350	10,900
50			4,740	9,600
60			4,290	8,760
70				8,050
80				7,490
90				7,030
100				6,640
125				5,890
150				5,330
175				4,910
200				4,560
**Fuel: Natural Gas				
**Inlet Pressure: Less than 2.0 psi				
****Pressure Drop: 0.50" w.c.**				
**Specific Gravity: 0.60				

6. Gas Header

Design of a single common gas header with individual takeoffs for a multiple unit installation is recommended. Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main header.

For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, determine length of run from the source and determine what size header will be needed for the flow of all units firing.

Figure 2-6 Gas header piping



NOTES:
1. Dedicated gas pressure regulator required for each boiler if gas supply greater than max. pressure in Table 14
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. Overpressure protection required if gas supply pressure > 5 psig.

G. BOILER WATER PIPING

1. General

All boiler hot water outlet and return piping is connected at the rear of the boiler. Piping is to be installed per local codes and regulations.The pipelines for the hot water outlet and return may be connected in the usual manner without removing the cladding elements. Unused connectors must be safely blanked off.

2. Safety valve

The pressure relief valve (safety valve) should be piped from the coupling on top of the boiler (see **Figure 2-7**). 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.

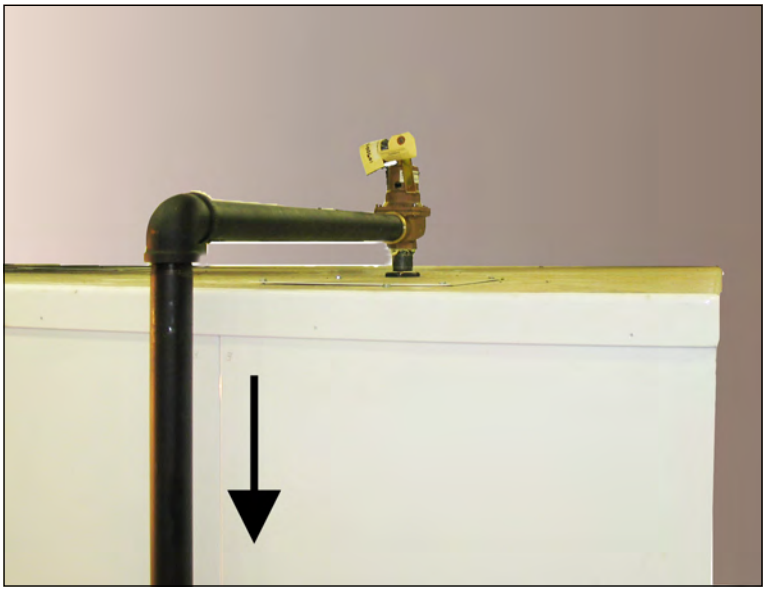


Figure 2-7 Pressure relief valve piped to safe point of discharge

⚠ Warning

Only properly certified personnel such as the safety valve manufacturer's certified representative should adjust or repair the boiler safety valve. *Failure to follow this warning could result in serious personal injury or death.*

3. Dual return design

The Model CFLC features separate high and low temperature return water connections, allowing for condensing performance within high temperature hydronic systems. With as little as 10% return water at or below 120 deg F, the Model CFLC will achieve condensing performance, with associated gains in efficiency.

If using only a single (common) return, the low temperature connection should be used. The low temperature connection is on the left when facing the rear of the boiler.

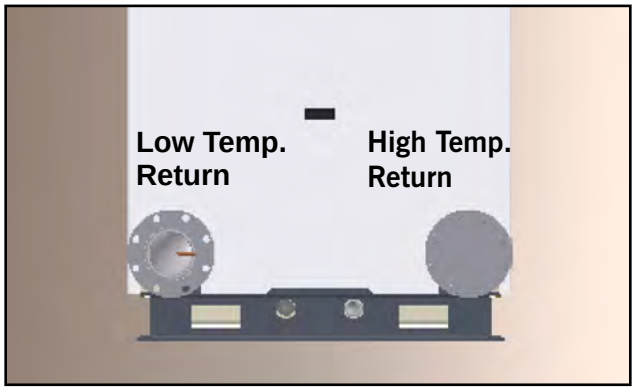


Figure 2-8 Dual returns

4. Pressure drop curves

The information in **Figure 2-8** and in Tables **2-6** and **2-7** can help in determining pump requirements for Model CFLC installations.

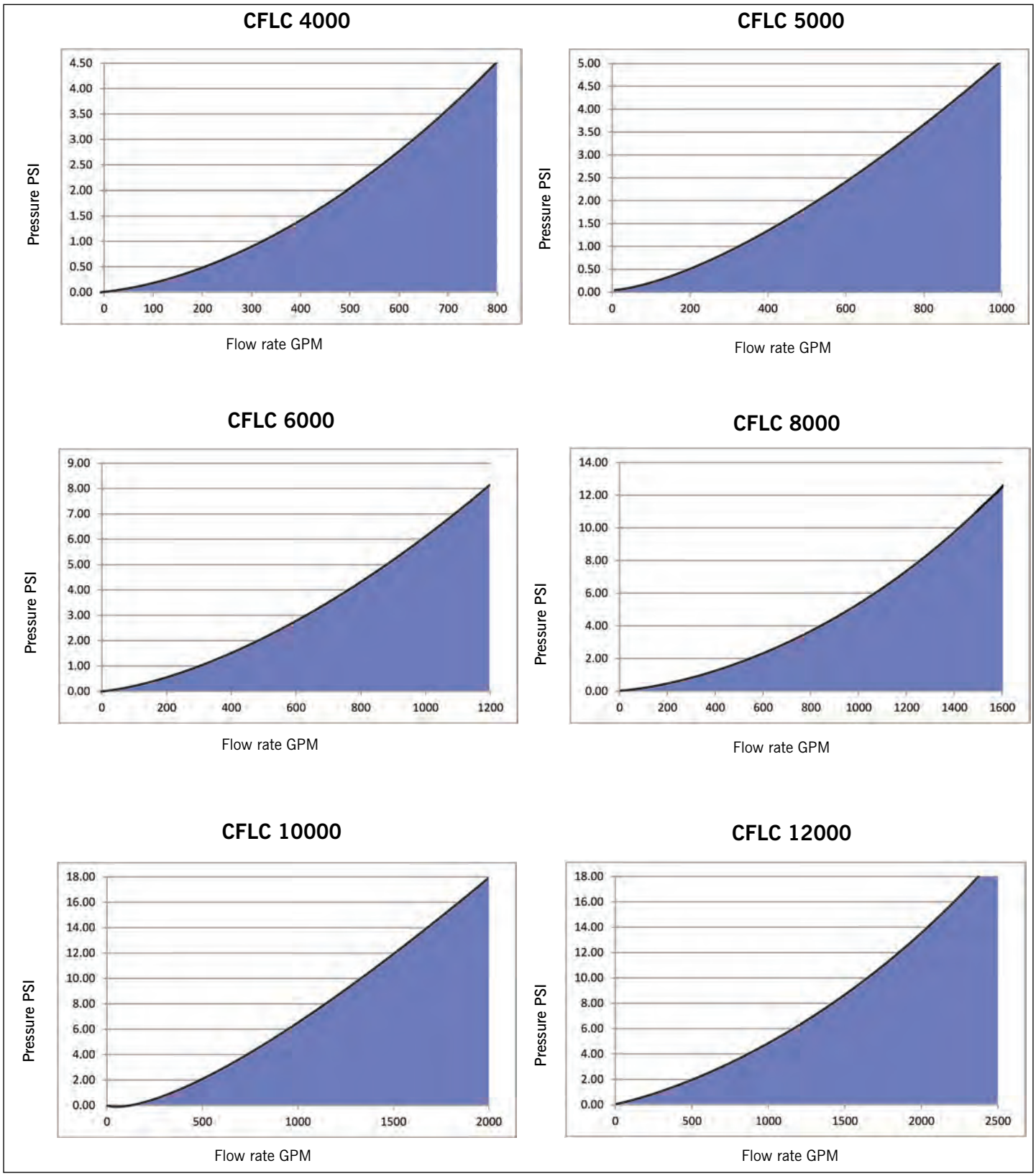


Figure 2-9 Pressure Drop Curves, CFLC

Table 2-6: CFLC flow rates

	System Temperature Drop Deg F					
Boiler Size	10	20	40	60	80	100
	Flow Rate GPM					
4000	752	376	188	125	94	75
5000	940	470	235	157	117	94
6000	1128	564	282	188	141	113
8000	1504	752	376	251	188	150
10000	1880	940	470	313	235	188
12000	2255	1128	564	376	282	226
Flow rates relative to temperature drop so as not to exceed boiler output. Based on 94% nominal efficiency.						

Table 2-7: CFLC flow rates (metric)

	System Temperature Drop Deg C					
Boiler Size	6	11	22	33	44	56
	Flow Rate m3/hr					
4000	171	85	43	28	21	17
5000	213	107	53	36	27	21
6000	256	128	64	43	32	26
8000	341	171	85	57	43	34
10000	427	213	107	71	53	43
12000	512	256	128	85	64	51
Flow rates relative to temperature drop so as not to exceed boiler output. Based on 94% nominal efficiency.						

H. CONDENSATE REMOVAL AND TREATMENT

The condensate generated during normal boiler operation must be removed in accordance with local codes and regulations. The condensate can be piped to a local treatment system or run into the optional condensate treatment assembly.

The water trap must be filled with water prior to commissioning and checked or refilled at each required maintenance interval.

Notice

The condensate occurring during operation in both the boiler and the flue gas pipeline has to be neutralized and piped to a safe drain. The conditions for the discharge of condensates into public drain systems are determined by the local authorities and municipalities.

Condensate leaving the boiler normally has a pH of 4-6. The responsible authority will inform you if a higher pH value is required for condensate piped to drain. The CFLC neutralization system contains the granulate NEUTRALAT, a natural compound which acts to increase the pH of the condensate flowing through it. The neutralization system comprises the plastic neutralization tank with condensate inlet, granulate chamber and condensate outlet. The system is installed per **Figure 2-11**.

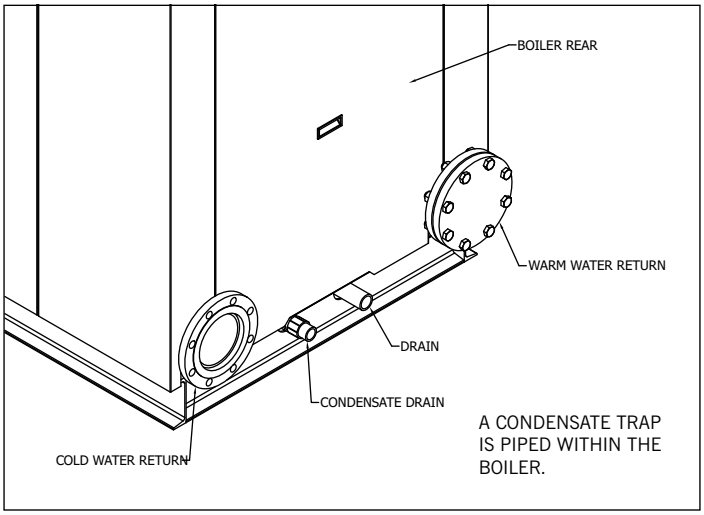


Figure 2-10 Condensate Piped Direct to Drain

Note: To ensure compliance with regulations, it is important to contact the responsible authorities prior to the planning and execution of the boiler installation. Condensate flow of 20 to 80 GPH can be expected depending on boiler size and return water temperature.

1. Condensate tank setup options

(1) Condensate direct to drain - The condensate is piped directly to a drain through the piping and water trap supplied during installation (see **Figure 2-10**). Piping is to be a minimum of 1-1/4" NPT.

(2) Condensate to treatment tank - The condensate is held in a condensate tank near the boiler. The condensate is neutralized as it passes through the granular bed. The neutralized condensate is then piped to the drain.

- To install the system, assemble the tank and fittings per instructions supplied with tank. Neutralization media are already installed in tank.
- Install the condensate tank cover and connect tank to boiler condensate discharge.

Pipe to an appropriate drain.

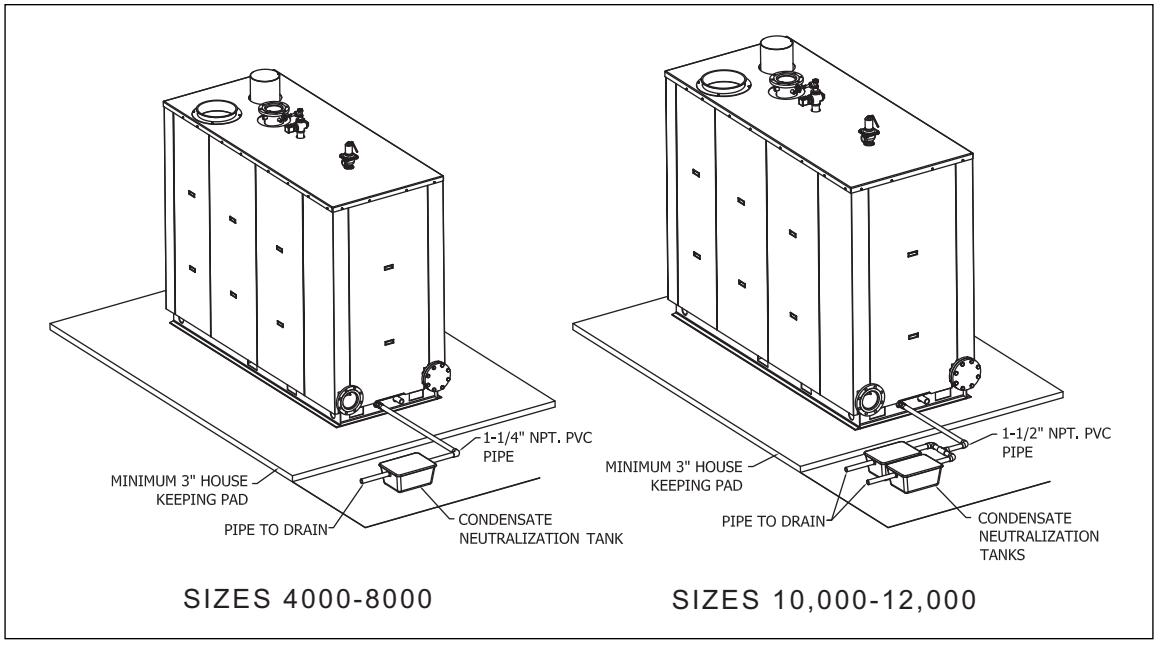


Figure 2-11 Condensate Treatment Tank

The neutralization media will require periodic replacement, to be determined by pH analysis of condensate. If condensate is too acidic (pH is below acceptable value) the neutralization media should be replaced.

The neutralizing media should be gently agitated periodically to ensure even distribution and to avoid channeling of the condensate.

The number of condensate treatment tanks required depends on the total amount of condensate produced by the system. As a general rule, CB recommends one tank per boiler (sizes 4,000 - 8,000) and two tanks (sizes 10,000 - 12,000).

CFLC Model	BTU/hr	Max. Condensation GPH
4000	4,000,000	27
5000	5,000,000	34
6000	6,000,000	41
8000	8,000,000	54
10000	10,000,000	68
12000	12,000,000	82

I. ELECTRICAL CONNECTIONS

A qualified electrician or service technician must make the electrical connections to the boiler.

For specific information on your boiler electrical system refer to the Cleaver-Brooks wiring diagram provided with the boiler.

Power is to be run from the top left corner of the boiler to the control panel (see **Figure 2-12**). AC power is to be connected to the incoming power terminals.

Note: The following temperature sensor cables should not be run near the high voltage incoming power wiring.

- Hot water outlet temperature sensor.
- Hot water return temperature sensor.
- Stack temperature sensor (optional).
- Outdoor temperature sensor (optional).

⚠ Warning

Ensure ignition cables are properly connected and not in direct contact with any sharp metal edges.

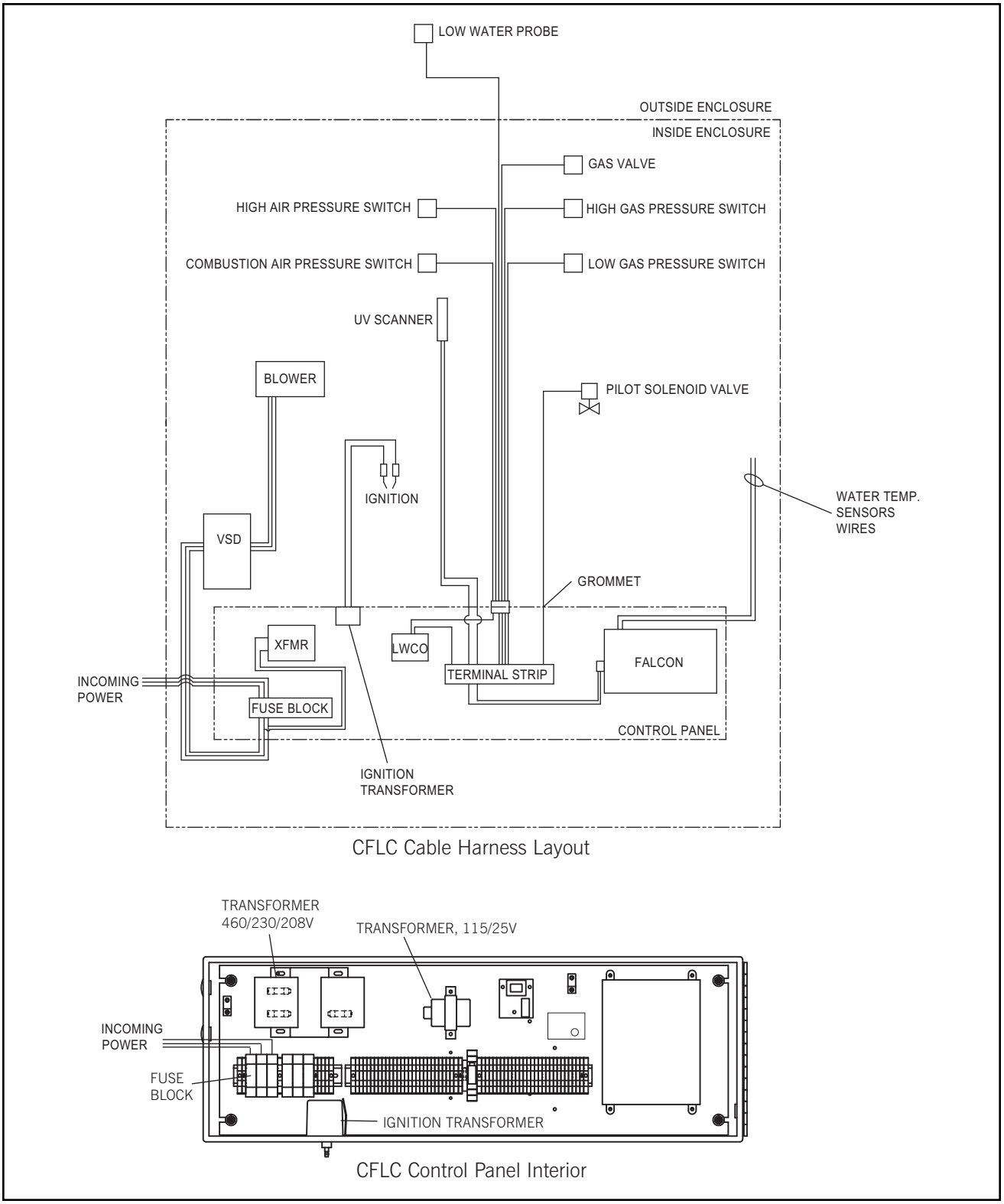
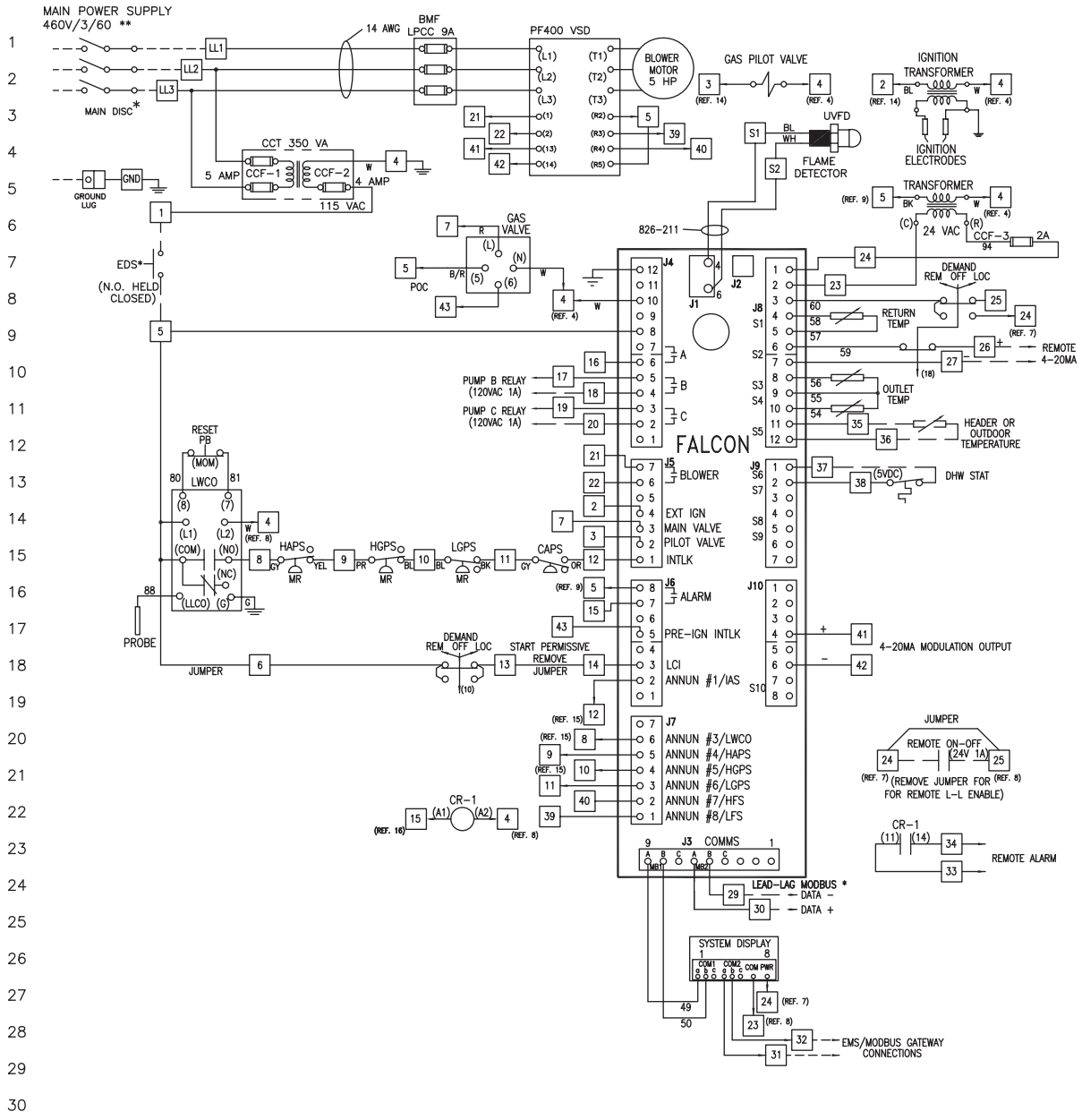


Figure 2-12 Electrical Connections CFLC

J. WIRING DIAGRAM



NOTES:
DASHED LINES INDICATE CUSTOMER CONNECTIONS
ALL CONTROL WIRE IS #18 AWG UNLESS OTHERWISE NOTED
COLOR DESIGNATIONS APPLY TO WIRE COLORS INSIDE CONTROL PANEL

DENOTES CONTROL PANEL TERMINAL

* FALCON L-L MODBUS - CONNECT EACH BOILER IN NETWORK DAISY CHAIN

CUSTOMER CONNECTIONS:
LEAD-LAG MODBUS 29 & 30
BLDG EMS/MODBUS GATEWAY 31 & 32
REMOTE ENABLE 24 & 25
REMOTE 4-20MA INPUT 26 & 27
HEADER OR OUTDOOR TEMPERATURE 35 & 36
AUX PUMP RELAYS 17 & 18, 19 & 20
DOMESTIC HOT WATER STAT 37 & 38

TERMINALS: 1,2,3,4-4-4,5-5-5,6,7,8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22, 23-23,24-24,25,26,27, 28,29,30,31,32,33,34,35,36, 37,38,39,40,41,42,43,44 S1,S2,

Figure 2-13 CFLC Wiring Diagram, single fuel (typical)

Note: Wiring diagrams shown are examples only. Installations may vary. For specific installations consult the wiring diagram provided with the boiler.

Section 3

Stack and Intake Vent Sizing and Installation

A. VENTING CONNECTIONS - GENERAL

1. Appliance Categories

Proper installation of flue gas exhaust venting is critical for the efficient and safe operation of the CFLC boiler. The boiler's appliance category is a major factor determining venting system design.

Definitions:

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.

Depending on the application, the Model CFLC may be considered Category II, III, or IV. The specifying engineer should dictate flue venting as appropriate to the installation.

Notice

For additional information on boiler categorization, see appropriate ANSI Z21 Standard and the latest edition Standard of National Fuel Gas Code or in Canada, the latest edition of CSA 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 II, III or IV 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. Condensate can freeze on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition.

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.

Vent material should be appropriate for the Appliance Category. Application-specific information will further determine the material selected.

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.**

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/CSA-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:
    - The verandah, porch or deck is fully open on a minimum of two sides beneath the floor.
    - 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 direct 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

Follow items listed below to avoid personal injury or property damage.

- Cut nonmetallic vent pipe with 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.

4. Draft Tolerances

Maximum allowed pressure at vent connection is plus or minus 0.25 inches WC.

Recommended maximum design pressure at vent connection is 0.10 inches WC.

B. VERTICAL VENTING / INSIDE COMBUSTION AIR

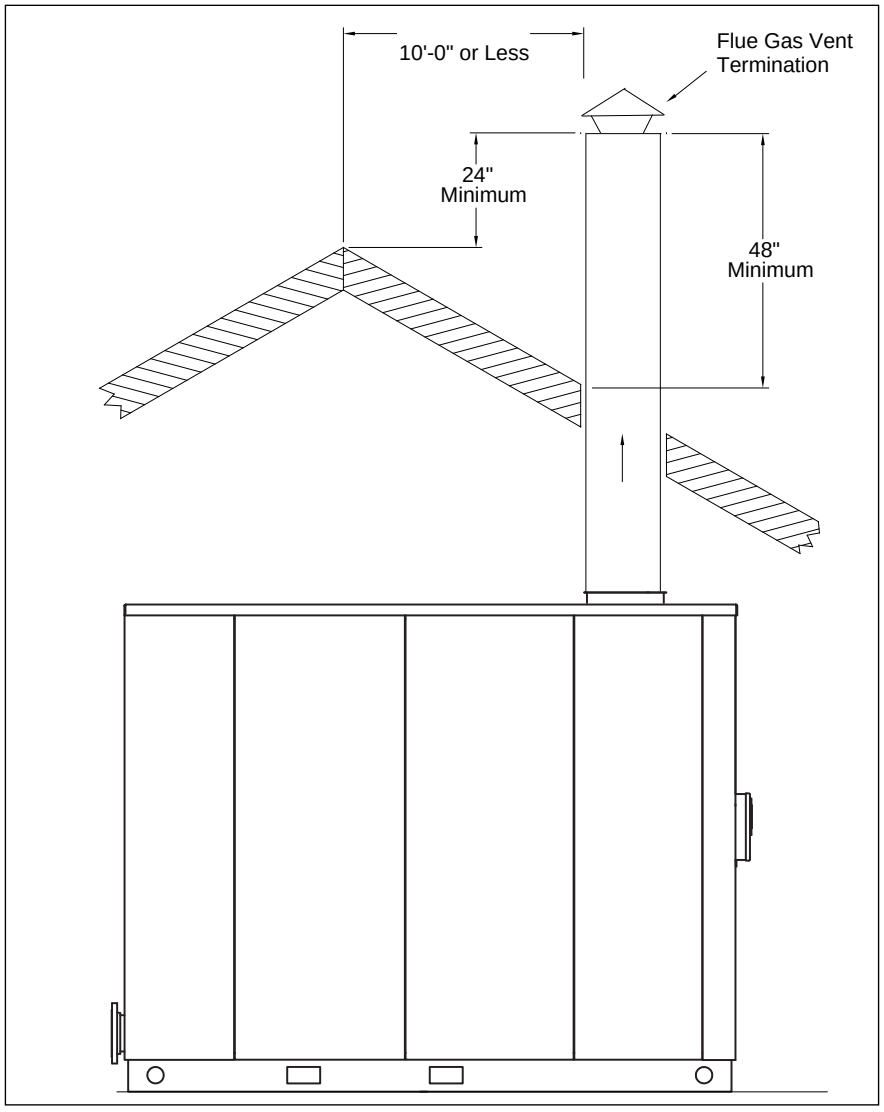


Figure 3-1 Vertical Stack with Inside Combustion Air

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/CSA-B 149.1 and 149.2 Installation Code for Gas Burning Appliances and Equipment.

To prevent accumulation of condensation in the vent, it is required to install the horizontal portion of vent with a slight slope of at least 1/4” per foot of horizontal run, pitched either back to the boiler or to a low point equipped with suitable condensate trap and drain.

⚠ Warning

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

C. VERTICAL VENTING / DIRECT VENT COMBUSTION AIR

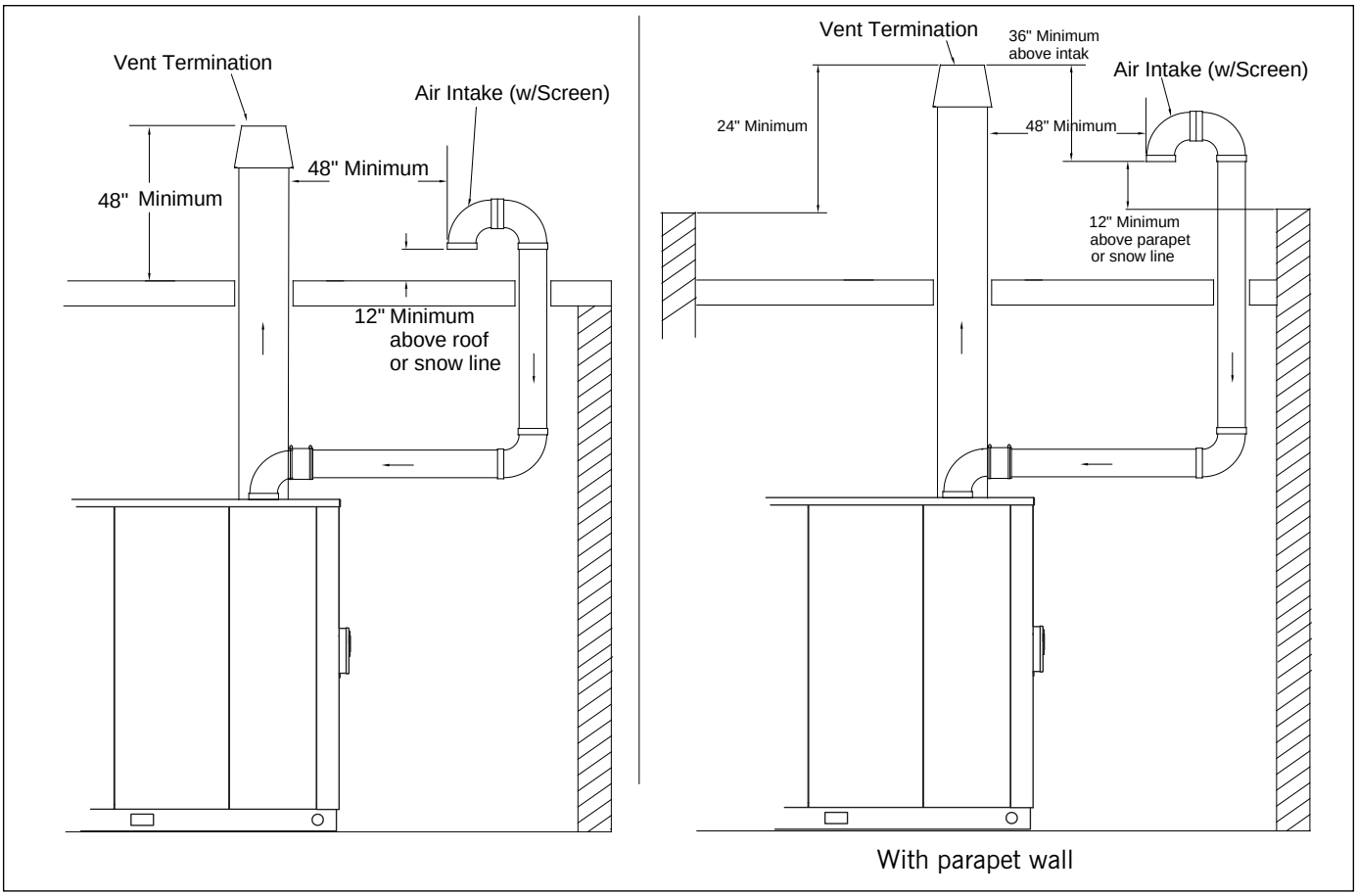


Figure 3-2 Vertical Stack with Direct Vent Combustion Air

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

To prevent accumulation of condensation in the vent, it is required to install the horizontal portion of vent with a slight slope of at least 1/4” per foot of horizontal run, pitched either back to the boiler or to a low point equipped with suitable condensate trap and drain.

D. VENTING FOR MULTIPLE UNITS

Cleaver-Brooks recommends that each Model CFLC in a multiple boiler installation be vented individually. If it becomes necessary to connect multiple boilers to a common breeching, measures should be taken to ensure an unrestricted flow of flue gas from each boiler.

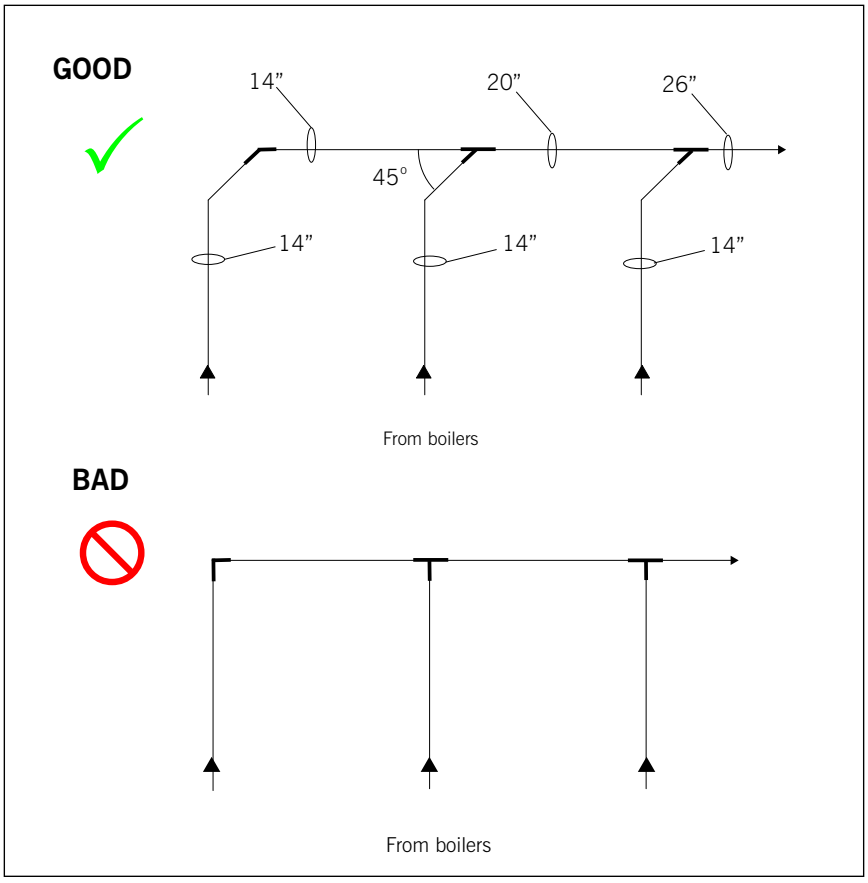
An active draft inducer is recommended when venting multiple boilers. In the absence of a draft inducer, ductwork sizing and connections require special attention.

Use 'wye' connections (not 'tees') to connect each boiler to the common breeching (see Examples 1 and 2 below).

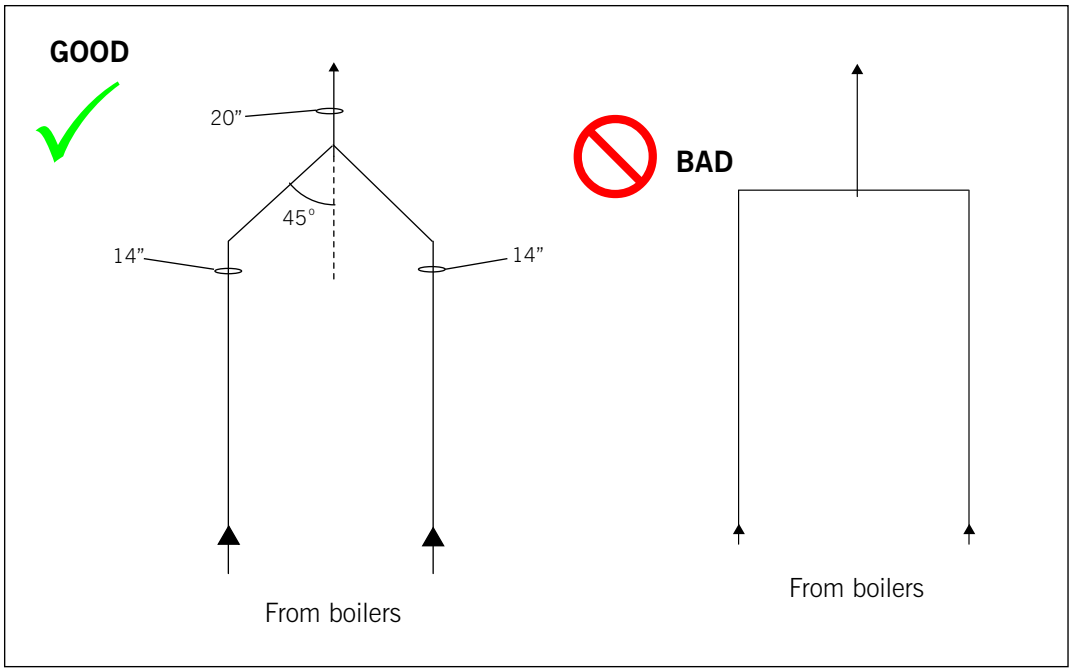
Breeching should be sized upward when necessary to accommodate additional boilers (see Example 3). As a rule of thumb, the cross-sectional area of any ductwork downstream of a wye connection should be equal to or greater than the combined area of the incoming vent sections.

When multiple boilers are connected in a Falcon-controlled lead/lag network, a 'Fan rate during off cycle' feature is available. When a boiler goes off line and completes a post purge, the fan will continue to run at a user-selectable rate. This feature provides a further measure to prevent flue gas from flowing back into the boiler.

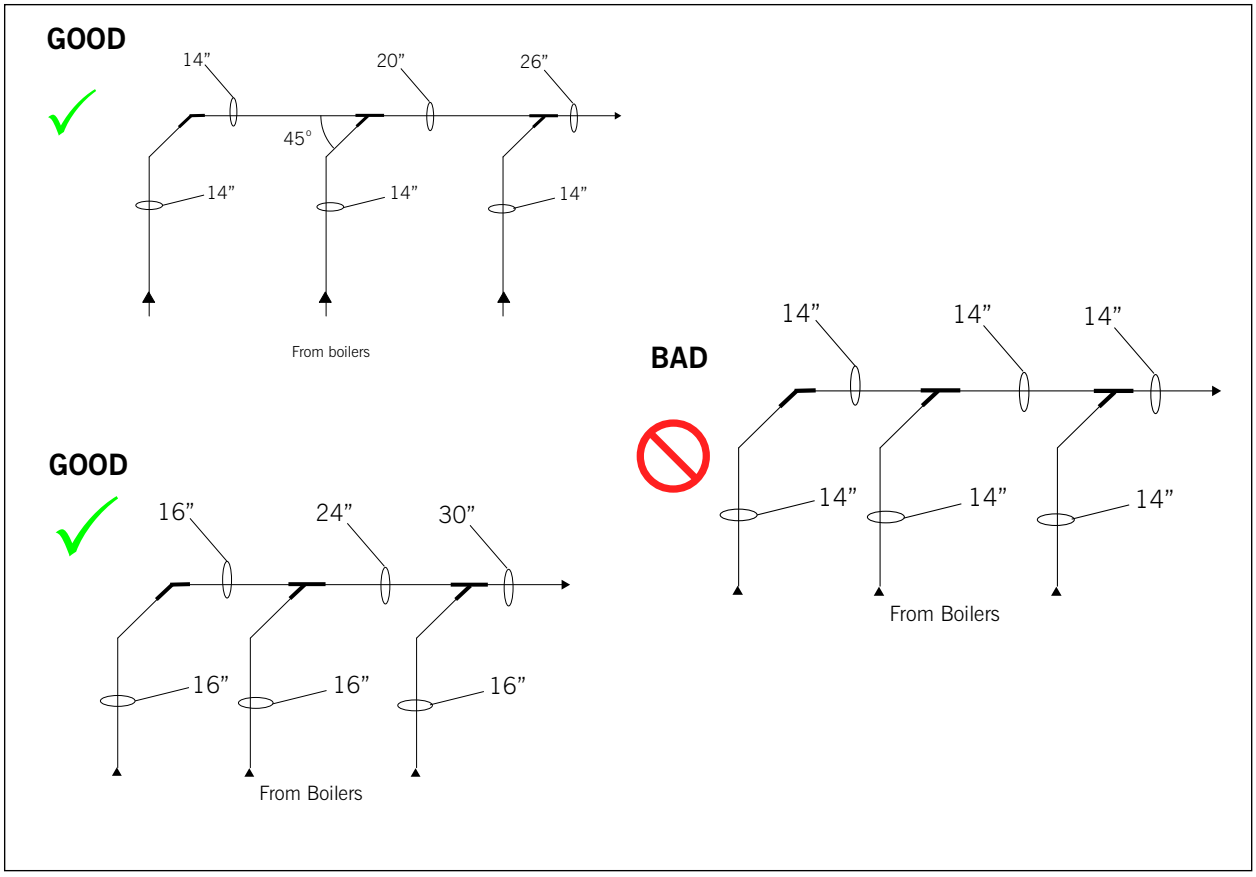
EXAMPLE 1



EXAMPLE 2



EXAMPLE 3



E. COMBUSTI0N AIR/BOILER ROOM VENTILATION REQUIREMENTS

The boiler(s) must be supplied with adequate quantities of uncontaminated air to support proper combustion and equipment ventilation. Air shall be free of chlorides, halogens, fluorocarbons, construction dust or other contaminants that are detrimental to the burner/boiler. If these contaminants are present, we recommend the use of direct vent combustion provided the outside air source is uncontaminated.

Combustion air can be supplied by means of conventional venting, where combustion air is drawn from the area immediately surrounding the boiler (boiler room must be positive pressure), or with direct vent (direct vent combustion) where air is drawn directly from the outside. All installations must comply with local Codes and with NFPA 54 (the National Fuel Gas Code - NFGC) for the U.S. and for Canada, CAN/CGA B 149.1 and B 149.2.

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 a conventional air intake.

In accordance with NFPA54, the required volume of indoor air shall be determined in accordance with the "Standard Method" or "Known Air Infiltration Rate Method. Where the 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 Section 8.3 in the NFPA54 Handbook for additional information).

1. Air Supply - Unconfined Spaces (For U.S. Installations Only)

A. **All Air From Inside the Building** - If all 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 combustion) and the boiler is located in an unconfined space, use the following guidelines:

1. 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 meet 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.
2. 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.

3. One opening must terminate within twelve inches of the top, and one opening must terminate within twelve inches of the bottom of the room.
4. Refer to the NFGC, Section 8.3 for additional information.

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

1. Two Opening Method - 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 of the bottom of the room.
2. The openings must be linked directly (**Figure 3-5**) or by ducts (**Figure 3-6**) with the outdoors.
3. 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.
4. 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.

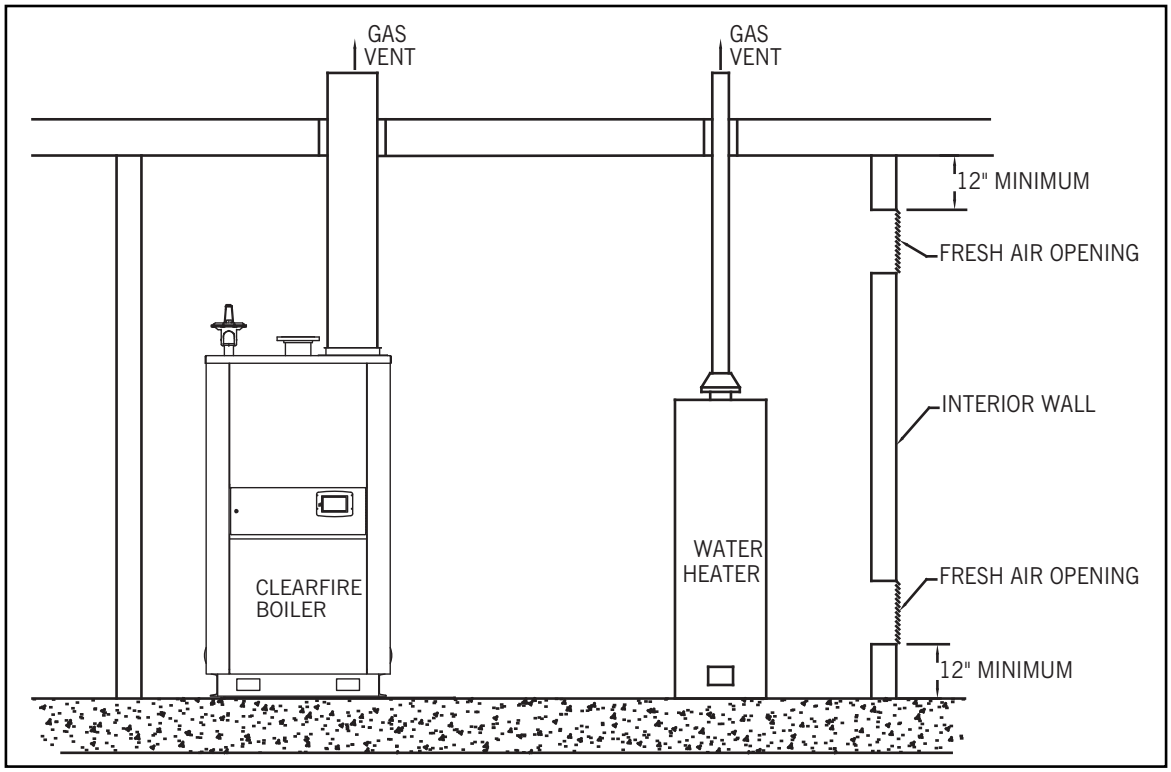


Figure 3-5 Two Opening Outside Wall Method

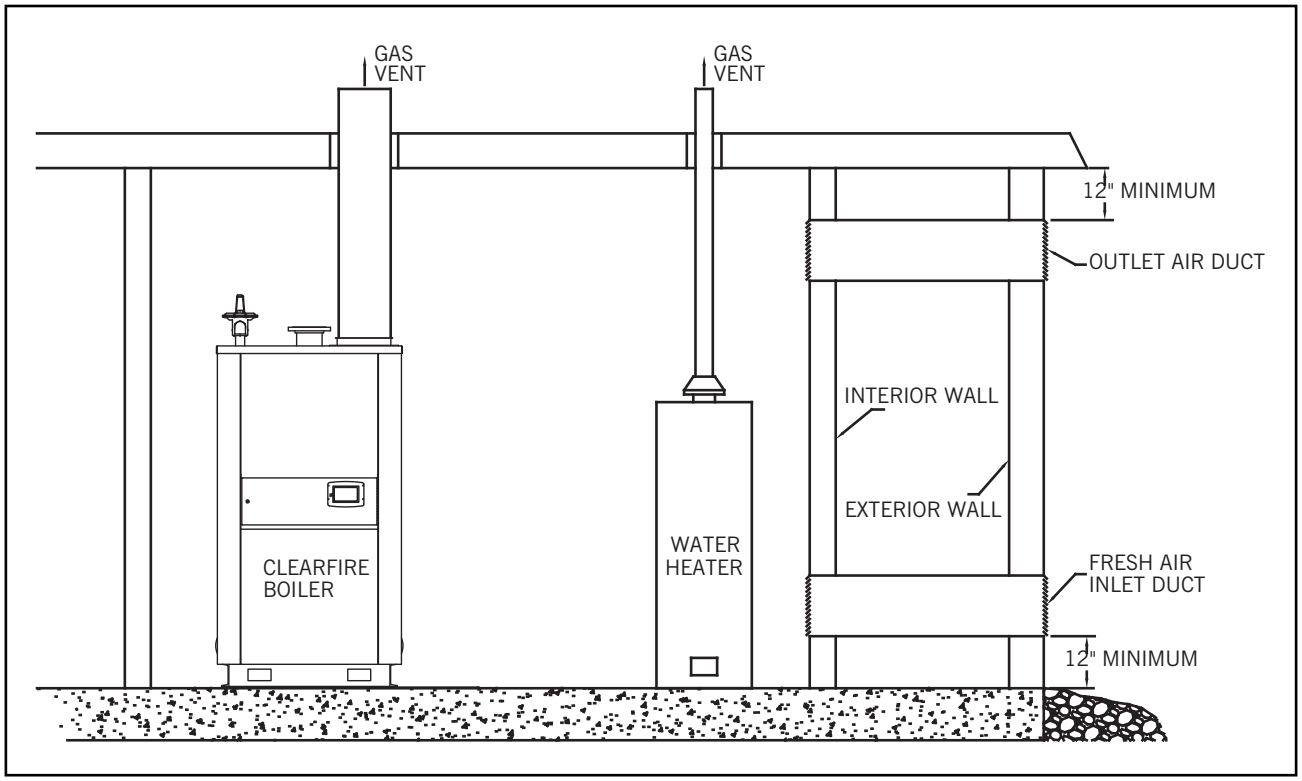


Figure 3-6. Two Opening Ducted Method

C. One Opening Method (**Figure 3-7**) - One permanent opening, commencing within 12 inches of the top of the enclosure, shall be provided.
   1. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.
   2. 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 confined space.
   3. Refer to the NFGC, Section 8.3 for additional information.

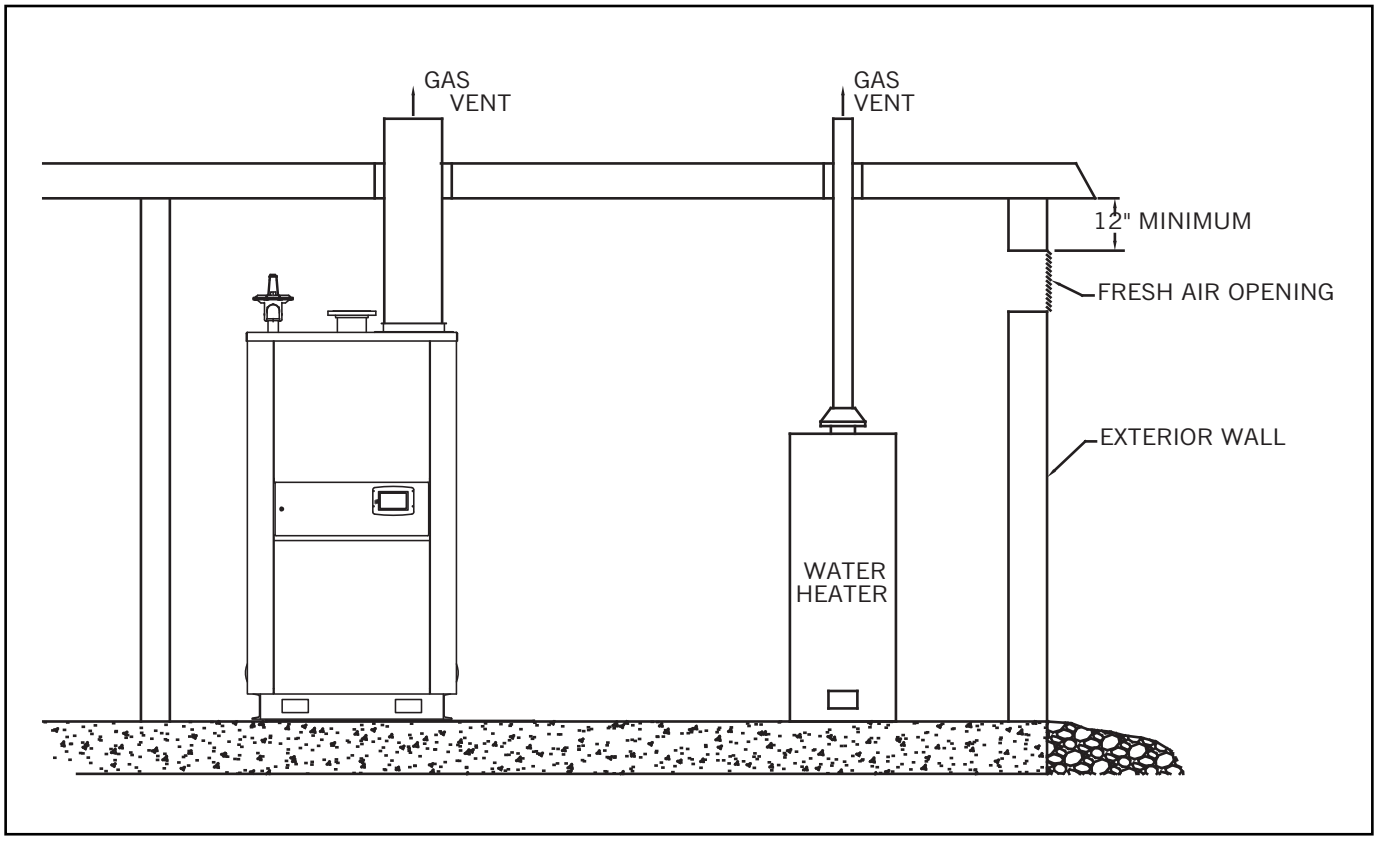


Figure 3-7. One Opening Method

2. Air Supply - Engineered Method

When determining boiler room air requirements for an unconfined space, the size of the room, airflow, and velocity of air must be reviewed as follows:

1. Size (area) and location of air supply openings in the boiler room.
   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**.
   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. Under no condition should the total area of the air supply openings be less than one square foot.

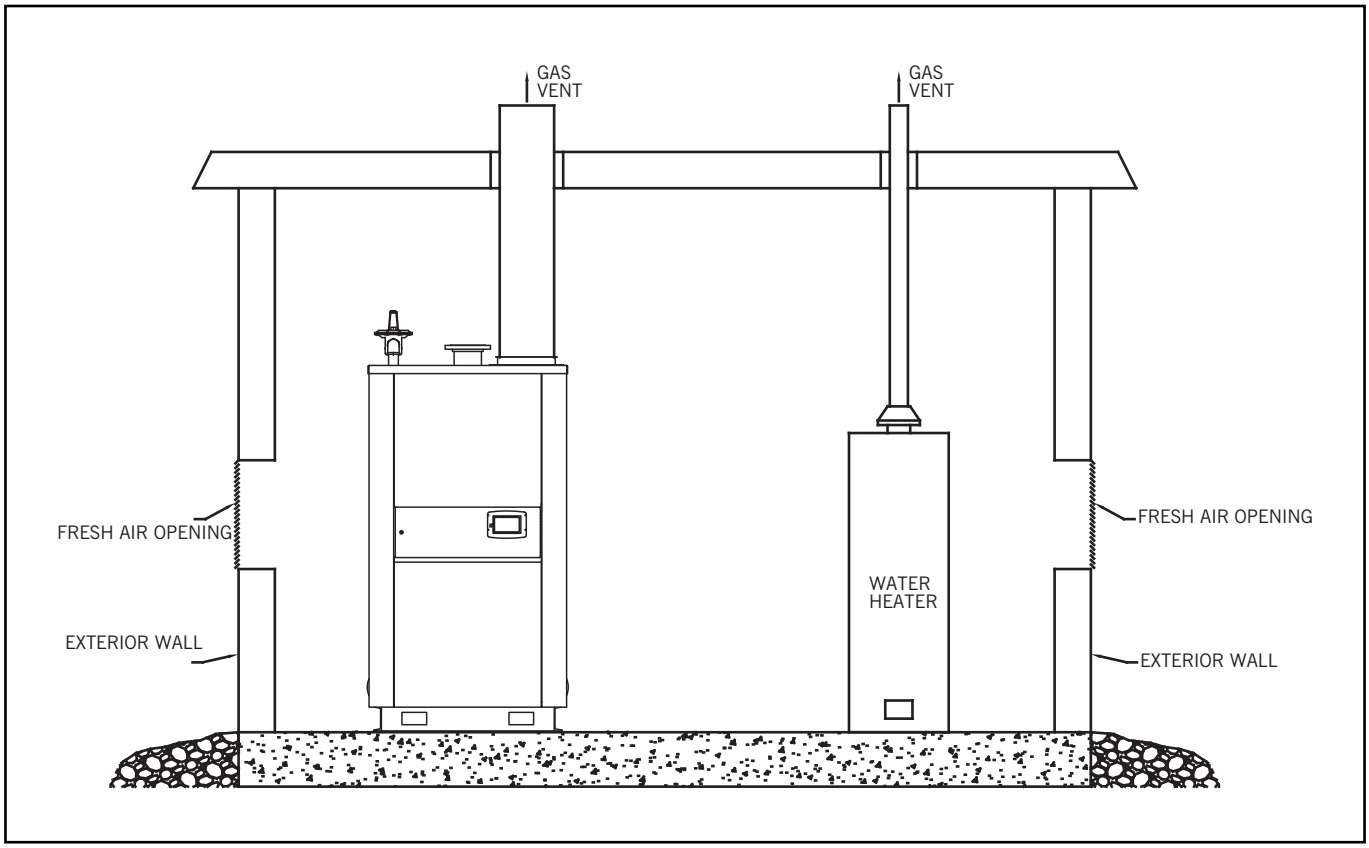


Figure 3-8. Two Opening Engineered Method

E. Size the openings by using the formula:

Area in square feet = cfm/fpm

Where cfm = cubic feet per minute of air

Where fpm = feet per minute of air

2. Amount of Air Required (cfm).
   A. Combustion Air = 0.25 cfm per kBtuh.
   B. Ventilation Air = 0.05 cfm per kBtuh.
   C. Total air = 0.3 cfm per kBtuh (up to 1000 feet elevation. Add 3% more per 1000 feet of added elevation).
3. Acceptable air velocity in the Boiler Room (fpm).
   A. From floor to 7 feet high = 250 fpm.
   B. Above 7 feet above floor = 500 fpm.

Example: Determine the area of the boiler room air supply openings for (2) CFLC 4000 boilers at 750 feet elevation. The air openings to be 5 feet above floor level.

- Air required: 4000 x 2 = 8000 kBtuh. From 2C above, 8000 x 0.3 = 2400 cfm.
- Air Velocity: Up to 7 feet = 250 fpm from 3 above.

- Area required: Area = cfm/fpm = 2400/250 = 9.6 square feet total.
- Area/Opening: 9.6/2 = 4.8 sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Direct Vent Combustion

If combustion air will be drawn directly from the outside by means of a duct connected to the burner air intake, use the following as a guide:

1. Install combustion air vent (direct vent combustion) in accordance with the boiler's Operating and Maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. In cold climates, and to mitigate potential freeze-up of the intake pipe, it is highly recommended that a motorized sealed damper be used to prevent the circulation of cold air through the boiler during non-operating hours.
4. Refer to **Figure 3-2** and **Figure 3-4** for suggested piping of direct vent combustion installations. **Figure 3-9** shows the optional direct vent combustion kit providing easy adaptation of the contractor supplied air duct to boiler connection. Refer to Table 3-2 for sizing the direct vent combustion air pipe.

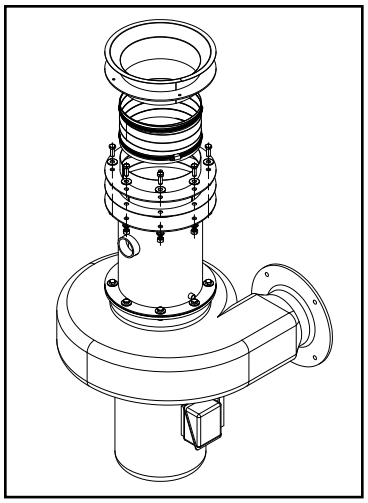


Figure 3-9. Optional Direct Vent Combustion Kit

Note: Direct vent ductwork should be securely attached to the boiler casing. No weight should be supported by the venturi. Venting should be installed to allow easy disconnection for burner service. For best results, the Cleaver-Brooks direct vent kit is recommended. See Table 3-2 for kit part numbers.

Section 48

Section 4
Commissioning

⚠ Warning

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

A. 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.
- Refer to Section 3 in this manual for combustion air requirements.

⚠ 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.*

Boiler room ambient conditions	
Relative humidity	$\leq$ 85% non-condensing
Ambient temperature range	0 °C to 50 °C / 32°F to 122°F
Storage temperature range	-40 °C to 60 °C / -40°F to 140°F
Combustion air temperature	0 °C to 50 °C / 32°F to 122°F

B. FILLING BOILER

Fill the boiler and/or hydronic system. Water should be circulated through the system to allow entrapped air to escape at appropriate air venting provisions. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed. When no air remains in the boiler, it will be possible to reset the low water cutoff. If the low water cutoff can not be reset, it is likely that some air remains in the boiler.

C. CONTROL SETPOINTS

Preliminary settings of the burner/boiler safety 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. Combustion Air Proving Switch - Set the dial @ minimum.
2. Low Gas Pressure Switch - Set the dial @ minimum.
3. High Gas Pressure Switch - Set the dial @ maximum.
4. High Air Pressure Switch - Set the dial @ maximum.

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

D. MODEL CFLC BOILER / BURNER CONTROLLER

The Model CFLC boiler uses the Falcon hydronic boiler control system. Primary controller functions include:

- Flame supervision
- Burner sequencing
- Heating/modulation control
- Hot water system pump control
- High Limit temperature control
- Thermowell-mounted NTC temperature sensors to provide measured process variable signals to the controller.

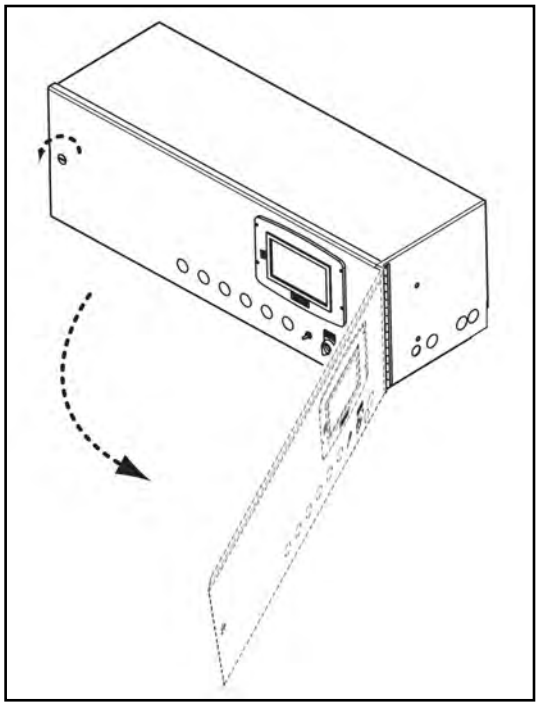


Figure 4-1 Opening control panel

Additional features include:

- User-friendly touchscreen interface
- Modbus communication capability
- Alarm/lockout messaging with history (last 15 messages)
- Annunciation
- Outdoor reset
- Central Heating and Domestic Hot Water loop control
- Password protection of configurable parameters
- Time of Day (dual setpoint) control

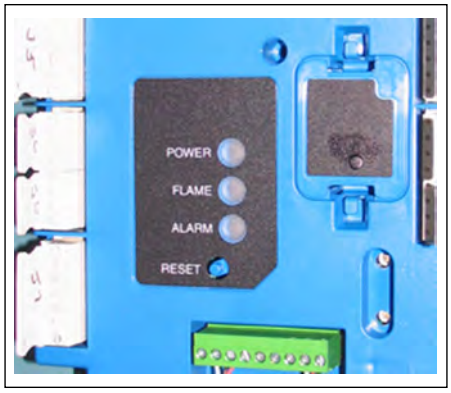


Figure 4-2 Controller status LEDs and reset button

- High Stack Temperature limit
- Remote reset
- Lead/Lag sequencing
- (3) configurable pump relays
- Remote modulation/remote setpoint
- Frost protection

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.

⚠ Warning

The Model CFLC 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.**

Figure 4-3 Falcon Display/Operator Interface

E. FALCON DISPLAY/OPERATOR INTERFACE

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

1. Home Page

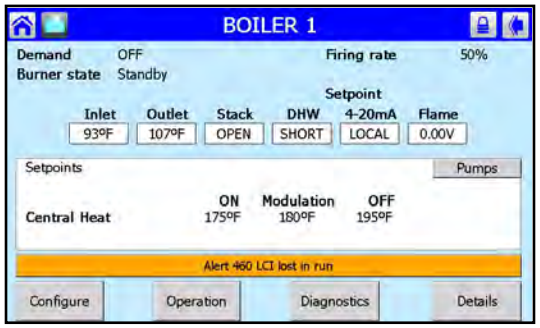
Apply power to the boiler. The Home page will appear on the Falcon display.

Each Falcon in the hydronic system is represented on the Home page by an icon and name.

2. Status Page

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

Home page



Status page

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

Burner enable off
Off (burner switch on but no demand)
Central Heat
Domestic Hot Water (if configured)

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 on/off status of boiler and system pumps.
Modulation shows fan speed RPM settings for Demand, Limited, and Override rates
Setpoints shows the ON, Modulation, and OFF temperature setpoints.

3. Operation Page

The operation page (**Figure 4-4**) displays the 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, view annunciation information, and switch between heating loops (Central Heat and Domestic Hot Water). 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.

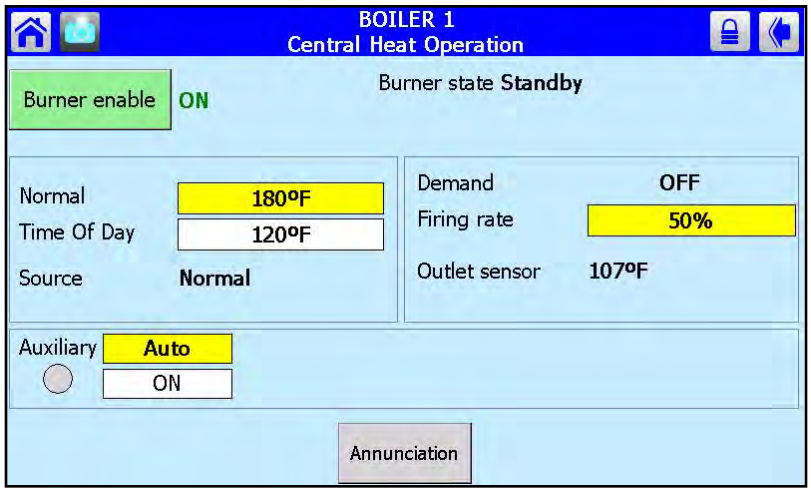


Figure 4-4 Operation Page

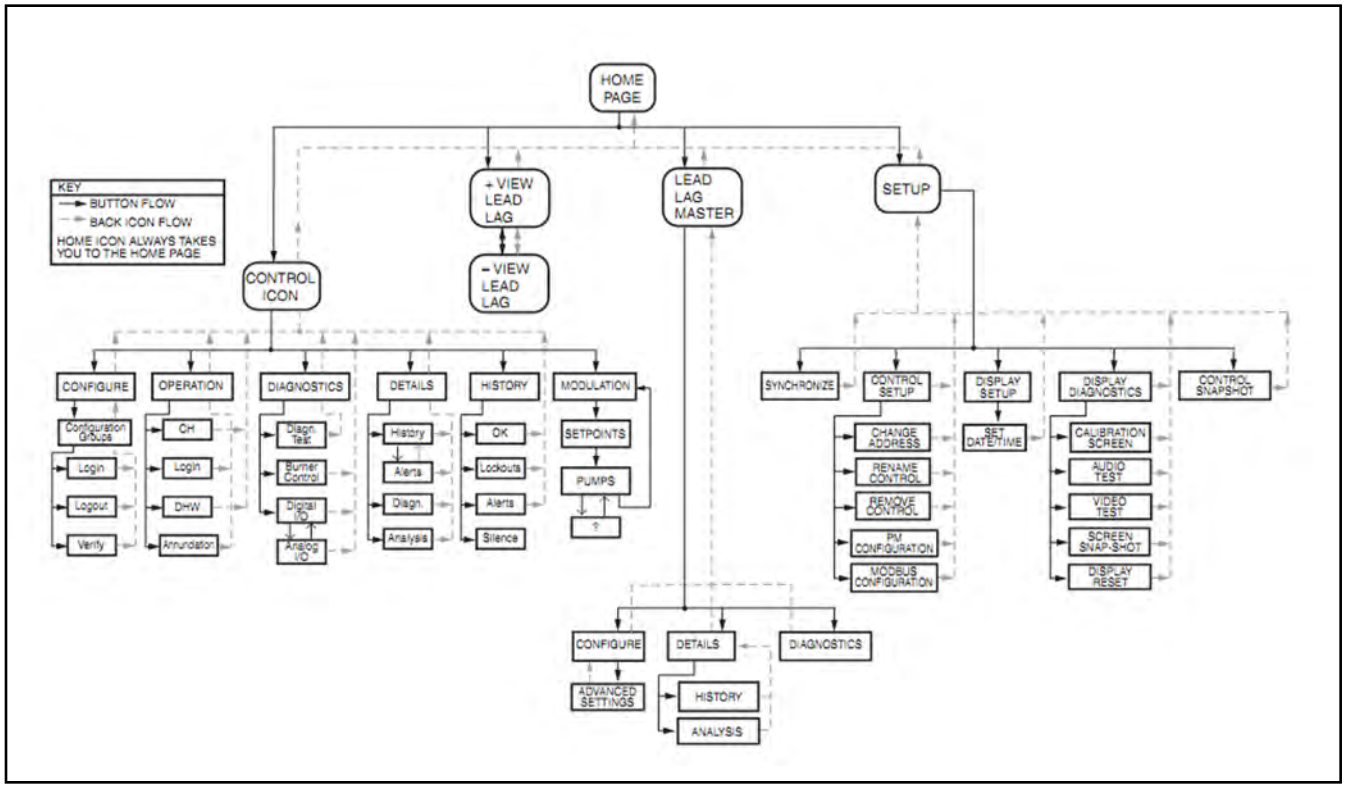


Figure 4-5 Falcon Display/Interface page flow

4. Lockouts, Holds, and Alerts

To assist in monitoring boiler operation, the Falcon control system employs messages of three types: **Lockouts**, **Holds**, and **Alerts**.

- **Lockouts** and **Holds** indicate interruptions in boiler operation, whether occurring as part of the normal operating sequence or due to an abnormal condition. Lockouts require a manual reset to continue operation, while Holds do not. A Hold will automatically clear when the hold condition is removed or satisfied.

The most recent Lockouts are stored in Falcon memory and may be accessed through the Lockout History. Holds are not logged in memory.

Note: *Before attempting to restart the boiler after a Lockout, identify and correct the Lockout condition.*

- **Alerts** indicate conditions or events which, while not preventing boiler operation, may nevertheless be of interest in evaluating boiler performance or operating conditions. Examples include certain operator actions, out-of-range configuration data, controller internal status reports (e.g. timers, counters, memory read/write activity), and recycle events. Alerts require no operator acknowledgment and are for informational purposes only.

The most recently occurring message (Lockout, Hold, or Alert) is displayed in the alarm banner on the Status screen (see **Figure 4-6**). Press this banner to access the Alert or Lockout History, where a list of the most recently occurring Alerts/Lockouts can be viewed.

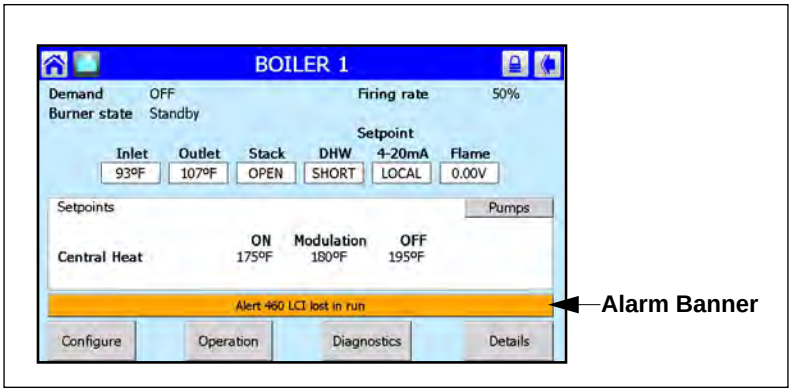


Figure 4-6 Alarm Banner

To obtain more information for a particular message, press that item in the respective history list. For Alerts, burner cycle and hours of operation at the time of occurrence will be displayed. For Lockouts, in addition to cycle and hours the screen will show on/off status of all interlocks at the time of the lockout. This information can be used to help pinpoint the cause of a particular Lockout.

See also Section 5 - **Service and Maintenance**, Subsection E - **Troubleshooting**.

F. CONTROLLER CONFIGURATION

The Falcon controller should be factory configured for the specific CFLC 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.

Falcon configuration is organized into the following functional groups:

- System Identification & Access
- CH - Central Heat ConfigurCation
- Outdoor Reset Configuration
- DHW - Domestic Hot Water Configuration
- Modulation Configuration
- Pump Configuration
- Statistics Configuration
- High Limits
- Stack Limit
- Other Limits
- Anti-condensation Configuration
- Frost Protection Configuration
- Annunciation Configuration
- Burner Control Interlocks

- Burner Control Timings & Rates
- Burner Control Ignition
- Burner Control Flame Failure
- System Configuration
- Fan Configuration
- Lead Lag Configuration

Table 4-1 CFLC Falcon Parameters

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
System ID & Access	Boiler name	Service		BOILER 1			183
System ID & Access	Installation data	Service		SERIAL NUMBER			184
System ID & Access	OEM identification	Read Only		FALCON 833-04097			185
System ID & Access	Installer Password	Service		9220			190
System ID & Access	Factory Data	Read Only					191
System ID & Access	Modbus Address	Service	0	1	250		
Central Heat Configuration	CH enable	User		Enabled			208
Central Heat Configuration	CH demand switch	Service		B:STAT terminal			209
Central Heat Configuration	CH modulation sensor	Service		A:Modulation from Outlet (S3S4) sensor			210
Central Heat Configuration	CH setpoint	User	130	150	230	oF	211
Central Heat Configuration	CH TOD setpoint	User	130	130	230	oF	212
Central Heat Configuration	CH on hysteresis	Service		5	60	oF	213
Central Heat Configuration	CH off hysteresis	Service		15	60	oF	214
Central Heat Configuration	CH outdoor reset enable	Service		Disabled			215
Central Heat Configuration	CH P gain	Service		25			216
Central Heat Configuration	CH I gain	Service		10			217
Central Heat Configuration	CH D gain	Service		0			218
Central Heat Configuration	CH hysteresis step time	Service		0m 0s		mmm ss	219
Central Heat Configuration	CH setpoint source	Service		A:Local setpoint is used			578
Central Heat Configuration	CH modulation rate source	User		A:Local modulation (PID) is used			580
Central Heat Configuration	CH has priority over LL	Service		No/False/Off			582
Central Heat Configuration	CH 4 mA water temperature	Service		130	194	oF	583
Central Heat Configuration	CH 20 mA water temperature	Service		210	230	oF	584
Outdoor Reset Configuration	CH ODR max outdoor temperature	Service		80		oF	512
Outdoor Reset Configuration	CH ODR min outdoor temperature	Service		0		oF	513
Outdoor Reset Configuration	CH ODR low water temperature	Service		80		oF	514
Outdoor Reset Configuration	CH ODR boost time	Service		30m 0s		mmm ss	515
Outdoor Reset Configuration	CH ODR boost maximum off point	Service		180	230	oF	516
Outdoor Reset Configuration	CH ODR boost step	Service		0°F (0°C)		oF	522
Outdoor Reset Configuration	Minimum boiler water temperature	Service	130	130		oF	526
Domestic HW Configuration	DHW enable	User		Disabled			448
Domestic HW Configuration	DHW demand switch	User		A:Modulation sensor only			449
Domestic HW Configuration	DHW has priority over CH	Service		Yes/True/On			450
Domestic HW Configuration	DHW has priority over LL	Service		Yes/True/On			451
Domestic HW Configuration	DHW priority override time	Service		30m 0s		mmm ss	452
Domestic HW Configuration	DHW setpoint	User	130	180	230	oF	453
Domestic HW Configuration	DHW TOD setpoint	User	130	130	230	oF	454
Domestic HW Configuration	DHW on hysteresis	Service		5	80	oF	455
Domestic HW Configuration	DHW off hysteresis	Service		15	80	oF	456
Domestic HW Configuration	DHW P gain	Service		25			457
Domestic HW Configuration	DHW I gain	Service		10			458
Domestic HW Configuration	DHW D gain	Service		0			459
Domestic HW Configuration	DHW hysteresis step time	Service		1m 0s		mmm ss	460
Domestic HW Configuration	DHW modulation sensor	Service		F:Auto Mod from DHW (S6)or Outlet (S3S4)			461
Domestic HW Configuration	DHW priority source	Service		B:DHW heat demand			463
Domestic HW Configuration	DHW storage enable	Service		Disabled			504
Domestic HW Configuration	DHW priority method	Service		B:Drop DHW after priority time expires			509
Domestic HW Configuration	DHW demand ON temperature	User		NoValue			510

Table 4-1 CFLC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Domestic HW Configuration	DHW demand OFF temperature	User		NoValue			511
Modulation Configuration	Modulation output	Read Only		C:Analog 4-20mA			192
Modulation Configuration	CH maximum modulation rate	Service	0	100%	100%	%	193
Modulation Configuration	DHW maximum modulation rate	Service	0	100%	100%	%	194
Modulation Configuration	Minimum modulation rate	Service	0	10%	100%	%	195
Modulation Configuration	CH forced rate	Service	0	35%	100%	%	199
Modulation Configuration	CH forced rate time	Service		1m 0s		mmm ss	200
Modulation Configuration	DHW forced rate	Service	0	35%	100%	%	201
Modulation Configuration	DHW forced rate time	Service		0m 0s		mmm ss	202
Modulation Configuration	Firing rate control	User		A:Automatic firing			204
Modulation Configuration	Manual firing rate	User	0	30%	100%	%	205
Modulation Configuration	CH slow start enable	Service		Enabled			477
Modulation Configuration	DHW slow start enable	Service		Disabled			478
Modulation Configuration	Slow start ramp	Service	0	5%	100%	% per min	479
Modulation Configuration	Slow start degrees	Service		20		oF	480
Modulation Configuration	Rate assigned to 0V/4mA (Min mod > 80%)	User		100%		0 to 100%	534
Modulation Configuration	Analog input hysteresis	Service		.2		mA	543
Modulation Configuration	Analog rate tracking	User		A:Analog rate tracking disabled			667
Pump Configuration	CH pump output	Service		A:No pump assignment			272
Pump Configuration	CH pump control	Service		A:Automatic pump control			273
Pump Configuration	CH pump overrun time	Service		5m 0s		mmm ss	274
Pump Configuration	CH pump frost protection overrun time	Service		60m 0s		mmm ss	275
Pump Configuration	DHW pump output	Service		A:No pump assignment			276
Pump Configuration	DHW pump control	Service		A:Automatic pump control			277
Pump Configuration	DHW pump overrun time	Service		1m 0s		mmm ss	278
Pump Configuration	DHW pump frost protection overrun time	Service		60m 0s		mmm ss	279
Pump Configuration	DHW pump start delay	Service		1m 0s		mmm ss	280
Pump Configuration	Boiler pump output	Service		C:Pump assigned to terminal B			281
Pump Configuration	Boiler pump control	Service		A:Automatic pump control			282
Pump Configuration	Boiler pump overrun time	Service		5m 0s		mmm ss	283
Pump Configuration	Auxiliary 1 pump output	Service		D:Pump assigned to terminal C			284
Pump Configuration	Auxiliary 1 pump control	Service		A:Automatic pump control			285
Pump Configuration	System pump output	Service		A:No pump assignment			287
Pump Configuration	System pump control	Service		A:Automatic pump control			288
Pump Configuration	System pump overrun time	Service		15m 0s		mmm ss	289
Pump Configuration	Pump exercise interval	Service		0		Days	290
Pump Configuration	Pump exercise time	Service		0m 0s		mmm ss	291
Pump Configuration	CH pump start delay	Service		0m 10s		mmm ss	292
Pump Configuration	Boiler pump start delay	Service		0m 10s		mmm ss	293
Pump Configuration	System pump start delay	Service		0m 0s		mmm ss	294
Pump Configuration	Auxiliary 1 pump start delay	Service		0m 20s		mmm ss	295
Pump Configuration	CH pump options 1	Service		0x0324			296
Pump Configuration	CH pump options 2	Service		0xC048			297
Pump Configuration	DHW pump options 1	Service		0x0048			298
Pump Configuration	DHW pump options 2	Service		0x4190			299
Pump Configuration	Boiler pump options 1	Service		0x0002			300
Pump Configuration	Boiler pump options 2	Service		0x4009			301
Pump Configuration	System pump options 1	Service		0x0360			302
Pump Configuration	System pump options 2	Service		0x8009			303
Pump Configuration	Auxiliary 1 pump overrun time	Service		5m 30s		mmm ss	752
Pump Configuration	Auxiliary 1 pump options 1	Service		0x0262			753
Pump Configuration	Auxiliary 1 pump options 2	Service		0x4019			754
Pump Configuration	Auxiliary 2 pump output	Service		B:Pump assigned to terminal A			755
Pump Configuration	Auxiliary 2 pump control	Service		A:Automatic pump control			756
Pump Configuration	Auxiliary 2 pump start delay	Service		0m 0s		mmm ss	757
Pump Configuration	Auxiliary 2 pump overrun time	Service		3m 0s		mmm ss	758
Pump Configuration	Auxiliary 2 pump options 1	Service		0x0003			759
Pump Configuration	Auxiliary 2 pump options 2	Service		0x4000			760

Table 4-1 CFLC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Statistics Configuration	Burner cycle count	Read Only		0		Cycles	128
Statistics Configuration	Burner run time	Read Only		0		Hours	130
Statistics Configuration	CH pump cycle count	Service		0		Cycles	132
Statistics Configuration	DHW pump cycle count	Service		0		Cycles	134
Statistics Configuration	System pump cycle count	Service		0		Cycles	136
Statistics Configuration	Boiler pump cycle count	Service		0		Cycles	138
Statistics Configuration	Auxiliary 1 pump cycle count	Service		0		Cycles	140
Statistics Configuration	Auxiliary 2 pump cycle count	Service		0		Cycles	146
High Limits	Outlet high limit setpoint	Service	32	240	250	oF	464
High Limits	Outlet high limit response	Read Only		A:Lockout			465
High Limits	DHW high limit enable	Service		A:No high limit			474
High Limits	DHW high limit setpoint	Service	32	NoValue	250	oF	475
High Limits	DHW high limit response	Service		B:Recycle && hold			476
High Limits	Outlet high limit enable	Read Only		B:Dual sensor safety high limit			484
Stack Limit	Stack limit enable	Service		A:No stack high limit			466
Stack Limit	Stack limit setpoint	Service		250	266	oF	467
Stack Limit	Stack limit response	Service		A:Lockout			468
Stack Limit	Stack limit delay	Service		5m 0s		mmm ss	469
Delta-T Limits	Delta-T inlet/outlet enable	Service		D:Enable both Delta-T and inversion			470
Delta-T Limits	Delta-T inlet/outlet degrees	Service		50		oF	471
Delta-T Limits	Delta-T response	Service		C:Recycle && delay with retry limit			472
Delta-T Limits	Delta-T delay	Service		5m 0s		mmm ss	473
Delta-T Limits	Delta-T retry limit	Service		3	100		485
Delta-T Limits	Delta-T rate limit enable	Service		Enabled			486
Delta-T Limits	Delta-T inverse limit time	Service		5m 0s	30m 0s	mmm ss	487
Delta-T Limits	Delta-T inverse limit response	Service		C:Recycle && delay with retry limit			488
T-rise Limit	Outlet T-rise enable	Service		Disabled			481
T-rise Limit	T-rise degrees	Service		10		oF	482
T-rise Limit	T-rise delay	Service		3m 0s		mmm ss	483
T-rise Limit	T-rise response	Service		C:Recycle && delay with retry limit			492
T-rise Limit	T-rise retry limit	Service		10			493
Anticondensation Configuration	CH anticondensation enable	Service		Disabled			496
Anticondensation Configuration	CH anticondensation setpoint	Service		130	230	oF	497
Anticondensation Configuration	DHW anticondensation enable	Service		Enabled			499
Anticondensation Configuration	DHW anticondensation setpoint	Service		130	230	oF	500
Anticondensation Configuration	Anticondensation > Forced rate	User		Yes/True/On			502
Anticondensation Configuration	Anticondensation > Slow start	User		Yes/True/On			502
Anticondensation Configuration	Anticondensation > Outlet limit	User		No/False/Off			502
Anticondensation Configuration	Anticondensation > Stack limit	User		No/False/Off			502
Anticondensation Configuration	Anticondensation priority	Service					502
Anticondensation Configuration	Anticondensation > Delta-T	User		No/False/Off			502
Anticondensation Configuration	Frost protect anticondensation enable	Service		Disabled			503
Frost Protection Configuration	CH frost protection enable	Service		Disabled			528
Frost Protection Configuration	DHW frost protection enable	Service		Disabled			529
Frost Protection Configuration	Outdoor frost protection setpoint	Service		32		oF	530
Frost Protection Configuration	LL frost protection enable	Service		Disabled			532
Frost Protection Configuration	LL frost protection rate	Service	0	20%	100%	%	533
Annunciation Configuration	Annunciation enable	Read Only		Enabled			304
Annunciation Configuration	Annunciator 1 location	OEM		E:Other annunciation			306

Table 4-1 CFLC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Annunciation Configuration	Annunciator1 short name	OEM		A1			307
Annunciation Configuration	Annunciator 1 long name	OEM		AIR SWITCH			309
Annunciation Configuration	Annunciator 2 location	Service		A:No annunciation for this terminal			319
Annunciation Configuration	Annunciator2 short name	Service		A2			320
Annunciation Configuration	Annunciator 2 long name	Service		AUX LOW WATER			322
Annunciation Configuration	Annunciator 3 location	OEM		D:Interlock circuit			332
Annunciation Configuration	Annunciator3 short name	OEM		A3			333
Annunciation Configuration	Annunciator 3 long name	OEM		LOW WATER			335
Annunciation Configuration	Annunciator 4 location	OEM		D:Interlock circuit			345
Annunciation Configuration	Annunciator4 short name	OEM		A4			346
Annunciation Configuration	Annunciator 4 long name	OEM		HIGH AIR PRESSURE			348
Annunciation Configuration	Annunciator 5 location	OEM		D:Interlock circuit			358
Annunciation Configuration	Annunciator5 short name	OEM		A5			359
Annunciation Configuration	Annunciator 5 long name	OEM		HIGH GAS PRESSURE			361
Annunciation Configuration	Annunciator 6 location	OEM		D:Interlock circuit			371
Annunciation Configuration	Annunciator6 short name	OEM		A6			372
Annunciation Configuration	Annunciator 6 long name	OEM		LOW GAS PRESSURE			374
Annunciation Configuration	Annunciator 7 location	Service		A:No annunciation for this terminal			384
Annunciation Configuration	Annunciator7 short name	Service		HFS			385
Annunciation Configuration	Annunciator 7 long name	Service		HIGH FIRE SWITCH			387
Annunciation Configuration	Annunciator 8 location	Service		A:No annunciation for this terminal			397
Annunciation Configuration	Annunciator8 short name	Service		LFS			398
Annunciation Configuration	Annunciator 8 long name	Service		LOW FIRE SWITCH			400
Annunciation Configuration	PII short name	OEM		PII			410
Annunciation Configuration	PII long name	OEM		Pre-Ignition ILK			412
Annunciation Configuration	LCI short name	OEM		LCI			422
Annunciation Configuration	LCI long name	OEM		Limit Circuit Input			424
Annunciation Configuration	ILK short name	OEM		ILK			434
Annunciation Configuration	ILK long name	OEM		Lockout Interlocks			436
Interlocks	Purge rate proving	Service		B:Prove via HFS terminal			229
Interlocks	Lightoff rate proving	Service		B:Prove via LFS terminal			230
Interlocks	Interlock open response	Read Only		A:Lockout			238
Interlocks	Interrupted air switch enable	OEM	{ xBCx }	C:Enable IAS during purge && ignition			246
Interlocks	LCI enable	Read Only		Enabled			248
Interlocks	PII enable	OEM		Enabled			249
Interlocks	ILK bounce detection enable	Service		Enabled			253
Safetey Timing	Prepurge rate	Service	60	65%	100%	%	196
Safetey Timing	Postpurge rate	Service	40	50%		%	198
Safetey Timing	Standby rate	Service	0	35%	100%	%	207
Safetey Timing	Prepurge time	Service	0m 30s	0m 30s		mmm ss	231
Safetey Timing	Run stabilization time	Service		0m 10s		mmm ss	235
Safetey Timing	Postpurge time	Service	0m 15s	0m 15s		mmm ss	236
Ignition Configuration	Lightoff rate	Service	0	25%	50%	%	197
Ignition Configuration	Ignition source	Read Only		B:External ignition			224
Ignition Configuration	Igniter on during	Read Only		B:On in first half of PFEP			226
Ignition Configuration	Pilot type	Read Only		A:Interrupted (off during Run)			227
Ignition Configuration	Preignition time	Service		0m 0s		mmm ss	232
Ignition Configuration	PFEP	Read Only		C:10 seconds			233
Ignition Configuration	MFEP	OEM		B:5 seconds			234
Ignition Configuration	Flame threshold	OEM	.5	.8	5	10ths (V or uA)	250
Flame Failure	Ignite failure response	Service		A:Lockout			239
Flame Failure	Ignite failure retries	Service		D:Retry 1 time			240
Flame Failure	Ignite failure delay	Service		0m 30s	60m 0s	mmm ss	241

Table 4-1 CFLC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Flame Failure	Run flame failure response	Read Only		A:Lockout			243
System Configuration	Temperature units	Service		A:Fahrenheit			178
System Configuration	Antishort cycle time	Service		0m 0s		mmm ss	179
System Configuration	Power up with lockout	OEM		Enabled			181
System Configuration	Burner switch	User		No/False/Off			203
System Configuration	BLR HSI function	Read Only		A:Blower motor			225
System Configuration	Flame sensor type	Service		D:UV power tube, ignore ignitor UV			228
System Configuration	Forced recycle interval time	Service		0h 0m		min	254
System Configuration	Fan speed error response	Service		A:Lockout			255
System Configuration	Inlet connector type	Read Only		D:10K single non-safety			608
System Configuration	S2 connector type	OEM		H:4_20_MA			609
System Configuration	Outlet connector type	Read Only		C:10K dual safety			610
System Configuration	S5 connector type	Service		D:10K single non-safety			611
System Configuration	DHW connector type	Service		D:10K single non-safety			612
System Configuration	Stack connector type	Service		A:connector unconfigured			613
System Configuration	Outdoor temperature correction offset	User		0			615
System Configuration	Low fire cutoff time	User		0m 30s		mmm ss	617
System Configuration	Outdoor temperature source	Service		A:unconfigured			626
System Configuration	Warm weather shutdown enable	Service		A:Warm weather shutdown disabled			627
System Configuration	Warm weather shutdown setpoint	Service		100		oF	628
System Configuration	Line frequency	Service		C:auto detect 48 through 63 Hz			630
System Configuration	Safety configuration options	OEM		0x0001			631
System Configuration	Burner off inhibit time	User		NoValue		mmm ss	639
Fan Configuratiosn	Fan min duty cycle	Service		10		0-100%	264
Lead Lag Configuration	Lead lag master enable	Service		A:no Lead Lag master			545
Lead Lag Configuration	Lead lag CH setpoint	User	130	150	230		546
Lead Lag Configuration	Lead lag CH TOD setpoint	User	130	130	230		547
Lead Lag Configuration	Lead lag on hysteresis	Service		5		oF	549
Lead Lag Configuration	Lead lag off hysteresis	Service		15		oF	550
Lead Lag Configuration	Lead lag hysteresis step time	Service		0m 0s		mmm ss	551
Lead Lag Configuration	Lead lag P gain	Service		20			552
Lead Lag Configuration	Lead lag I gain	Service		15			553
Lead Lag Configuration	Lead lag D gain	Service		0			554
Lead Lag Configuration	Lead lag operation switch	User		No/False/Off			555
Lead Lag Configuration	Lead lag CH demand switch	Service		B:STAT terminal			556
Lead Lag Configuration	Lead lag CH setpoint source	Service		A:Local setpoint is used			557
Lead Lag Configuration	Lead lag modulation backup sensor	Service		B:Use Outlet sensor from lead boiler			559
Lead Lag Configuration	Lead lag CH 4 mA water temperature	Service		80		oF	560
Lead Lag Configuration	Lead lag CH 20 mA water temperature	Service		180		oF	561
Lead Lag Configuration	Lead Lag Modbus port	Service		C:Use MB2 port for Lead Lag messaging			569
Lead Lag Configuration	Base load common	Service		45%		0 to 100%	572
Lead Lag Configuration	Lead selection method	Service		A:rotate in sequence order			574
Lead Lag Configuration	Lag selection method	Service		A:rotate in sequence order			575
Lead Lag Configuration	Lead lag DHW demand switch	User		A:DHW loop is disabled			704
Lead Lag Configuration	Lead lag DHW setpoint	User		180		oF	705
Lead Lag Configuration	Lead lag DHW has priority over CH	User		Yes/True/On			706
Lead Lag Configuration	Lead lag add stage method 1	Service		C:Use firing rate threshold to add stage			714
Lead Lag Configuration	Lead lag add stage detection time 1	Service	1m 0s	3m 0s		mmm ss	716
Lead Lag Configuration	Lead lag add stage error threshold	Service		5		oF	718
Lead Lag Configuration	Lead lag add stage rate offset	Service		0%		-100% to 100%	719
Lead Lag Configuration	Lead lag add stage interstage delay	Service	3m 0s	10m 0s		mmm ss	722

Table 4-1 CFLC Falcon Parameters (Continued)

Parameter Group	Parameter Name	Access*	Min range	Default Setting	Max. Range	Parameter Units	Modbus Register (dec)
Lead Lag Configuration	Lead lag drop stage method 1	Service		C:Use firing rate to drop stage			723
Lead Lag Configuration	Lead lag drop stage detection time 1	Service	1m 0s	3m 0s		mmm ss	725
Lead Lag Configuration	Lead lag drop stage error threshold	Service		10		oF	727
Lead Lag Configuration	Lead lag drop stage rate offset	Service		-3%		-100% to 100%	728
Lead Lag Configuration	Lead lag drop stage interstage delay	Service	3m 0s	10m 0s		mmm ss	731
Lead Lag Configuration	Lead rotation time	Service		120h 0m		min	733
Lead Lag Configuration	Force lead rotation time	Service		168h 0m		min	734
Lead Lag Configuration	Lead lag DHW TOD setpoint	User	130	170		oF	735
Lead Lag Configuration	Boiler off options	Service		A:boiler off options disabled			736
Lead Lag Configuration	All boilers off threshold	Service		210		oF	737
Lead Lag Configuration	Lead lag slave enable	Service		A:Disabled			544
Lead Lag Configuration	Slave mode	Service		B:Equalize runtime			564
Lead Lag Configuration	Fan during off cycle rate	Service		0%		%	567
Lead Lag Configuration	Slave sequence order	Service		0		1 to 8	568
Lead Lag Configuration	Lead lag slave demand to firing delay	Service	1m 0s	3m 0s		mmm ss	570
Lead Lag Configuration	LL CH ODR max outdoor temperature	Service		80	140	oF	517
Lead Lag Configuration	LL CH ODR min outdoor temperature	Service		0	140	oF	518
Lead Lag Configuration	LL CH ODR low water temperature	Service		80	230	oF	519
Lead Lag Configuration	LL CH ODR boost time	Service		0m 0s		mmm ss	520
Lead Lag Configuration	LL CH ODR boost maximum off point	Service		180		oF	521
Lead Lag Configuration	LL CH ODR boost step	Service		0		oF	524
Lead Lag Configuration	LL CH ODR minimum water temperature	Service		80	230	oF	527
Lead Lag Configuration	Lead lag CH outdoor reset enable	Service		Disabled			548

*Access Levels:

Read Only = parameter not configurable

OEM = manufacturer only

Service = password required (default password is 9220)

User = no password required

Table 4-2 CFLC Variable Speed Drive (PF 400) Parameters

Par. No.	Parameter Name	Default Value	W/ CFLC
Basic Display			
b1	Output Freq	Read Only	
b2	Commanded Freq	Read Only	
b3	Output Current	Read Only	
b4	Output Voltage	Read Only	
b5	DC Bus Voltage	Read Only	
b6	Drive Status	Read Only	
b7	Fault 1 Code	Read Only	
b8	Process Display	Read Only	
b9	Not Used		
b10	Output Power	Read Only	
b11	Elapsed MWh	Read Only	
b12	Elapsed Run Time	Read Only	
b13	Torque Current	Read Only	
b14	Drive Temp	Read Only	
Basic Program			

Table 4-2 CFLC Variable Speed Drive (PF 400) Parameters (Continued)

Par. No.	Parameter Name	Default Value	W/ CFLC
P31	Motor NP Volts	Rated Volts	Motor NPL Volts
P32	Motor NP Hertz	60 Hz	Motor NPL Hertz
P33	Motor OL Current	Rated Amps	Motor NPL F.L. Amps x 1.15
P34	Minimum Freq	0.0 Hz	OK
P35	Maximum Freq	60 Hz	66 Hz
P36	Start Source	2-W Lvl Sens	2 Wire, 002
P37	Stop Mode	Coast,CF	COAST,CF
P38	Speed Reference	Analog In1	OK
P39	Accel Time 1	20.00 Secs	OK
P40	Decel Time 1	20.00 Secs	OK
P41	Reset to Defaults	Ready/Idle	OK
P42	Auto Mode	Hnd-Off-Auto	No Funtion - 000
Terminal Block			
T51	Digital In 1 Sel	Purge	OK
T52	Digital In 2 Sel	Local	OK
T53	Digital In 3 Sel	Clear Fault	OK
T54	Digital In 4 Sel	Comm Port	OK
T55	Relay Out 1 Sel	Ready/Fault	Above Freq, 006
T56	Relay Out 1 Level	0.0	15
T57	Not Used		
T58	Relay 1 On Time	0.0 Secs	OK
T59	Relay 1 Off Time	0.0 Secs	OK
T60	Relay Out 2 Select	Motor Running	Above Freq, 006
T61	Relay Out 2 Level	0.0	40
T62	Not Used		
T63	Relay 2 On Time	0.0 Secs	OK
T64	Relay 2 Off Time	0.0 Secs	OK
T65	Opto Out Sel	At Frequency	OK
T66	Opto Out Level	0.0	OK
T67	Not Used		
T68	Opto Out Logic	0	OK
T69	Analog In 1 Sel	2	4-20 mA, 001
T70	Analog In 1 Lo	0.0%	OK
T71	Analog In 1 Hi	100.0%	OK
T72	Analog In 1 Loss	Disabled	OK
T73	Analog In 2 Sel	2	OK
T74	Analog In 2 Lo	0.0%	OK
T75	Analog In 2 Hi	100.0%	OK
T76	Analog In 2 Loss	Disabled	OK
T77	Sleep-Wake Sel	Disabled	OK
T78	Sleep Level	10.0%	OK
T79	Sleep Time	0.0 Secs	OK
T80	Wake Level	15.0%	OK
T81	Wake Time	0.0 Secs	OK
T82	Analog Out1 Sel	0	OK
T83	Analog Out1 High	100.0%	OK
T84	Analog Out1 Setpt	0.0%	OK
T85	Analog Out2 Sel	1	OK
T86	Analog Out2 High	100.0%	OK
T87	Analog Out2 Setpt	0.0%	OK
Communications			
C101	Language	English	OK
C102	Comm Format	RTU 8-N-1	OK

Table 4-2 CFLC Variable Speed Drive (PF 400) Parameters (Continued)

Par. No.	Parameter Name	Default Value	W/ CFLC
C103	Comm Data Rate	9600	OK
C104	Comm Node Addr	100	OK
C105	Comm Loss Action	Fault	OK
C106	Comm Loss Time	5.0 Secs	OK
C107	Comm Write Mode	Save	OK
Advanced Program			
A141	Purge Frequency	5.0 Hz	OK
A142	Internal Freq	60.00 Hz	OK
A143	Preset Freq 0	0.0 Hz	OK
A144	Preset Freq 1	5.0 Hz	OK
A145	Preset Freq 2	10.0 Hz	OK
A146	Preset Freq 3	20.0 Hz	OK
A147	Accel Time 2	30.00 Secs	OK
A148	Decel Time 2	30.00 Secs	OK
A149	S Curve %	20% Disabled	OK
A150	PID Trim Hi	60.00 Hz	OK
A151	PID Trim Lo	0.0 Hz	OK
A152	PID Ref Sel	PID Disabled	OK
A153	PID Feedback Sel	Analog In 1	OK
A154	PID Prop Gain	1	OK
A155	PID Integ Time	2.0 Secs	OK
A156	PID Diff Rate	0.00	OK
A157	PID Setpoint	0.0%	OK
A158	PID Deadband	0.0%	OK
A159	PID Preload	0.0 Hz	OK
A160	Process Factor	30.0	OK
A161	Not Used		
A162	Not Used		
A163	Auto Restart Tries	0	2
A164	Auto Restart Delay	1.0 Secs	2
A165	Start At Power Up	Disabled	OK
A166	Reverse Disable	Rev Disabled	OK
A167	Flying Start Enable	Disabled	Enabled, 001
A168	PWM Frequency	4.0 kHz	OK
A169	PWM Mode	2-Phase	OK
A170	Boost Select	45.0, VT	OK
A171	Start Boost	2.5%	OK
A172	Break Voltage	25.0%	OK
A173	Break Frequency	15.0 Hz	OK
A174	Maximum Voltage	Rated Volts	OK
A175	Slip Hertz @ FLA	2.0 Hz	OK
A176	DC Brake Time	0.0 Secs	OK
A177	DC Brake Level	Rated Amps x 0.05	OK
A178	DC Brk Time @Strt	0.0 Secs	OK
A179	Current Limit 1	Rated Amps x 1.1	OK
A180	Current Limit 2	Rated Amps x 1.1	OK
A181	Motor OL Select	No Derate	OK
A182	Drive OL Mode	Both-PWM 1st	OK
A183	SW Current Trip	0.0 Disabled	OK
A184	Load Loss Level	0.0 Disabled	OK
A185	Load Loss Time	0 Secs	OK
A186	Stall Fault Time	60 Seconds	OK
A187	Bus Reg Mode	Enabled	OK
A188	Skip Frequency 1	0 Hz	OK
A189	Skip Freq Band 1	0.0 Hz	OK

Table 4-2 CFLC Variable Speed Drive (PF 400) Parameters (Continued)

Par. No.	Parameter Name	Default Value	W/ CFLC
A190	Skip Frequency 2	0 Hz	OK
A191	Skip Freq Band 2	0.0 Hz	OK
A192	Skip Frequency 3	0 Hz	OK
A193	Skip Freq Band 3	0.0 Hz	OK
A194	Compensation	Electrical	Disable, 000
A195	Reset Meters	Ready/Idle	OK
A196	Testpoint Select	1024	OK
A197	Fault Clear	Ready/Idle	OK
A198	Program Lock	Unlocked	OK
A199	Motor NP Poles	4	2
A200	Motor NP Amps	Drive Rated Amps	SAME AS P-33
Advanced Display			
d301	Control Source	Read Only	
d302	Contrl In Status	Read Only	
d303	Comm Status	Read Only	
d304	PID Setpnt Displ	0.0%	
d305	Analog In 1	0.0%	
d306	Analog In 2	0.0%	
d307	Fault 1 Code	Read Only	
d308	Fault 2 Code	Read Only	
d309	Fault 3 Code	Read Only	
d310	Fault 1 Time-hr	Read Only	
d311	Fault 1 Time-min	Read Only	
d312	Fault 2 Time-hr	Read Only	
d313	Fault 2 Time-min	Read Only	
d314	Fault 3 Time-hr	Read Only	
d315	Fault 3 Time-min	Read Only	
d316	Elapsed Time-hr	Read Only	
d317	Elapsed Time-min	Read Only	
d318	Output Powr Fctr	Read Only	
d319	Testpoint Data	Read Only	
d320	Control SW Ver	Read Only	
d321	Drive Type	Read Only	
d322	Output Speed	Read Only	
d323	Output RPM	Read Only	

1. Changing Parameter Settings

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

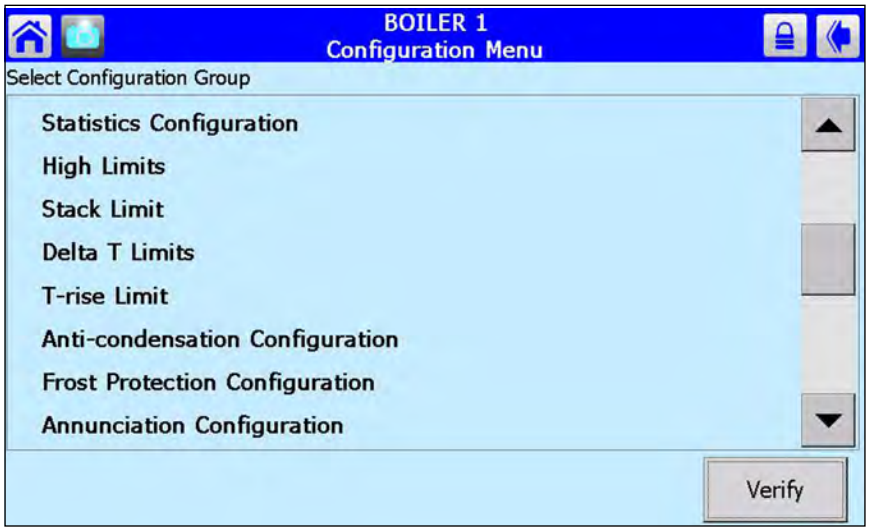


Figure 4-7 Configuration Menu

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

Safety Parameters

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

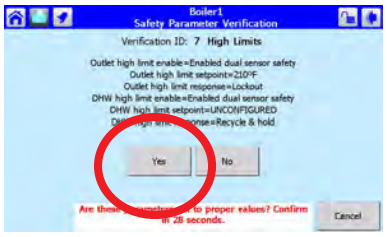
1. When a safety parameter is changed, the Safety Parameter Verification page will appear. Press <Begin> to continue.
2. The affected parameter group will be displayed, showing current parameter values and a prompt, “Are these parameters set to proper values?”. Press <Yes> to continue.
3. The screen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

Confirming Safety Parameter changes

1. Press <Begin>



2. Press <Yes>

3. Reset Falcon

2. Program Module

Falcon parameter information (non-safety parameters only) can be uploaded/ downloaded using the optional Program Module (PIM). When the Program Module is installed, its features are accessible from the Falcon Setup page. Starting from the Home page, press <SETUP>, then <PROGRAM MODULE>.

Figure 4-8 PIM

G. BURNER SEQUENCE

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

Basic burner sequencing (Central Heat):

1. Heat request detected (Setpoint minus On Hysteresis); LCI limits and demand detected (terminals J6 3 and J8 3).
2. The CH pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK input is energized, 10 sec. allowed for IAS input (combustion air proving) to energize, and purge rate proving fan RPM is achieved - prepurge time is started.
5. When 30 sec. purge time is complete, the purge 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 (4 sec.) or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition.

9. The ignition and the gas valve are switched on.
10. The ignition is turned off 5 seconds into pilot ignition.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. Release to modulation.
14. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
15. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
16. The pump stays on during the pump overrun time (if enabled).
17. At the end of the pump overrun time the pump will be switched off.

H. FAN SPEED SETTINGS

Because the input is determined by the fan speed, fan speed settings may have to be modified for the particular application, for high altitudes, or when using direct vent combustion. The default fan speed settings are intended for typical applications for the various boiler sizes. Please contact your authorized Cleaver-Brooks representative for proper settings in high altitude and direct vent combustion applications.

I. INITIAL START-UP PROCEDURE

NOTE: For LP gas-fired units or boilers with optional dual-fuel gas train, see section **K - Procedures for LP gas.**

⚠ Warning

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

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 and regulating actuator with safety shutoff. The blower speed is controlled by the 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 accordingly brings about a change in the gas flow proportional to the air pressure. The gas follows the airflow in a set ratio, so that fuel always matches the air as the burner firing rate increases or decreases.

1. Check the gas delivery system to be sure it is properly piped and wired.
2. Review available gas supply pressure to ensure that it is compatible with the ClearFire's gas train and regulator. Refer to Table 4-3 for minimum required supply pressure and maximum allowable supply pressure.
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.
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 gas valve inlet pressure to within the recommended levels in Table 4-3.

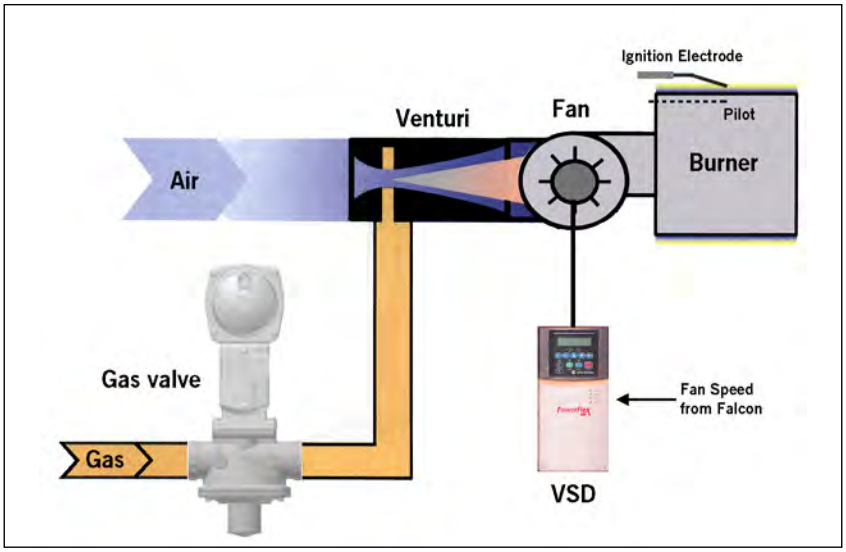


Figure 4-9 Premix Burner Technology - Full Modulation

Table 4-3 CFLC Gas Pressure Requirements

Boiler Model	Minimum pressure required at gas train connection	Max. pressure*
4000	14" WC	1.2 PSI
5000	14" WC	1.2 PSI
6000	28" WC	2 PSI
8000	28" WC	2 PSI
10000	31" WC	2 PSI
12000	31" WC	2 PSI

2. Power-Up

1. Ensure the boiler is properly wired for the available power supply. Refer to the wiring diagram provided with the boiler or to the appropriate wiring diagram in **Section 2 - Installation**.
2. Verify the voltage (control voltage is 115V-1Ph) to ensure it is within specifications.

3. Operation Check: Gas Valve, Gas Pressure Switches, Combustion Air Proving Switch, Ignition Fail

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 C - 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 Falcon Annunciation screen to monitor the status of the circuits involved. Press <Annunciation> on the Operation page to access this screen.

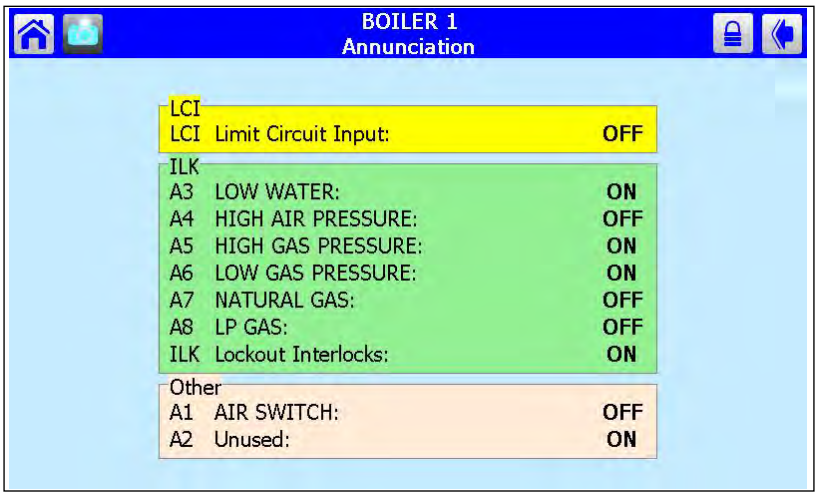
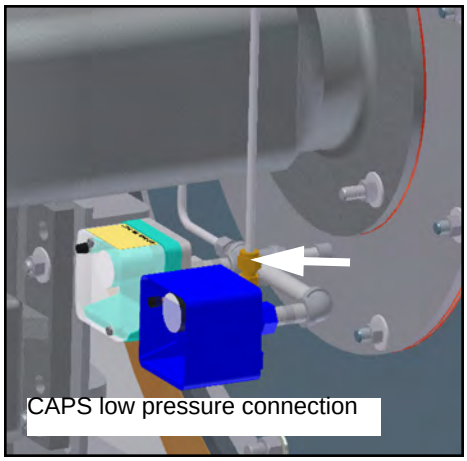


Figure 4-10 Annunciation Screen

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

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

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 Falcon.

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 Falcon should lock out on an interlock failure (Lockout 67).
5. Reset Falcon.
6. Open the downstream manual shutoff valve to clear the lockout condition.
7. Dial the HGPS back to its maximum setting and reset.

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 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 shutoff valve.

4. PILOT TESTS

PILOT FAIL CHECK

Close the gas pilot shutoff valve. Also shut off main fuel supply. Attempt to start the burner. There should be an ignition spark, but no pilot flame. The Falcon will lock out, indicating pilot failure.

Reset the Falcon, open the pilot shutoff valve, and re-establish fuel supply before continuing.

PILOT HOLD TEST

On the Falcon display, go to Configure>Ignition and turn <Pilot Hold> to ON. Open the manual valve on the pilot gas train, keeping the downstream main gas valve closed. Initiate the burner sequence. The burner will go through prepurge and will go to trial for pilot ignition. Once the pilot is lit, check for flame signal on the Falcon display and visually inspect the pilot flame through the sight port on top of the boiler. Once a good pilot flame has been established, open the downstream main gas shutoff valve and turn the Pilot Hold setting to OFF. The Falcon will proceed to main flame trial for ignition.

5. LOW WATER CUTOFF Check

1. Hold down the LOW WATER RESET-TEST switch for 3 seconds.
2. Check Annunciation screen. The ILK section (Interlock circuit) should show **A3 LOW WATER: OFF**
3. Press RESET-TEST switch once to reset.

6. Low and High Fire Adjustments

All CFLC 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.

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

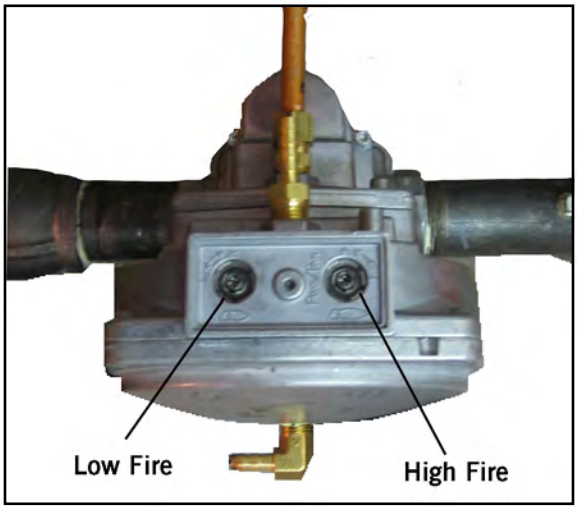


Figure 4-11 Gas valve actuator - adjusting screws

7. Modulation OFF point

Prior to setting combustion, the Modulation OFF point should be adjusted upward to avoid nuisance shutdowns while the burner is under manual control.

8. Setting Combustion

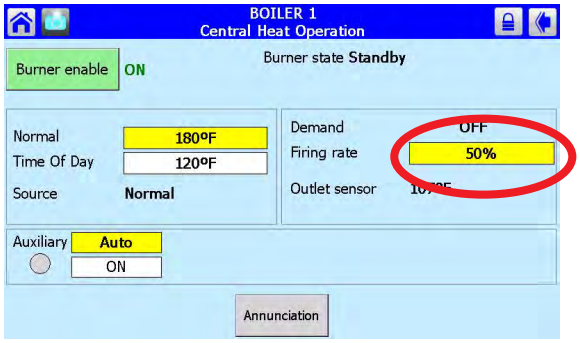
Note: A Combustion Analyzer is required to properly set up the Model CFLC burner. Do not attempt to fire and adjust the burner without this equipment.

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

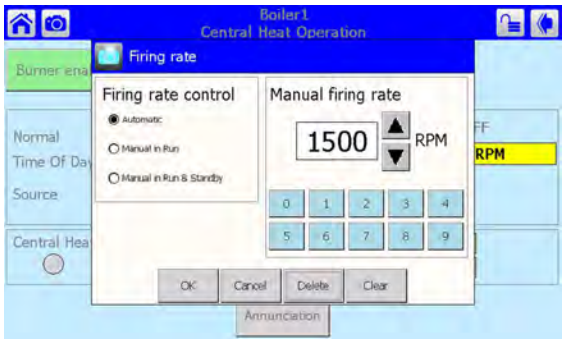
NOTE: Install the combustion analyzer probe as close as possible to the boiler vent connection. Sampling too far from the boiler vent can produce false readings due to air diluting the flue gas.

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 Falcon Control. Setting combustion will require manually modulating the burner via the Falcon from low fire to high fire two or more times to ensure a consistent air/fuel ratio.

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



1. On the Falcon **Operation** screen, press the **Firing rate** display.



2. A numeric keypad will appear, showing the current firing rate.

3. Press <Clear> to clear the current value.

4. Enter the desired RPM setting using the numeric keypad (refer to **Table 4-2**, Fan Speed Settings).

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

To set combustion:

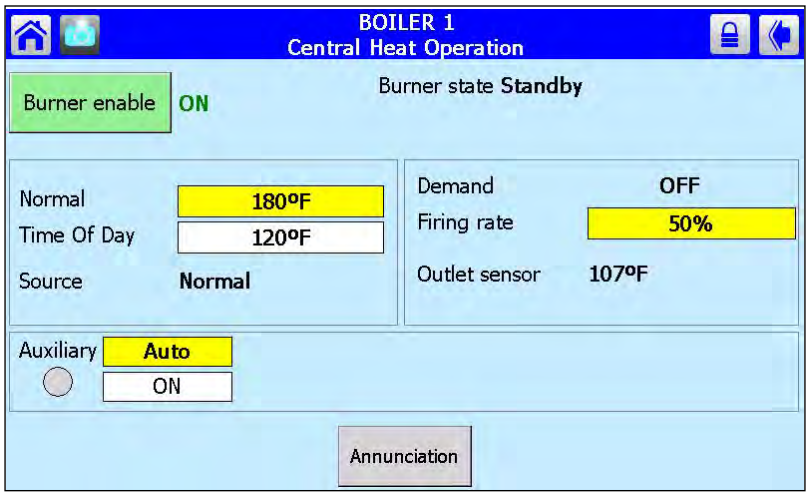


Figure 4-12 Operation screen

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 LOCAL/REMOTE switch to LOCAL.
4. Initiate burner firing sequence. The burner switch is accessed via the Falcon Operation page (**Figure 4-12**). 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% - 7%).
7. Modulate to low fire and fine tune offset screw to obtain desired O2% (6% - 7%).

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.

9. Limit Controls Check

The Modulation Off (operating limit) and High Limit functions can be tested while the boiler is operating by adjusting the respective setting downward and allowing the boiler outlet temperature to rise. The Modulation Off point is the sum of the Modulating setpoint and the Hysteresis Off value. The Modulation On point is the setpoint minus the Hysteresis On value.

When the boiler's outlet temperature exceeds either of these settings, the boiler will shut down. When the operating limit is exceeded, the boiler will automatically recycle upon the outlet temperature dropping below the on point. When the High Limit is exceeded, a lockout should result requiring a manual reset of the control after the temperature has dropped below the high limit setting.

Before testing the High Limit, temporarily set the Modulation OFF point higher than the High Limit setting.

Restore Modulation OFF and High Limit to operational settings after testing.

Specific settings are determined by application. Maximum High Limit for Model CFLC is 210 deg F.

The High Limit setting is considered a safety parameter. Any changes made will require a password login and reset of the Falcon.

J. POST START-UP CHECKOUT PROCEDURE

1. Ensure proper air venting to expansion tank.
2. 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.
3. 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. Operating outside of acceptable limits could result in light off and flame failure problems.
4. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
5. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
6. Verify HAPS switch operation by simulating a blocked flue condition.
7. Verify gas pressures remain within limits shown in Table 4-3.
8. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.
9. Provide instructions to owner and operators on proper water treatment guidelines and procedures.

K. FALCON CONTROL FUNCTIONS AND CUSTOMER INTERFACE

Following is a brief overview of the Falcon control features on ClearFire 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
- Rate Limiting/Override
- Configurable pump/auxiliary relay contacts
- Annunciator
- Diagnostics
- Lockout/Alarm History

- Trend Analysis
- Modbus communications
- Lead/Lag Control for up to 8 boilers
- DHW demand priority

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 system demand. The modulating set point can be adjusted at the Operation page or under the Central Heat 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 2-10 CFLC 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 Central Heat Configuration parameter group. Service level password login may be required to change this parameter.

The hysteresis on and hysteresis off points can only be changed under the Central Heat 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 5 deg F and 15 deg F, respectively.

The PID (Proportional-Integral-Derivative) load control operates on the demand source's modulation rate. Under Central Heat configuration, the PID gain values can be adjusted to match the desired modulation response. The default gain value settings of P=25, I=25 & D=0 have proven to work well with typical single boiler heating applications.

Decreasing the PID gain values slows down the controller's response to a change in load demand. Increasing the gain values causes more aggressive control, though setting the values too high can lead to 'overshoot' and unnecessary cycling.

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 Figure 2-10 in this manual or to your specific boiler wiring diagram for remote enable and remote 4-20mA input connections. 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 (demand input) is energized, the demand is enabled. The boiler then 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 "Local". This setting should be verified under the Falcon control's Central Heat configuration group, "Central Heat>Modulation>Modulation Rate Source". For remote modulation this parameter should be set to "S2 (J8-6) 4-20 mA with sensor on-off.

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 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 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 Central Heat configuration group. Change the setting of "Central Heat Configuration>Set Point>Set Point Source" to "S2 (J8-6) 4-20mA". Next, the span of the 4-20mA needs to be established. The "20mA water temperature" parameter determines the value for 20mA; "4mA water temperature" determines the value for 4mA.

Depending on the quality of the remote input signal, the modulation rate or operating set point may fluctuate slightly because of small changes in the measured current signal or because of induced noise. 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 0.2mA 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" or "LOCAL" 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.

Rate Limiting/Override

For safety reasons or to accommodate special operating conditions, the Falcon incorporates a number of control functions that either limit the modulation range or set the firing rate to a specific value. These functions include **Delta T** limiting, **Slow Start**, and **Forced Rate**. See Appendix A for a complete listing of control functions with detailed descriptions and parametrization instructions.

Delta T limiting is designed to reduce the firing rate in case of an excessive difference between the inlet and outlet temperatures caused by a mismatch between water flow rate and boiler firing rate. Sensor connections to the Falcon are at J8-4 and -5 (inlet temperature) and J8-8,-9, and -10 (outlet temperature). Delta T limiting includes an **Inversion Detection** mode which when enabled becomes active in case the inlet temperature is higher than the outlet temperature (indicating reverse water flow through the boiler).

Forced Rate limiting causes the burner to stay at a fixed firing rate for a fixed time period immediately after lightoff, following the Run Stabilization period (if any). The forced rate period is optionally followed by a Slow Start function that limits the ramp-up speed of the firing rate whenever the water is colder than a user-specifiable threshold. Slow Start can help reduce set point overshoot, high limit trips, and frequent cycling.

Configurable Pump/Aux Relay Contacts

The Falcon Pump/Aux Relay outputs are configurable by means of six pre-configured Pump Control Blocks. Each control block is configured for a specific application:

1. Central Heat Pump
2. Boiler Pump (for primary/secondary pumping)
3. DHW pump
4. System Pump
5. "Aux 1 Pump" - used for a boiler isolation valve
6. "Aux 2 Pump" - used for a boiler Start Permissive Interlock

Each pump control block has seven parameters (for details see Falcon Lead Lag appendix):

Pump Options (2 parameter blocks) - determine pump on/off conditions

Start Delay - if burner is just starting up, timer will delay pump turning on

Overrun Time - keeps the pump running for a short time after the input turns off or demand is satisfied

Output Connection - selects Pump A, B, or C (refer to WD, Figure 2-10)

Cycle Count - one cycle counter for each pump output; can be reset if a pump is replaced

Pump Control - selects Auto or Manual control

A Pump Exercise routine helps to prevent pumps from freezing up due to long periods of inactivity. Configurable parameters are Pump Exercise Interval (days) and Pump Exercise Time (minutes). Any pump that remains off for the Pump Exercise Interval will be turned on for the duration given by Pump Exercise Time.

The relays may be configured for various other functions, including freeze protection, isolation valves, damper interlocks, operating status, etc.

Annunciator

The Annunciator monitors the Falcon control circuit to provide fault and status messages, and also provides first out annunciation for interlock lockouts. Eight inputs are available in addition to the Interlock, Load Control, and Pre-Ignition Interlock inputs, totaling 11 monitored points. Annunciator points can be accessed from the Falcon display Operation screen.

Lead/Lag Control (up to eight boilers)

Multiple Falcon units can be connected in a lead/lag system. Controllers in a lead/lag configuration communicate over the Falcon's MB2 Modbus network.

One Falcon in the lead/lag network hosts the Lead Lag Master function, which coordinates the activities of the Slave units (individual Falcons, including the one hosting the Master) via Modbus. The Master uses its host controller's header sensor to receive control input information and to maintain the optimum setpoint. An outdoor temperature sensor can also be connected for Lead Lag outdoor reset control.

Boiler sequencing, on/off staging, and firing rate allocation are user-configurable. The Falcon's default lead lag parameter settings have been optimized specifically for ClearFire-C condensing boiler operation.

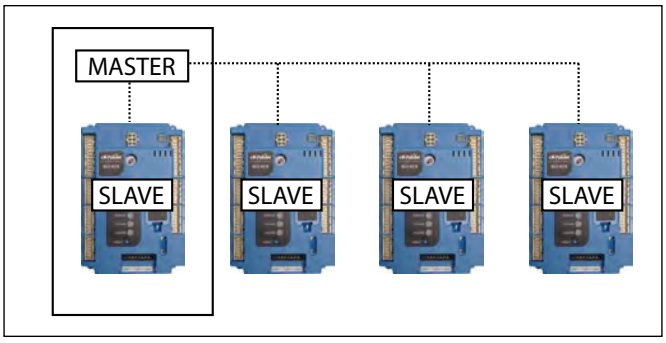


Figure 4-13 Falcon Lead/Lag

Refer to Falcon appendix or to the Falcon Lead/Lag appendix in this manual for additional information.

Modbus Communication

For remote enable / remote setpoint (see above) and for remote monitoring through a building EMS, the Falcon uses the Modbus communication protocol. For more information on Modbus setup and implementation, see the Falcon Modbus appendix in this manual.

Section 5
Service and Maintenance

⚠ Caution

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation.Failure to do so may result in equipment failure.

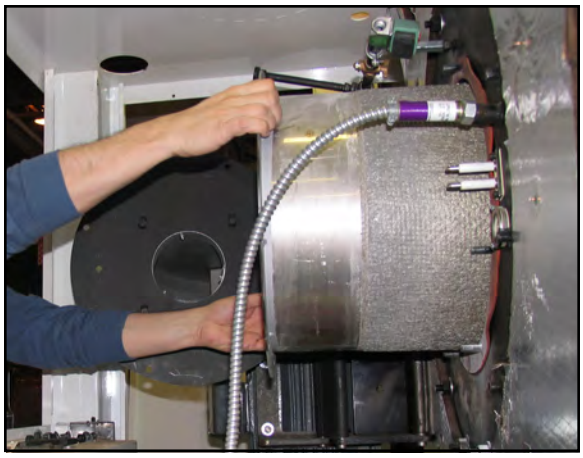
⚠ Caution

Verify proper operation after servicing. Failure to do so may result in equipment failure.

On an annual basis the boiler vessel and burner combustion system must be checked and cleaned. This work is to be carried out by an authorized Cleaver-Brooks Service Technician.

A. DISASSEMBLY FOR INSPECTION

1. Close off the gas supply to the boiler and disconnect electrical power at the primary switch box.
2. Remove the front upper and front left side casing panels.
3. Remove the gas train and set aside.
4. Disconnect the electrical connections to the blower assembly.
5. Disconnect scanner, ignition, and pilot cables.
6. Remove air filter (or direct vent coupling if supplied).
7. Remove the vent section between the flue collection chamber and the casing roof.
8. Remove the nuts securing the blower to the adapter plate.
9. The blower will swing out and to the left on its hinge.
10. The burner head can be separated by removing the nuts and washers holding the adapter plate to the dry oven.



Check the burner head for any damage, burn marks or perforations. If damage is found replace the damaged parts. If the canister is in good condition clean out any dirt and contaminates with a vacuum cleaner inside and out, alternating with compressed air to dislodge any debris.

With the burner head and blower removed the combustion chamber can be accessed for all service requirements.

Check ignition electrodes for deposits and proper gap. Clean or replace as needed.

Inspect the pressure vessel and combustion chamber area for any damage or contamination. If dirt or contaminates are found it is recommended that the tubes be washed with a high-pressure power washer.

⚠Caution

Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. Verify proper operation after servicing.

B. REASSEMBLY

1. Assembly is the reverse of the above instructions.
2. Burner gaskets should be replaced; see recommended spare parts list.
3. Replace combustion air filter if dirty. Remove filter retaining rod and install new CB approved filter media; see recommended spare parts list. Replace rod to hold filter in place.

C. IGNITION AND FLAME DETECTION SYSTEMS

Ignition Electrode

The ignition electrode should be replaced annually, or more frequently if conditions require. Inspect the electrode periodically for signs of fouling, displacement, or other damage.

Observe the dimensions below when replacing:

1/8” gap between ignitor electrode and ground electrode.

1” from ignitor electrode to the burner canister.

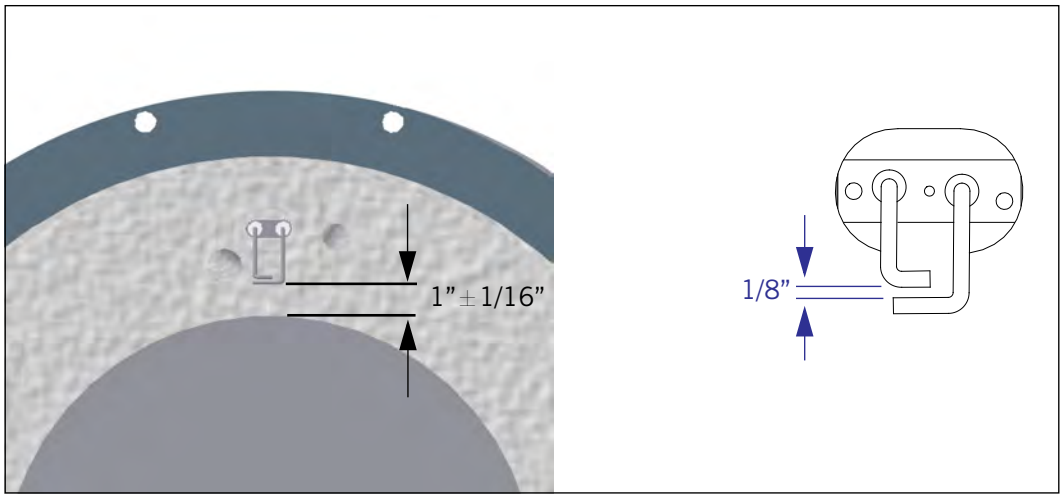


Figure 5-1 Electrode spacing CFLC

Pilot and UV Scanner

Maintenance of the UV scanner consists of periodic inspection and cleaning. To inspect, unscrew the UV flame detector from the bracket. Check to ensure that the flame viewing lens is clear and free of dust or debris. Wipe with a clean rag if necessary.

When replacing the scanner, verify an unobstructed line of sight through the scanner bracket to the burner canister.

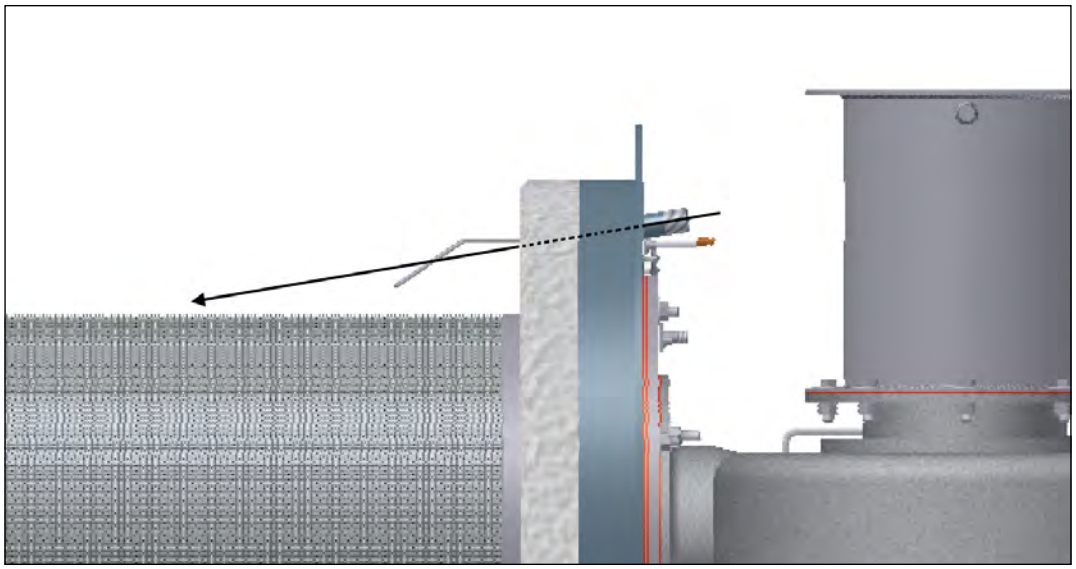


Figure 5-2

The CFLC uses an interrupted gas pilot in lieu of direct spark ignition. Ensure pilot is installed with the holes facing outward (towards the burner can).

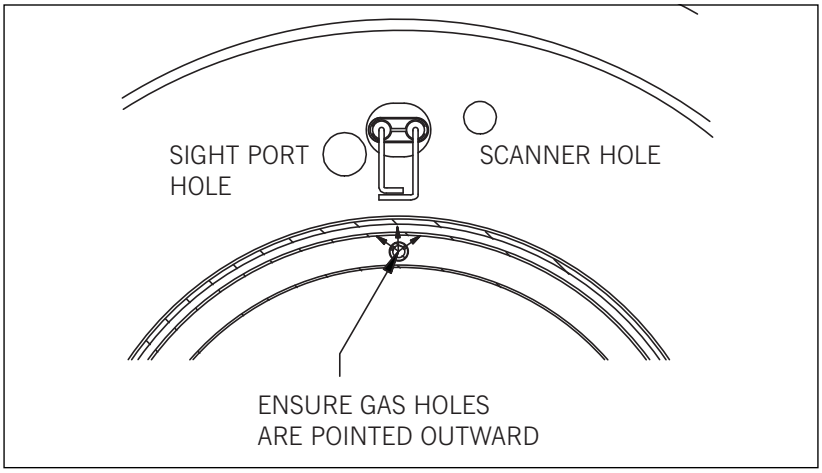


Figure 5-3

D. TROUBLESHOOTING

Lockout Conditions

1. Observe lockout code and description - refer to Falcon appendix if necessary.
2. After determining lockout condition, investigate possible causes.
3. When cause is diagnosed, remedy condition.
4. Reset control. Boiler should be able to start normally.
5. If lockout recurs, further investigation is required. Repeat steps 1 through 4 as needed. If necessary, contact your CB service representative for technical support.

EXAMPLE: Lockout 79 Outlet Temperature High Limit

1. Before resetting control to clear lockout, check for sufficient water flow through boiler. Possible sources of insufficient flow include closed water valves, insufficient pump speed, air trapped in boiler (inadequate air venting), or modulation set point and off point close to outlet high limit setting.

   The Falcon system display/interface provides extensive boiler diagnostic data at the time of lockout that can help in determining the source of a problem. This information is accessed through the Lockout History.

2. Remedy condition that caused lockout to occur.
3. Reset control by pressing <Clear Lockout> from the Lockout History screen.

Light-off Problems

Check electrode positioning according to Section C above.

The dimensions on the ignition electrodes are not easily adjustable - bending the rods can cause damage to the insulation material. In addition, a bent electrode will return to its original shape when heated. If an ignitor or flame rod is out of specification, replacement is generally required. Clean or replace as necessary.

Also see **Troubleshooting Chart** below.

Troubleshooting Chart

Symptom/Fault Indication	Possible Causes
Erratic display/controller behavior	Faulty electrical ground - Check ground terminals in control panel. System should be grounded firmly to metal casing. External ground wiring may be necessary.
Touch screen not working properly	Screen out of calibration - from Falcon home page, go to Setup/Advanced Setup/Diagnostics. Under “Touch Screen” press <Calibrate> and follow instructions on screen.
Burner can failure; High Gas Pressure lockouts	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. • A dedicated, properly sized gas pressure regulator is required for each boiler. • Customer connection should reduce to boiler gas train.
Lightoff problems	• Wrong 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. • Incorrect fan speed settings - increase fan speed by 100 RPM increments until successful lightoff occurs. • Bad cable connections (ignition or flame rod) • Electrodes fouled or improperly spaced - electrodes should be cleaned or replaced and spacing adjusted. • Debris on burner canister. To clean the unit, remove the burner can and blow compressed air from the outside in. Vacuum up the residue. • Electrical ground problem

Symptom/Fault Indication	Possible Causes
Outlet Temperature High Limit lockout	• Insufficient water flow through boiler - closed water valves, insufficient pump speed • Air trapped in boiler • Modulation set point and off point too close to outlet high limit setting
Interrupted Air Switch lockout	• Blower not running • Blocked blower inlet • CAPS switch defective or improperly wired
Loss of flame	• Debris on burner • Blocked condensate drain • Combustion improperly set • Flame scanner soiled, obstructed, or out of position

E. EXTENDED SHUTDOWN

When shutting down the boiler for an extended period of time, use the following general guidelines:

1. Turn the demand switch to the OFF position.
2. Close all main fuel valves.
3. If the boiler operates in a damp environment, cover electrical components in plastic to protect from moisture.

To restart after an extended period, follow the initial startup instructions in Chapter 4.

F. EMERGENCY SHUTDOWN

In case of emergency, shut down the boiler by turning the demand switch to the OFF position. Shut off the main manual fuel shutoff valves on the fuel supply line. The unit can also be shut down with the main electrical power disconnect. Inspect and troubleshoot the boiler before attempting to restart. Follow instructions in Chapter 4 for restart and continued operation.

Section 6
Parts

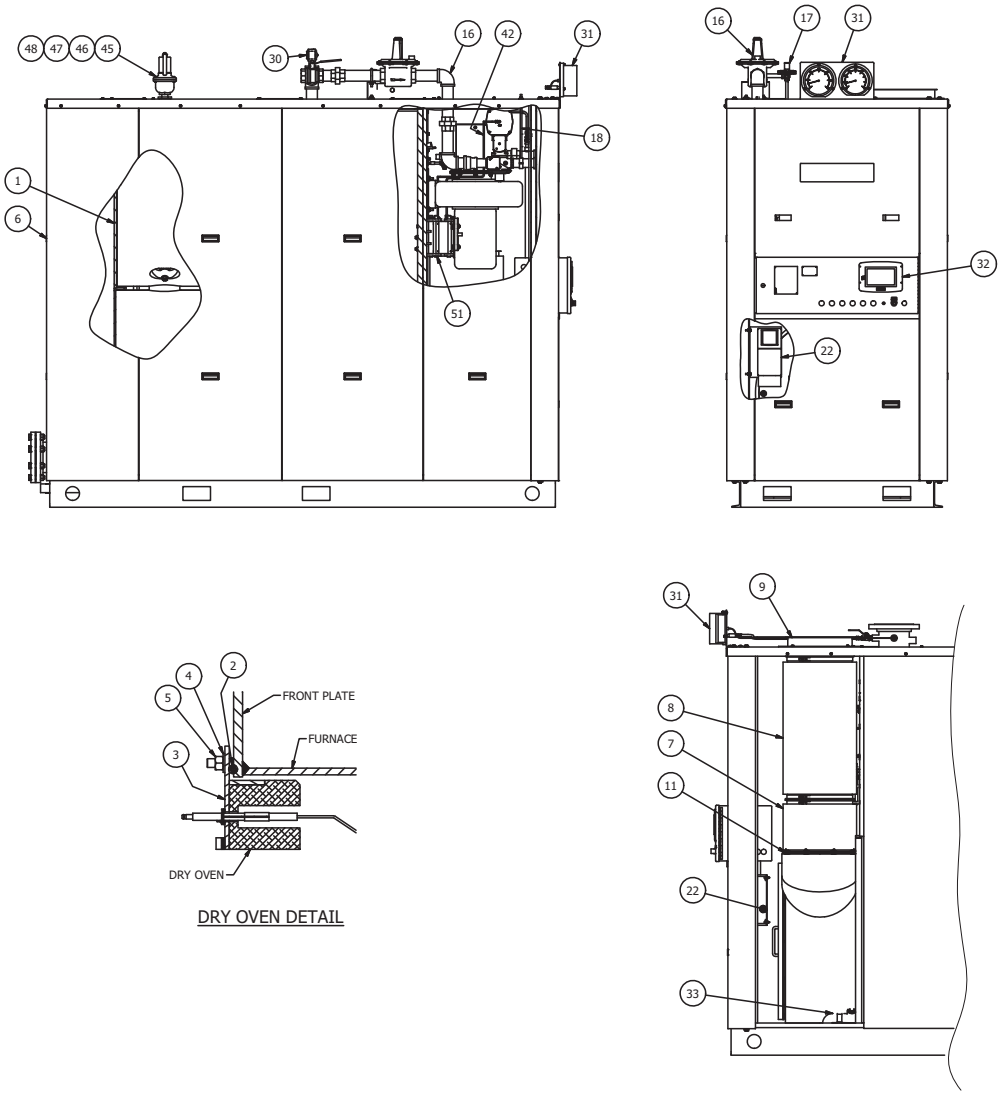
Recommended Spare Parts List Model CFLC

		Boiler Size
Item	**Qty**	**4000 / 5000**
Falcon Controller, Hydronic	1	833-04097
Display/Operator Interface, Falcon System	1	833-05105
UV Scanner	1	817-01743
Dual Electrode, Sparking	1	380-01061
Electrode Gasket	3	380-01032
Burner Canister	1	380-01130
Water Side Gaskets	5	853-00934
Transformer, 115V/25V	1	832-00235
Relay, DPDT, 115VAC Coil	1	833-03532
Gasket, Burner Canister	2	380-01118
Gasket, Adapter to Blower	1	380-01121
Cable, Gas Pilot	1	826-00262
Ignition Cable (2)	1	826-00298
Burner Sight Glass	1	851-00026
Retainer, Sight Glass	1	952-00498
Gasket, Sight Glass	2	853-00213
Filter Media		332-00091

Blower Fuse (9A)	3	832-01885
Fuse (5A), Control Circuit	2	832-01811
Fuse (4A), Control Circuit	1	832-01810
Fuse (2A), 24VAC Secondary	1	832-02051

Figure 6-1. Boiler Mechanical Assembly CFLC 4000-5000

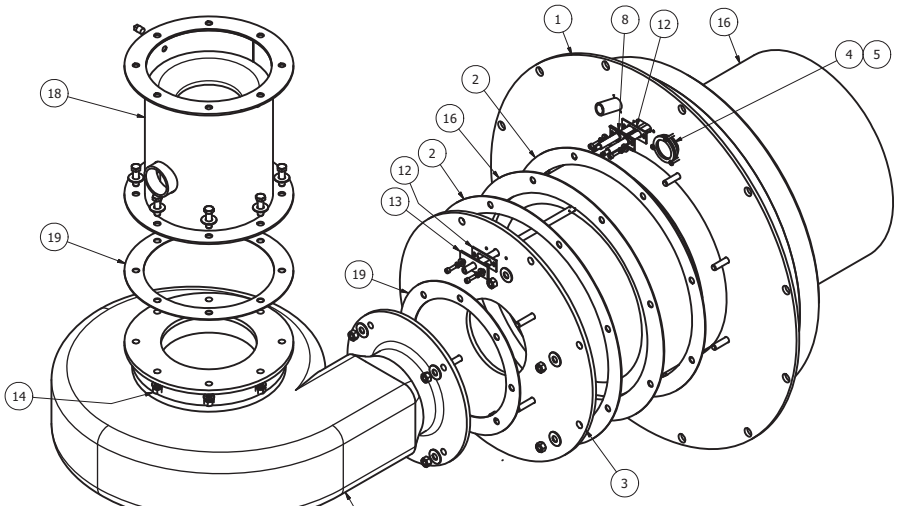
ITEM	QTY	CFLC 4000	CFLC 5000	DESCRIPTION
1	1	270-03748-000	270-03739-000	PRESSURE VESSEL ASSEMBLY
2	1	853-00996-000	853-00996-000	ROPE, 1/2" DIA. X 80" LG.
3	1	429-01882-000	429-01809-000	BURNER ASSEMBLY
6	1	465-02772-000	465-02772-000	INSULATION & LAGGING ASSEMBLY
7	1	426-03299-000	426-03299-000	DUCT, STACK STARTER SECTION, 14" DIA.
8	1	426-03300-000	426-03300-000	DUCT, STACK REMOVABLE SECTION, 14" DIA. W/BANDS
9	1	426-03301-000	426-03301-000	DUCT, STACK SUPPORT, 14" DIA.
11	1	872-00622-000	872-00622-000	ROPE, 1/2" DIA. x 45" LG.
16	1	185-01263-000	185-01263-000	GAS TRAIN, MAIN GAS
17	1	185-01264-000	185-01264-000	PIPING, PILOT GAS TRAIN
22	1	833-03362-000	833-03362-000	DRIVE, VARIABLE SPEED
30	1	507-09839-000	507-09839-000	PIPING, AIR VENT AND LWCO PROBE HOLDER
31	1	656-10183-000	656-10183-000	INSTALLATION, PRESSURE GAUGE & THERMOMETER
32	1	283-03650-000	283-03650-000	CONTROL PANEL, CFLC
33	1	189-01425-000	189-01425-000	PIPING, CONDENSATE DRAIN
36	1	817-00405-000	817-00405-000	WELL, SEPARABLE, 1/2" NPT. W/CLAMP
41	1	826-00296-000	826-00296-000	CABLE HARNESS, MALE END
42	1	090-04682-000	090-04682-000	TUBING, AIR SENSING LINE
45	1	940-05199-000	940-05199-000	VALVE RELIEF, 160 PSI. 1" x 1-1/4" (STANDARD, SHIP LOOSE)
46	1	940-00601-000	940-00601-000	VALVE RELIEF, 125 PSI. 1" x 1-1/4" (OPTIONAL, SHIP LOOSE)
47	1	940-00566-000	940-00566-000	VALVE RELIEF, 60 PSI. 1-1/2" x 2" (OPTIONAL, SHIP LOOSE)
48	1	940-00962-000	940-00962-000	VALVE RELIEF, 30 PSI. 2" x 2-1/2" (OPTIONAL, SHIP LOOSE)
50	1	880-02711-000	880-02711-000	KIT, AIR FILTER, CFLC
51	1	462-00243-000	462-00243-000	HINGE ASSEMBLY, BLOWER



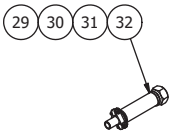
DRY OVEN DETAIL

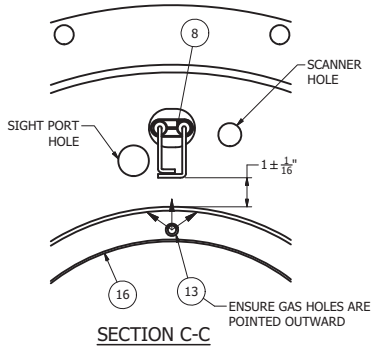
Figure 6-2. Burner Assembly CFLC 4000/5000

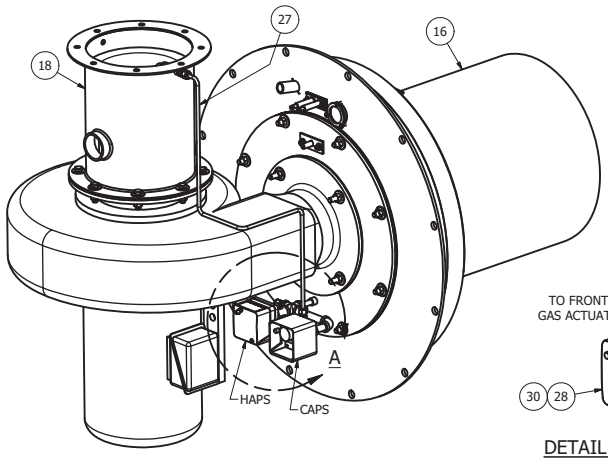
ITEM	QTY	CFLC 4000	CFLC 5000	DESCRIPTION
1	1	279-00749-000	279-00749-000	DRY OVEN ASSEMBLY
2	2	380-01118-000	380-01118-000	GASKET, BURNER CANISTER
3	1	380-01119-000	380-01119-000	ADAPTER PLATE, BURNER TO BLOWER
4	2	853-00213-000	853-00213-000	SIGHT GLASS GASKET
5	1	851-00026-000	851-00026-000	SIGHT GLASS
8	1	380-01061-000	380-01061-000	ELECTRODE, DUAL, CLEARFIRE IGNITION
12	2	380-01032-000	380-01032-000	GASKET, ELECTRODE
13	1	090-04464-000	090-04464-000	TUBE, GAS PILOT
16	1	380-01130-000	380-01130-000	BURNER CAN
17	1	894-05502-000	894-05372-000	BLOWER, COMBUSTION AIR
18	1	048-00859-000	048-00859-000	VENTURI ASSEMBLY
19	2	380-01121-000	380-01121-000	GASKET, BLOWER INLET & OUTLET
22	1	817-03468-000	817-03468-000	COMBUSTION AIR PROVING SWITCH
28	1	817-02420-000	817-02420-000	PRESSURE SWITCH, 3-21"WC RANGE, MR, 1/4" NPT MOUNT



29	1	817-01743-000	SCANNER ASSEMBLY - UV
30	1	848-00003-000	CONNECTOR, STRAIGHT, 3/8"
31	2	848-00100-000	BUSHING, ANTI-SHORT, GREENFIELD, 3/8"
32	1	827-00006-000	CONDUIT, FLEX, GREENFIELD, 3/8" x 60" LG.







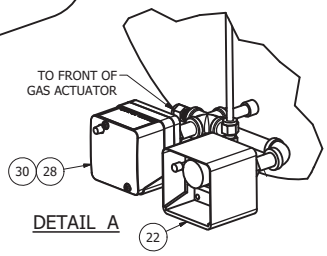


Figure 6-3 Gas train CFLC 4000/5000

ITEM	QTY	PART NO	DESCRIPTION
5	1	941-01946-000	BALL VALVE, 1-1/2" NPT.
7	1	949-00461-000	VALVE BODY, 1-1/2" NPT, MOTORIZED, GAS
8	1	797-07871-000	ACTUATOR, SIEMENS SKP75.011U1
16	1	918-00161-000	REGULATOR, GAS PRESSURE, MAXITROL #210E, 2"NPT, 15"-30" WC
19	1	941-01947-000	VALVE, BUTTERBALL, 2" NPT.
21	2	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
24	1	817-02416-000	LGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
27	1	817-02420-000	PRESSURE SWITCH, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
28	2	845-00022-000	CONNECTOR, COMP, BRASS, 1/4" NPT. x 3/8" ODC
29	1	939-00413-000	TUBING, ALUMINUM, 3/8" O.D. x .035" WALL x 21" LG.
31	1	048-00871-000	ORIFICE, 20PPM NATURAL GAS

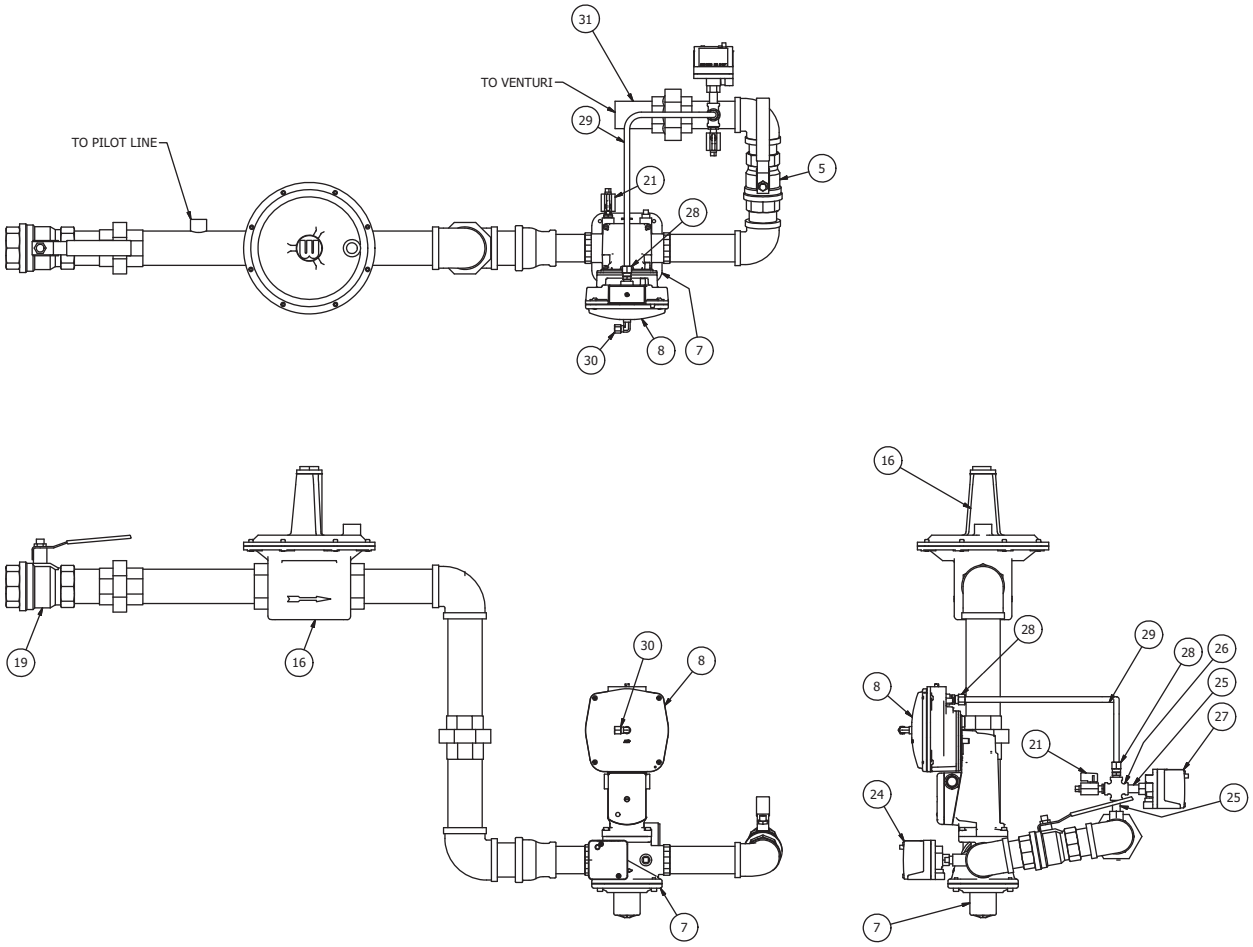


Figure 6-4. Gas Train (9 ppm) CFLC 4000/5000

ITEM	QTY	PART NO	DESCRIPTION
5	1	941-01946-000	BALL VALVE, 1-1/2" NPT.
7	1	949-00461-000	VALVE BODY, 1-1/2" NPT, MOTORIZED, GAS
8	1	797-07871-000	ACTUATOR
16	1	918-00161-000	REGULATOR, GAS PRESSURE (OPTIONAL)
19	1	941-01947-000	VALVE, BUTTERBALL, 2" NPT.
21	2	825-00239-000	LEAKAGE TEST COCK, 1/8" NPT.
22	2	858-00088-000	PIPE PLUG, SQ. HD. 1/8" NPT 150# M.I., B16.14
24	1	817-02416-000	LGPS, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
27	1	817-02420-000	PRESSURE SWITCH, 3-21"WC RANGE, MR, 1/4" NPT MOUNT
28	2	845-00022-000	CONNECTOR, COMP, BRASS, 1/4" NPT. x 3/8" ODC
29	1	939-00413-000	TUBING, ALUMINUM, 3/8" O.D. x .035" WALL x 14" LG.
31	1	048-00872-000	ORIFICE, 9PPM NATURAL GAS
32	1	048-00873-000	ORIFICE ASSEMBLY, NATURAL GAS SENSING LINE, 9 PPM
35	1	235-00091-000	VALVE, SOLENOID, GAS PILOT, 1/4" NPT.
36	1	845-00468-000	CONNECTOR, .125" MPT. x .25" ODC
37	1	939-00642-000	BULK TUBING, ALUMINUM, 1/4" ODC x .035" WALL x 14" LG.

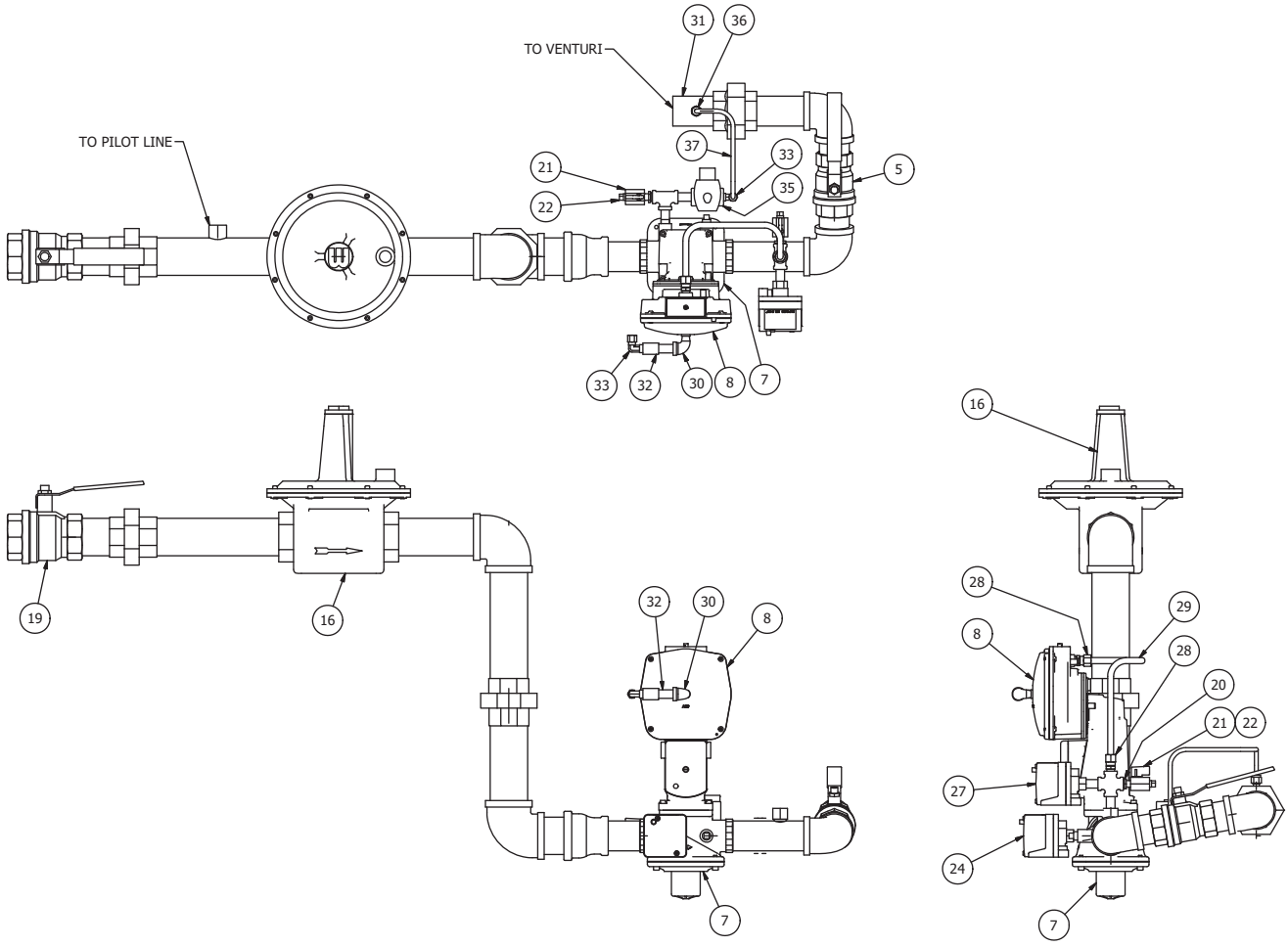


Figure 6-5. Control Panel

ITEM	QTY	PART NO	DESCRIPTION
1	1	119-00433-000	CABINET, ELECTRICAL, W/SUB-BASE
2	1	833-05105-000	DISPLAY, SYSTEM INTERFACE
3	1	817-03571-000	ALARM, BUZZER, PANEL MOUNTED (OPTIONAL)
4	1	836-01148-000	SWITCH, SELECTOR, 3 POSITION
5	5	836-01136-000	CONTACT BLOCK, N.O.
6	1	118-03922-000	NAME PLATE, DEMAND REM/OFF/LOC
7	1	832-02451-000	IGNITION TRANSFORMER
8	1	833-04097-000	FALCON CONTROLLER, HYDRONIC, CFLC
9	1	880-02343-000	PLUG, CONNECTOR KIT, FALCON
10	2	884-00078-000	TERMINAL, SCRULUG, #14 THRU #4 AWG
11	1	833-03547-000	CONTROLLER, LWCO
12	1	832-00235-000	TRANSFORMER, 115v/25v
13	1	178-00049-000	TRANSFORMER, 460/230/208V PRI, 350VA, FUSED TOP
14	1	434-00088-000	TERMINAL TRACK, CFx BOILERS
15	3	832-01885-000	FUSE, 9 AMP, LPCC TIME DELAY (BLOWER)
16	2	832-01811-000	FUSE, 5.0 AMP, 600V (PRIMARY)
17	1	832-01810-000	FUSE, 4.0 AMP, 600V (SECONDARY)
18	1	833-03532-000	ELECTRICAL-RELAY, DPDT,115VAC COIL
19	1	826-00200-000	CABLE, INLET TEMP. SENSOR
20	1	826-00201-000	CABLE, OUTLET TEMP. SENSOR
21	1	817-04403-000	SENSOR, HW SUPPLY/OUTLET TEMP.
22	1	817-04814-000	SENSOR, RETURN/INLET TEMP.
23	1	832-02051-000	FUSE, 2 AMP, 5x20mm
24	1	881-00348-000	LATCH, PLASTIC
25	1	SEE TABLE	RELAY, 1.8-180 SECOND DELAY ON MAKE

WHERE USED	ASSY PART NO.	ITEM 25 PART NO.
STANDARD	283-03650-000	N/A
9 PPM	283-03653-000	833-01223

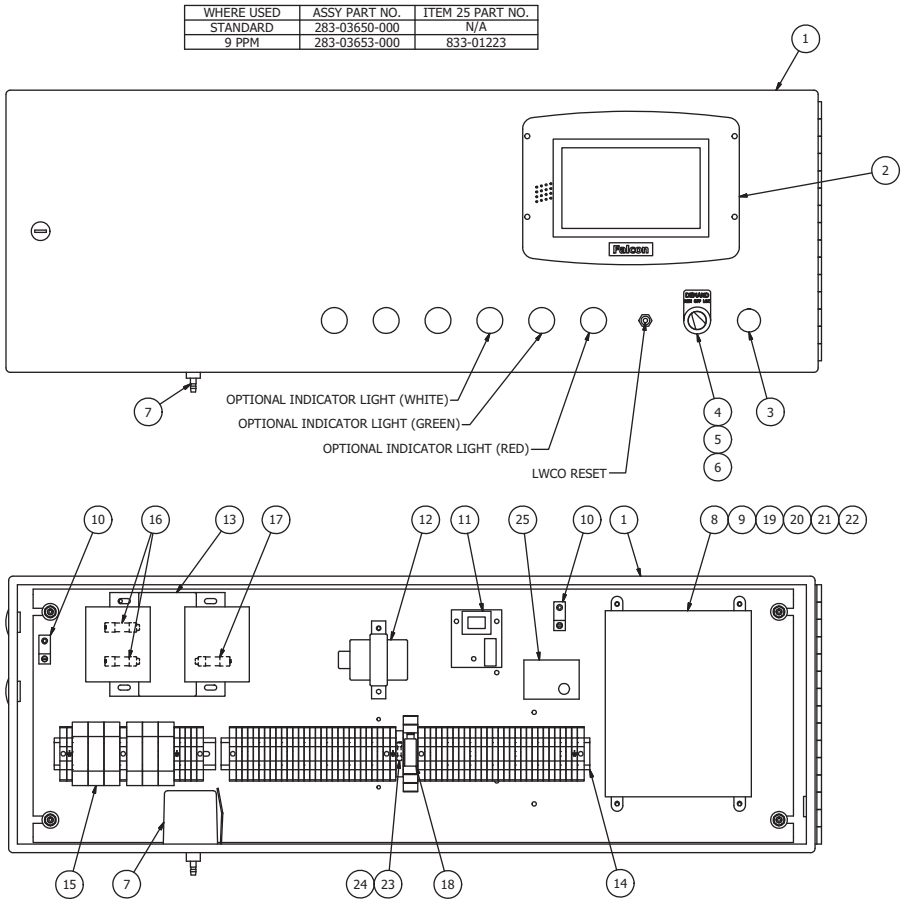
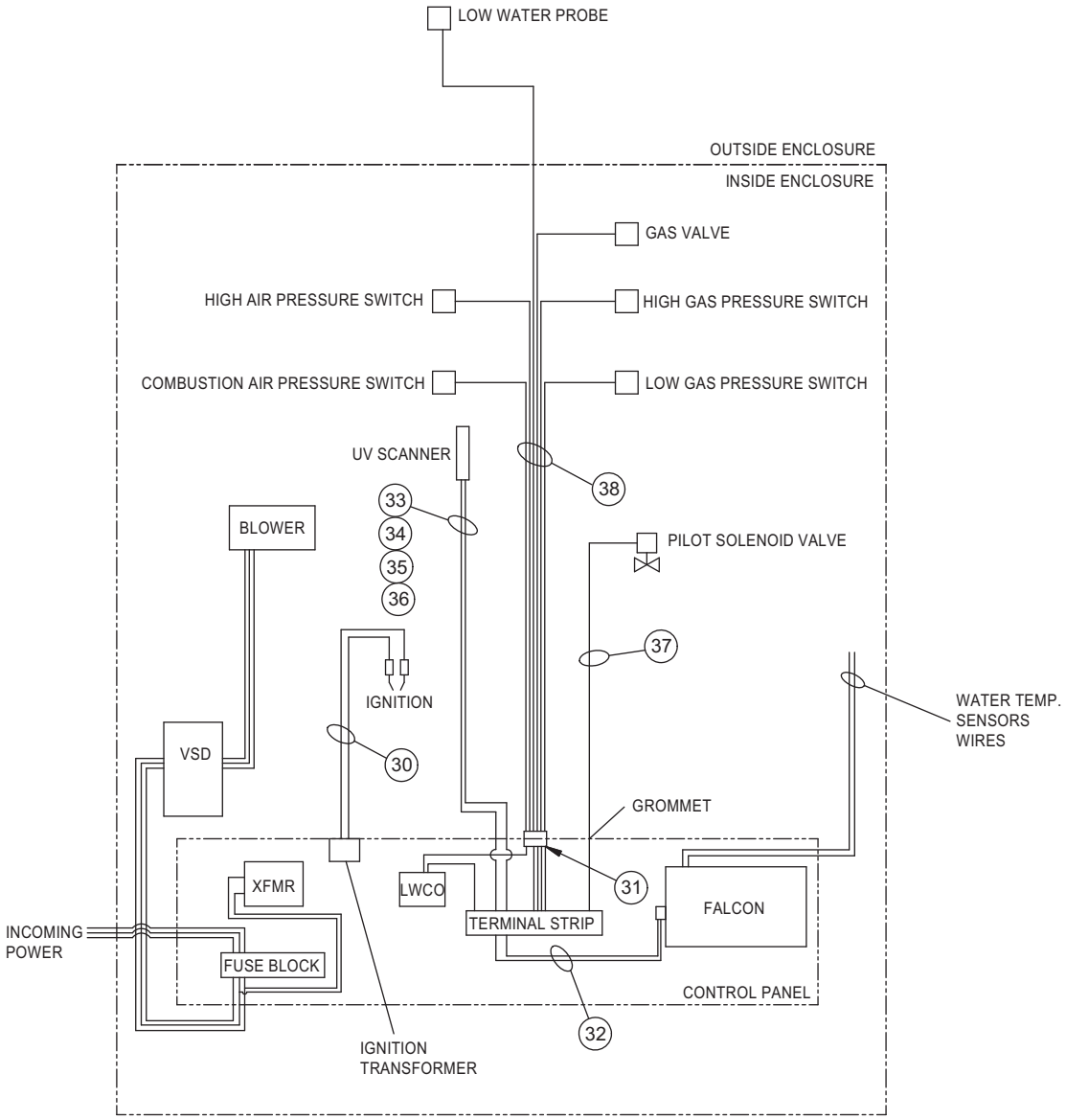


Figure 6-6. Cables and Cable Harness

ITEM	QTY	PART NO	DESCRIPTION
30	2	826-00298-000	CABLE, IGNITION
31	1	826-00297-000	CABLE HARNESS, FEMALE END
32	1	826-00211-000	CABLE, UV SCANNER TO FALCON J1
33	1	817-01743-000	SCANNER ASSEMBLY - UV
34	1	848-00003-000	CONNECTOR, STRAIGHT, 3/8"
35	2	848-00100-000	BUSHING, ANTI-SHORT, GREENFIELD, 3/8"
36	1	827-00006-000	CONDUIT, FLEX, GREENFIELD, 3/8" x 60" LG.
37	1	826-00262-000	CABLE, GAS PILOT SOLENOID
38	1	826-00296-000	CABLE HARNESS, MALE END



CABLE HARNESS LAYOUT