CLEARFIRE - MODEL CFH

10-60 HP

Steam Horizontal Boiler

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FEATURES AND BENEFITS

General

The ClearFire Model CFH is a single pass, horizontally fired durable firetube steam boiler. Extended heating surface tubes provide a very high level of performance in a compact package. An integral premix burner is provided for natural gas operation. As standard, the Model CFH burner provides low emissions of <20 PPM NOx. Propane fuel is also available.

Advanced Technology

Heat is transferred through 3" OD carbon steel tubes with patented AluFer© extended heating surfaces. The AluFer© tube design provides for optimum heat transfer and eliminates laminar gas flow during minimum firing, providing optimized efficiency throughout the firing range (see Figure B6-1 and Figure B6-2).

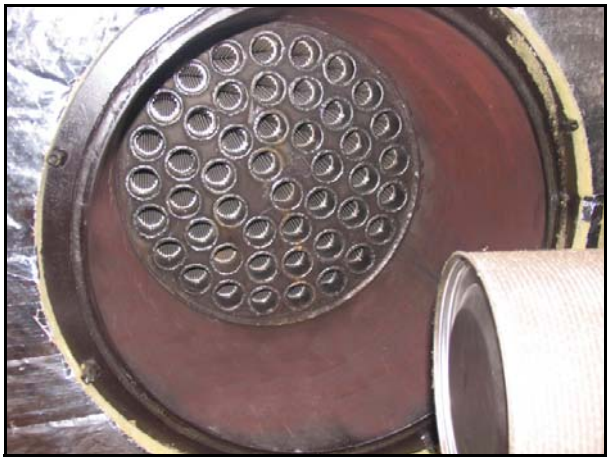


Figure B6-1. AluFer© Tubes

Figure B6-2. Tube Cross Section

High Efficiency

With the AluFer© extended heating surface tubes, the Model CFH steam boiler will provide fuel-to-steam efficiency of up to 83% operating at 125 psig or 85% at 10 psig (85% efficiency for high-pressure steam is available with an optional flue gas economizer package).

Quality Construction

ISO 9001-2001 certification ensures the highest manufacturing standards.

ASME code construction ensures high quality design, safety, and reliability. Units are third-party inspected and are stamped to assure compliance.

Certification

Each unit is tested and certified in accordance with UL/cUL standards and the UL/cUL label is affixed attesting to equipment meeting the latest UL requirements for packaged steam boilers.

Premix Technology

The ClearFire CFH burner utilizes Premix technology to mix both gas fuel and combustion air prior to entering the burner canister, with fuel flow governed by the air flow during firing transitions. Combined with a variable speed fan, this technology provides very low emission levels, exceptionally safe operation, and nearly 100% combustion efficiency. An inlet air filter is provided as standard to prevent airborne dust from entering the combustion canister.

Full Modulation

The variable speed fan modulates to provide only the amount of heat required to the boiler. Full modulation reduces on/off cycling and provides excellent load tracking with reduced operating costs. The burner does not require mechanical linkage connections between the fuel input valve and air control. Instead, the microprocessor control adjusts the 3 in accordance with system demand, determining fuel input without mechanical device positioning. This

method of controlling the fuel-air ratio eliminates slippage due to linkages, minimizes burner maintenance, and provides control repeatability. See Figure B6-3.

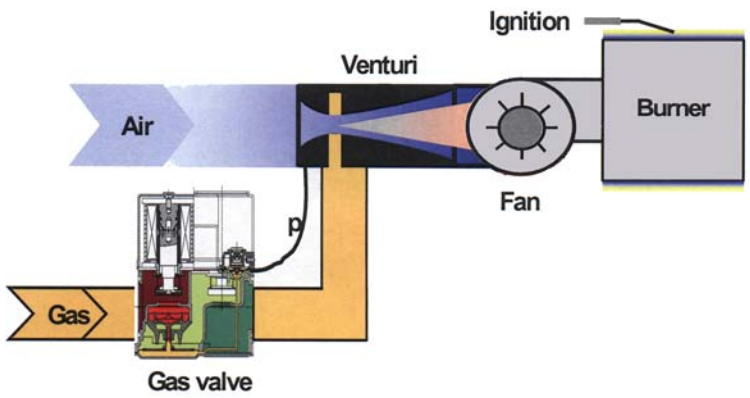


Figure B6-3. Premix Burner Technology

Ease of Maintenance

The burner is hinged and swings out to allow inspection or service of the burner canister, tubes, and tube sheets (see Figure B6-4). A union connection provides easy disconnect from the fuel train. All burner components are easily accessed for inspection and maintenance.

Figure B6-4. Burner maintenance

Designed for commercial steam applications

Whether for heating or for steam process, the CFH packaged boiler is designed for 15 psig or 150 psig MAWP (Maximum Allowable Working Pressure) and is constructed of durable ASTM grade steel materials. Figure B6-5 shows the component and connection locations.

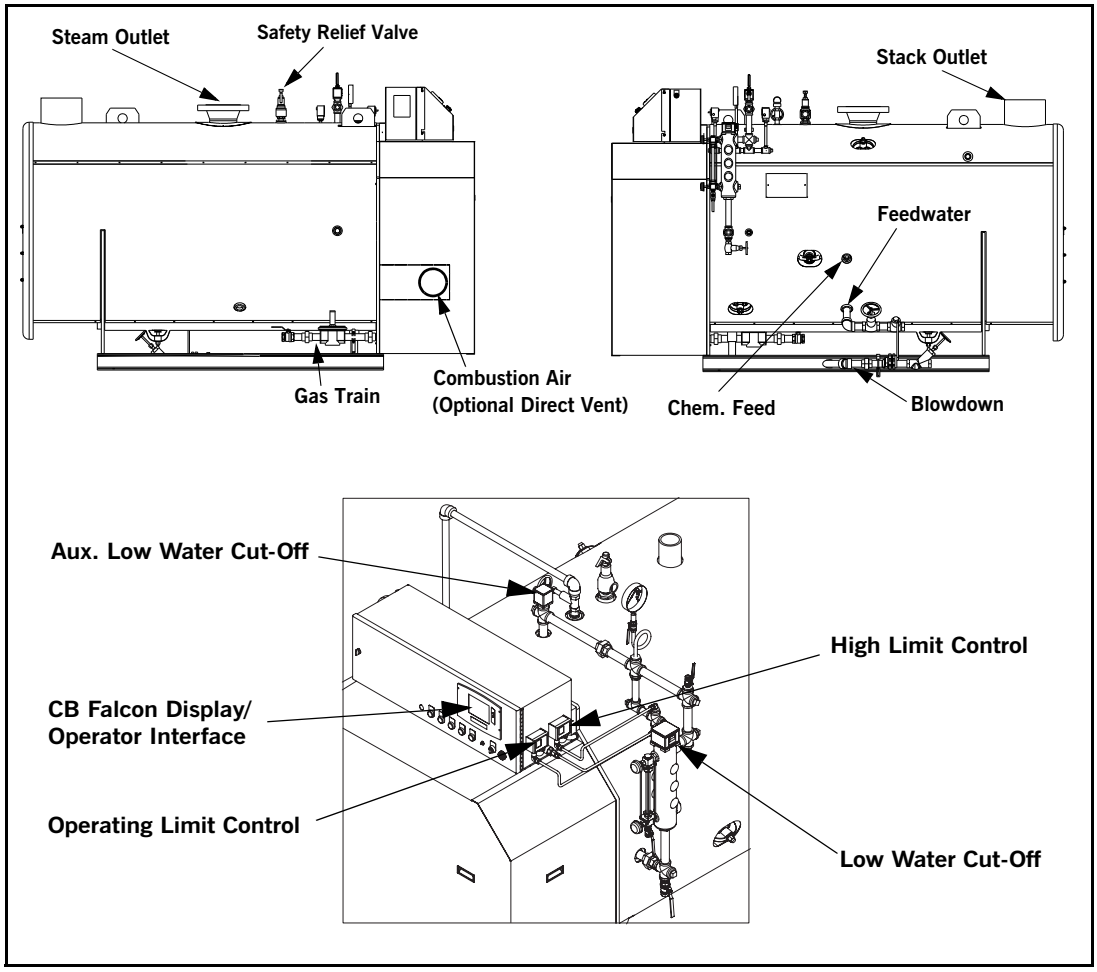


Figure B6-5. Model CFH Steam Boiler

PRODUCT OFFERING

Information in this section applies to steam boiler sizes ranging from 10 horsepower through 60 horsepower for operation on natural gas or LP gas only. Fuel oil operation is not available for the model CFH. Standard installation is for indoor use with an optional engineering design for outdoor applications.

The complete package has been tested and certified in accordance with UL/cUL. Package is approved and listed and bears the appropriate UL/cUL package boiler label.

Dimensions, ratings, and product information may change due to market requirements or product enhancements. The information contained herein is a guide for general purposes only.

Standard Equipment

The equipment listed below applies to the standard boiler package offering. Optional items are available to meet specific projects when required.

A. The Boiler

A. Each boiler (pressure vessel) size is designed and built for a Maximum Allowable Working Pressure (MAWP) of 15 psig in accordance with ASME Section IV (bearing the "H" stamp) or 150 psig in accordance with ASME Section I (bearing the "S" stamp).

B. The vessel is insulated with a 2" thick blanket and mounted on a base frame. A powder-coated 18 gauge steel casing covers the insulation.

C. Vessel connections are furnished for:

Steam outlet
Bottom drain or blowoff
Surface blowoff
Chemical feed
Feedwater makeup
High water level overflow

D. For waterside inspection, handholes are provided.

E. Two lifting lugs are provided for rigging purposes.

F. The combustion exhaust is located at the top rear.

B. Boiler trim and controls

- Water column with primary low water cutoff and pump control (probe type).
- Water column gauge glass and gauge glass drain valve.
- Water column drain valve.
- Auxiliary low water cutoff (probe type), manual reset.
- Operating limit pressure control, auto reset.
- Excess steam pressure control, manual reset.
- Pressure transmitter for burner on/off and modulation.
- Steam pressure gauge.
- ASME safety relief valve.

C. CB Falcon Control System

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

B. Functionality - The controller incorporates the following functions:

- PID load control.
- Burner sequencing with safe start check, pre-purge, direct spark ignition, and post purge.
- Electronic ignition.
- Flame Supervision.
- Safety shutdown with time-stamped display of lockout condition - last 15 lockouts stored in memory.
- Variable speed control of the combustion air fan.

- Supervision of low and high gas pressure, air proving, stack back pressure, and low water.
- Alarm output
- Remote enable & remote modulation or set point.
- First-out annunciator.
- Diagnostics.
- Real-time data trending (w/System Display).
- (3) pump/auxiliary relay outputs.
- Modbus communication.
- Outdoor temperature reset.
- Anti-short-cycling mode
- Time-of-day (night setback) operation
- Three levels of access to control configuration:
  - End-user
  - Installer/Service Engineer (password protected)
  - OEM Manufacturer (password protected)

Table B6-1. Operating Conditions - CB Falcon

Temperature Range	Operating	32 F to 122 F (0 C to 50 C)
	Storage	-40 F to 140 F (-40 C to 60 C)
Humidity	85% max. relative humidity	

Table B6-2. CB Falcon burner sequence

1. Heat request detected (Setpoint minus On Hysteresis); LCI limits and steam demand detected (terminals J6 3 and J8 3).
2. The CH pump is switched on (relay contact closes).
3. After a system Safe Start Check, the Blower (combustion air fan) is started
4. After the ILK input is energized - 10 sec. allowed for IAS input (combustion air proving) to energize - and the purge rate proving fan RPM is achieved, prepurge time is started.
5. When 30 sec. purge time is complete, the fan RPM is changed to the lightoff speed.
6. Trial for Ignition (4 sec).
7. The ignitor and the gas valve are energized.
8. The ignitor is turned off at the end of the direct burner ignition period.
9. The fan is kept at the lightoff rate during the stabilization time.
10. Release to modulation (Run).
11. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete (15 sec.). Boiler enters standby mode.

C. Main Electrical Connection - 115V/single phase/60Hz

D. Demand switch - Local/Remote/Off.

E. Combustion Air Proving Switch

F. Gas Pressure Switch - Gas pressure switches for low gas pressure and high gas pressure prevent the burner from being activated if either is open. Each switch is a physical manual reset device, requiring physical depression of the reset button if either switch is not closed prior to burner start or during burner operation. Monitored in Interlock (ILK) Circuit.

G. System Configuration - CB Falcon configuration is grouped into the following functional groups:

- System Identification and Access
- Central Heat Configuration
- 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

H. CB Falcon Control Access - There are three levels of access to the CB Falcon controller:

- End User Level - read or view parameters; change setpoints. No password required.
- Installer/Service Level - read all parameters; enables changing of most parameters. This access level is used to configure the CB Falcon for a particular installation, and is password-protected.
- OEM Level - read/change all parameters; for factory configuration of boiler-

specific parameters. Password-protected and restricted to CB or factory authorized service personnel.

For additional information regarding service and setup of the burner controller, refer to CB manual part no. 750-295.

Figure B6-6. CB Falcon Display/Operator Interface

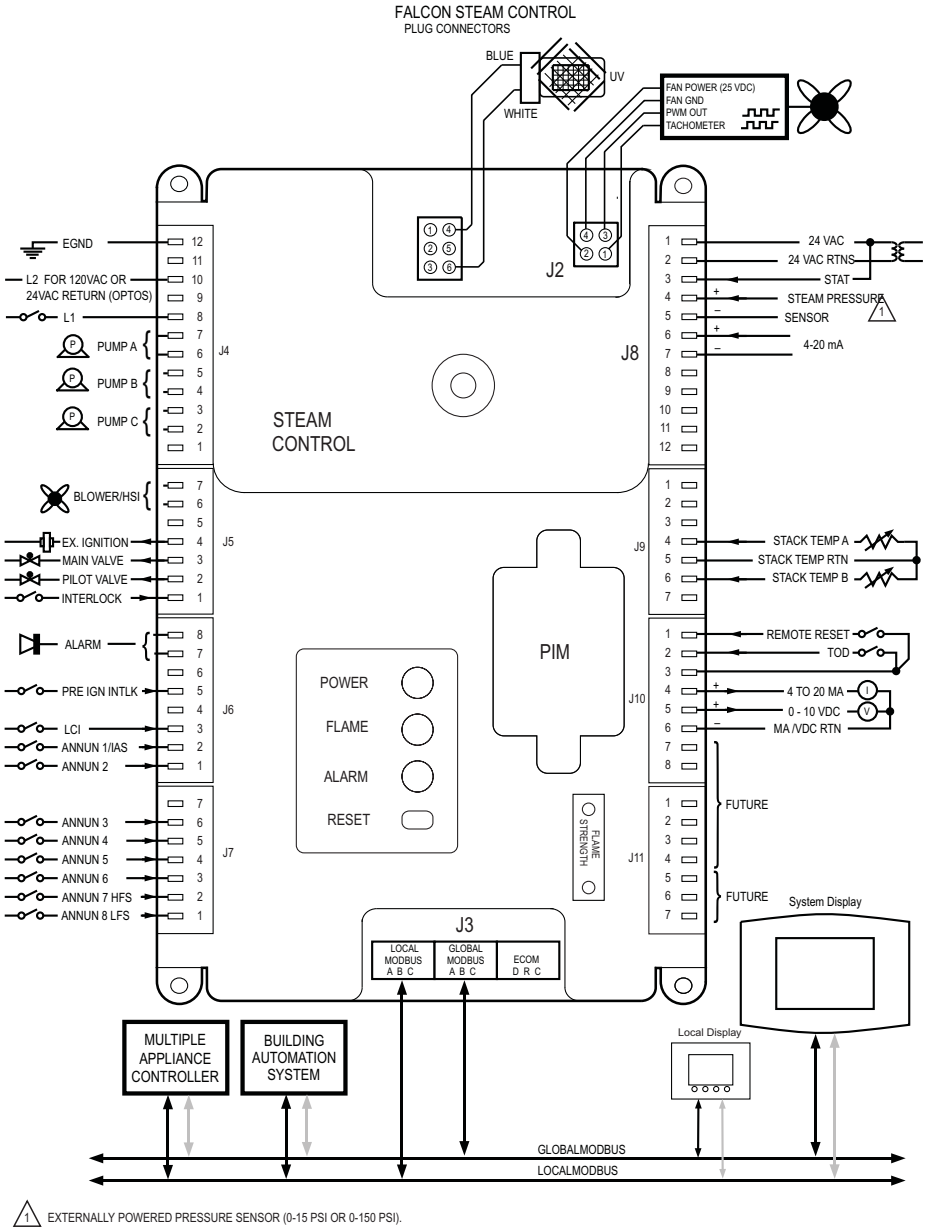


Figure B6-7. CB Falcon pinout

D. Forced draft burner

A. The burner is a "Pre-mix" design consisting of a unitized venturi, single body dual safety gas valve, blower, and burner head (canister).

B. Full modulation is accomplished with a variable speed fan for up to 5:1 turndown ratio on 40 horsepower boilers and larger (4:1 turndown on 30 horsepower and less).

C. For near flameless combustion, the burner utilizes a Fecralloy metal fiber head (canister).

D. Noise level at maximum firing is less than 70 dBA regardless of boiler size.

E. When boiler is operating on natural gas, NOx emissions will be less than 20 PPM regardless of boiler size; certified for California and Texas low emissions requirements.

F. As an option, the burner can utilize direct vent combustion air.

G. Ignition of the main flame is via direct spark, utilizing high voltage electrodes and a separate electrode for flame supervision.

H. To ensure adequate combustion air is present prior to ignition, and to ensure the fan is operating, a combustion air proving switch is provided.

I. For ease of inspection and maintenance, the burner is hinged for easy swing away from the boiler permitting full inspection of the burner components, front tube sheet and furnace.

J. A flame observation port is located in the burner door.

Figure B6-8. ClearFire-H burner

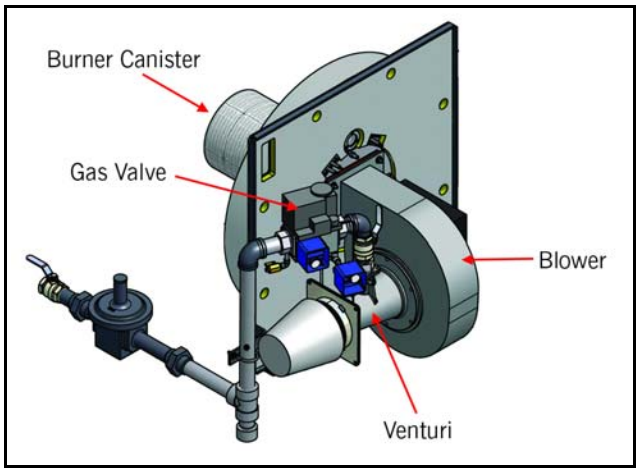


Figure B6-9. Burner Components

E. Burner Gas Train

The standard gas train is equipped in accordance with UL 795, ASME, CSD-1, GE-GAP (formerly IRI), and FM. Each burner gas train includes:

- Low gas pressure interlock, manual reset
- High gas pressure interlock, manual reset
- ASME CSD-1 test cocks
- Downstream manual ball type shutoff cock
- Single body dual safety shutoff gas valve
- Gas pressure regulator for maximum of 1 psig inlet pressure

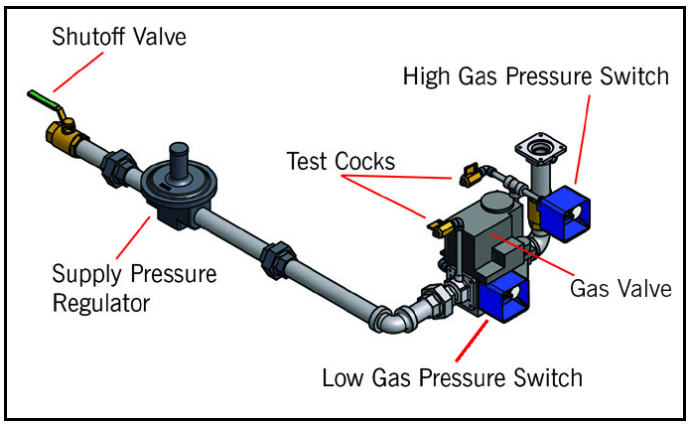


Figure B6-10. Gas Train

F. Boiler control panel

A standard NEMA 1A type panel enclosure is located at the front top of the boiler. This panel encloses the CB Falcon operating control, water level circuit boards, transformers, electrical terminals, and fuses. 115/1/60 terminals are provided for contractor connections.

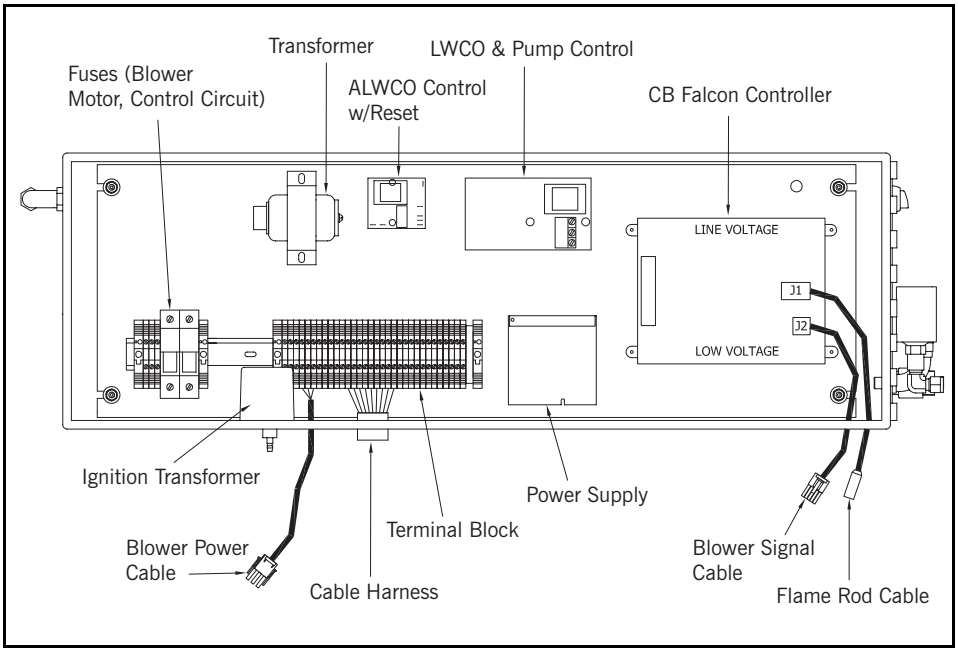


Figure B6-11. Model CFH electrical panel

Optional Equipment

For option details, contact the local authorized Cleaver-Brooks representative. In summary, here are some of the options that can be provided with the boiler package:

- Bottom blowdown valves, shipped loose or mounted and piped
- Surface blowoff valve, shipped loose or mounted and piped
- Feedwater stop and check valves, shipped loose or mounted and piped
- Surface blowoff skimmer tube
- Steam stop valve
- ASME hydro test of boiler piping
- Integral economizer package (150 psig boiler only) complete with vertical feedwater tank and make-up pump
- Modbus communications
- Alarm light package
- Direct vent combustion air provision

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFH are shown in Figure B6-12 and Tables B6-1 (U.S. dimensions) and B6-2 (metric). Connection sizes are given in Table B6-3 and ratings of each boiler size are noted in Table B6-4. Additional information is shown in the following tables and illustrations:

Table B6-7 Recommended steam nozzle sizes
Table B6-8 Minimum required gas pressure
Table B6-9 Safety valve outlet sizes
Table B6-10, Figure B6-13 Boiler room width
Figure B6-14 Lifting lug locations
Table B6-11, Figure B6-15 Boiler mounting piers

Figure B6-12. Model CFH Steam Boiler Dimensions

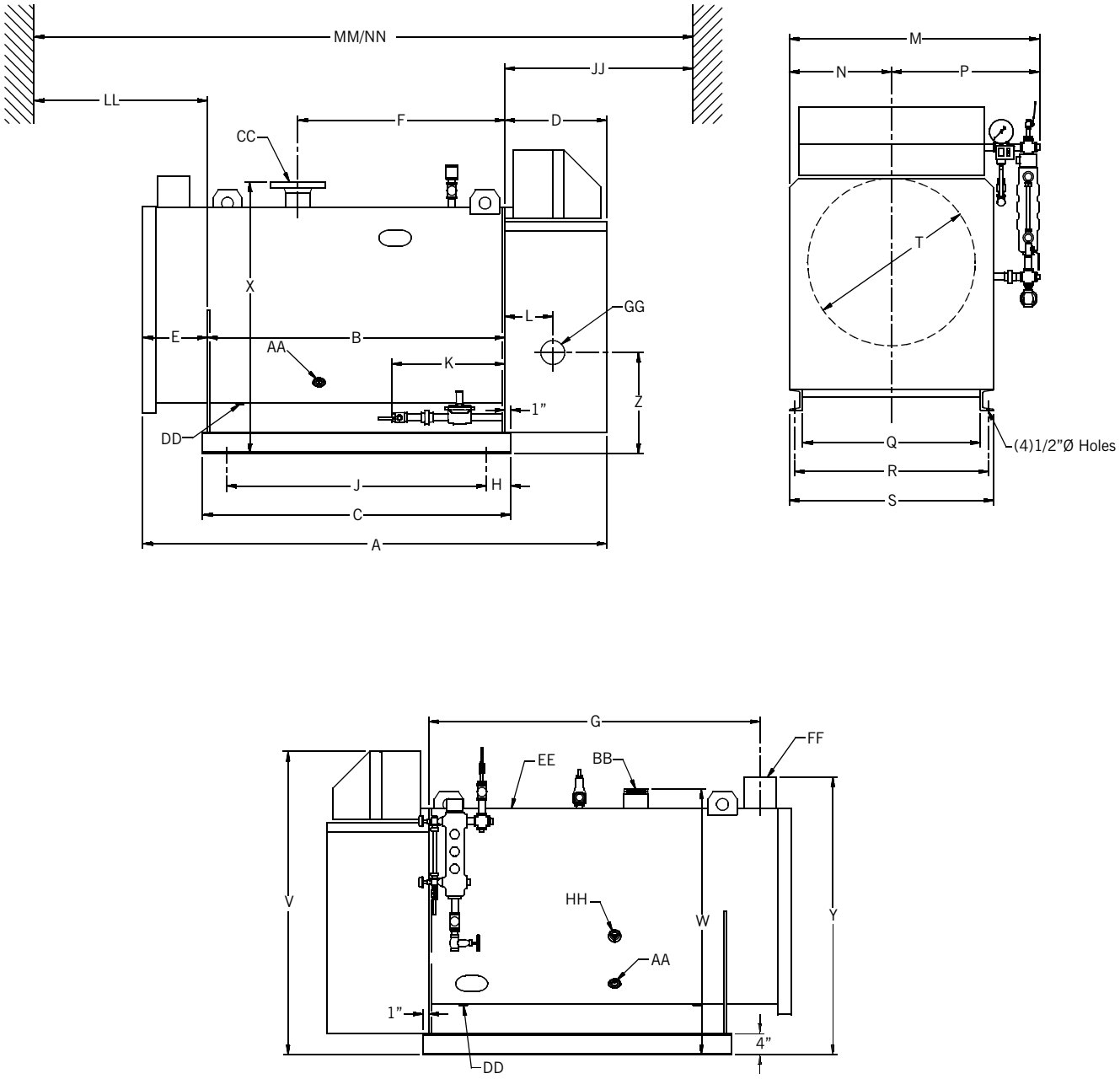


Table B6-3. Model CFH Steam Boiler Dimensions

		Boiler Horsepower							
	Dimension	10	15	20	25	30	40	50	60
LENGTHS inches									
Overall	A	86	86	87	87	91.5	104	110	110
Shell	B	54	54	56	56	58	66	68	68
Base Channel	C	56	56	58	58	60	68	70	70
Front Lagging Extension	D	18	18	18	18	18	23.5	23.5	23.5
Rear Lagging Extension	E	14	14	13	13	15.5	14.5	18.5	18.5
Front Tubesheet to Steam Outlet	F	30	30	38	38	34	40	38	38
Front Tubesheet to Stack Outlet	G	61	61	62.5	62.5	66	74	77.5	77.5
Base End to Bolt Hole	H	4	4	4	4	4	4	4	4
Hole to Hole	J	48	48	50	50	52	60	62	62
Rear Base to Gas Train Inlet	K	34.25	34.25	35.5	35.5	34	44	43.25	43.25
Front Tubesheet to Combustion Air Inlet	L	9	9	9	9	10	13	14	14
WIDTHS inches									
Overall	M	43.5	43.5	47	47	56	56	60	60
Center to Lagging	N	17.5	17.5	19.5	19.5	23.5	23.5	26.5	26.5
Center to Water Column	P	26	26	27.5	27.5	32.5	32.5	33.5	33.5
Base, Inside of Channel	Q	30.5	30.5	34	34	42	42	48	48
Base Bolt Hole to Bolt Hole	R	33	33	36.5	36.5	44.5	44.5	50.5	50.5
Base, Outside of Channel	S	35	35	38.5	38.5	46.5	46.5	52.5	52.5
Boiler I.D.	T	30.5	30.5	34	34	42	42	48	48
HEIGHTS inches									
Overall	V	54	54	57	57	65.5	65.5	69	69
Base to 150# Steam Outlet	W	47	47	50	50	58	58.5	64.5	64.5
Base to 15# Steam Outlet	X	47.5	47.5	50.5	50.5	58.5	59	65	65
Base to Stack Outlet	Y	49	49	52	52	60.5	60.5	66.5	66.5
Base to Combustion Air Inlet	Z	19	19	19	19	22	19.5	21.5	21.5
CLEARANCES inches									
Front Door Swing[A]	JJ	31	31	32	32	39	39	46	46
Tube Removal, Rear	LL	41	41	41	41	41	49	49	49
MINIMUM BOILER ROOM LENGTH (INCHES) ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:									
Rear of Boiler	MM	126	126	129	129	138	154	163	163
Front of Boiler	NN	123	123	125	125	136.5	143.5	156.5	156.5
WEIGHTS - LBS									
Water Weight (150# Normal Level)		1010	1010	1250	1250	1850	2150	2700	2700
Water Weight (15# Normal Level)		920	920	1150	1150	1710	1980	2510	2510
Approx. Dry Weight (150#)		2020	2020	2410	2410	3160	3700	5600	5600
Approx. Dry Weight (15#)		2000	2000	2330	2330	2870	3400	5400	5400

A. Front Door Swing clearance sufficient for front tube removal.

Table B6-4. Model CFH Steam Boiler Metric Dimensions

		Boiler Horsepower							
	Dimension	10	15	20	25	30	40	50	60
LENGTHS mm									
Overall	A	2184.4	2184.4	2209.8	2209.8	2324.1	2641.6	2794	2794
Shell	B	1371.6	1371.6	1422.4	1422.4	1473.2	1676.4	1727.2	1727.2
Base Channel	C	1422.4	1422.4	1473.2	1473.2	1524	1727.2	1778	1778
Front Lagging Extension	D	457.2	457.2	457.2	457.2	457.2	596.9	596.9	596.9
Rear Lagging Extension	E	355.6	355.6	330.2	330.2	393.7	368.3	469.9	469.9
Front Tubesheet to Steam Outlet	F	762	762	965.2	965.2	863.6	1016	965.2	965.2
Front Tubesheet to Stack Outlet	G	1549.4	1549.4	1587.5	1587.5	1676.4	1879.6	1968.5	1968.5
Base End to Bolt Hole	H	101.6	101.6	101.6	101.6	101.6	101.6	101.6	101.6
Hole to Hole	J	1219.2	1219.2	1270	1270	1320.8	1524	1574.8	1574.8
Rear Base to Gas Train Inlet	K	869.95	869.95	901.7	901.7	863.6	1117.6	1098.55	1098.55
Front Tubesheet to Combustion Air Inlet	L	228.6	228.6	228.6	228.6	254	330.2	355.6	355.6
WIDTHS mm									
Overall	M	1104.9	1104.9	1193.8	1193.8	1422.4	1422.4	1524	1524
Center to Lagging	N	444.5	444.5	495.3	495.3	596.9	596.9	673.1	673.1
Center to Water Column	P	660.4	660.4	698.5	698.5	825.5	825.5	850.9	850.9
Base, Inside of Channel	Q	774.7	774.7	863.6	863.6	1066.8	1066.8	1219.2	1219.2
Base Bolt Hole to Bolt Hole	R	838.2	838.2	927.1	927.1	1130.3	1130.3	1282.7	1282.7
Base, Outside of Channel	S	889	889	977.9	977.9	1181.1	1181.1	1333.5	1333.5
Boiler I.D.	T	774.7	774.7	863.6	863.6	1066.8	1066.8	1219.2	1219.2
HEIGHTS mm									
Overall	V	1371.6	1371.6	1447.8	1447.8	1663.7	1663.7	1752.6	1752.6
Base to 150# Steam Outlet	W	1193.8	1193.8	1270	1270	1473.2	1485.9	1638.3	1638.3
Base to 15# Steam Outlet	X	1206.5	1206.5	1282.7	1282.7	1485.9	1498.6	1651	1651
Base to Stack Outlet	Y	1244.6	1244.6	1320.8	1320.8	1536.7	1536.7	1689.1	1689.1
Base to Combustion Air Inlet	Z	482.6	482.6	482.6	482.6	558.8	495.3	546.1	546.1
CLEARANCES mm									
Front Door Swing[A]	JJ	787.4	787.4	812.8	812.8	990.6	990.6	1168.4	1168.4
Tube Removal, Rear	LL	1041.4	1041.4	1041.4	1041.4	1041.4	1244.6	1244.6	1244.6
MINIMUM BOILER ROOM LENGTH (mm) ALLOWING FOR DOOR SWING AND TUBE REMOVAL FROM:									
Rear of Boiler	MM	3200.4	3200.4	3276.6	3276.6	3505.2	3911.6	4140.2	4140.2
Front of Boiler	NN	3124.2	3124.2	3175	3175	3467.1	3644.9	3975.1	3975.1
WEIGHTS - kg									
Water Weight (150# Normal Level)		458.13	458.13	566.99	566.99	839.15	975.22	1224.7	1224.7
Water Weight (15# Normal Level)		417.31	417.31	521.63	521.63	775.64	898.11	1138.5	1138.5
Approx. Dry Weight (150#)		916.26	916.26	1093.2	1093.2	1433.4	1678.3	2540.1	2540.1
Approx. Dry Weight (15#)		907.19	907.19	1056.9	1056.9	1301.8	1542.2	2449.4	2449.4

A. Front Door Swing clearance sufficient for front tube removal.

Table B6-5. Model CFH Steam Boiler Connection Sizes

BOILER CONNECTIONS inches		10	15	20	25	30	40	50	60
Feedwater, Both Sides	AA	1	1	1	1	1	1	1-1/4	1-1/4
Steam Outlet (150# Only)	BB	1-1/2	1-1/2	2	2	2	2	3	3
Steam Outlet (15# Only)[A]	CC	4	4	4	4	4	6	6	6
Drain / Blowdown (Front)	DD	1	1	1	1	1	1	1-1/4	1-1/4
Surface Blowoff	EE	1	1	1	1	1	1	1	1
Stack O.D.	FF	6	6	6	6	8	8	10	10
Combustion Air Inlet	GG	4	4	4	4	6	6	6	6
Chemical Feed	HH	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Gas Train		1	1	1	1	1-1/4	1-1/4	1-1/2	1-1/2

A. Connections are 150# F.F. Flanged

Table B6-6. Model CFH Steam Ratings

Boiler H.P.	10	15	20	25	30	40	50	60
ASME Rated Capacity - Steam (lbs-steam/hr from & at 212ºF) - Steam Safety Relief Valve sizing	345	518	690	863	1,035	1,380	1,725	2,070
ASME Rated Capacity - Steam (kg-steam/hr from & at 100ºC) - Steam Safety Relief Valve sizing	156	235	313	391	469	626	782	939
Rated Capacity - Steam (lbs-steam/hr at 6# operating pressure)	338	507	676	845	1,014	1,352	1,690	2,028
Rated Capacity - Steam (kg-steam/hr at 41.4 kPa)	153	230	307	383	460	613	767	920
Output Btu/hr	334,750	502,125	669,500	836,875	1,004,250	1,339,000	1,673,750	2,008,500
Output KW	98	147	196	245	294	392	490	588
Approximate Fuel Consumption At Rated Capacity [Input]								
Natural Gas [ft3/hr] - 15# SteamA	394	591	788	985	1,181	1,575	1,969	2,363
Natural Gas [m3/hr] - 15# SteamA	11.1	16.7	22.3	27.9	33.4	44.6	55.7	66.9
Natural Gas [ft3/hr] - 150# SteamB	408	612	816	1,020	1,225	1,633	2,041	2,449
Natural Gas [m3/hr] - 150# SteamB	11.5	17.3	23.1	28.9	34.7	46.2	57.8	69.3
Propane Gas [ft3/hr] - 15# SteamA	157	236	315	394	473	630	788	945
Propane Gas [m3/hr] - 15# SteamA	4.4	6.7	8.9	11.1	13.4	17.8	22.3	26.8
Propane Gas [ft3/hr] - 150# SteamB	163	245	327	408	490	653	817	980
Propane Gas [m3/hr] - 150# SteamB	4.6	6.9	9.3	11.5	13.9	18.5	23.1	27.8
Power Requirements - 60 Hz (Single Phase, 115 VAC)								
Blower Motor Size (Watts)C,D	255	335	335	335	335	750	1,200	1,200
Minimum Ampacity								
Blower Motor	4	4	4	4	4	8.8	12	12
Blower Motor Fuse	6	6	6	6	6	12	15	15
Control Circuit	1.4	1.4	1.4	1.6	1.6	1.6	2.1	2.1

Notes:

A. Input calculated at nominal 85% efficiency with Nat. Gas @ 1000 Btu/ft3 and Propane @ 2500 Btu/ft3.

B. Input calculated at nominal 82% efficiency with Nat. Gas @ 1000 Btu/ft3 and Propane @ 2500 Btu/ft3.

C. For altitudes above 1000 Feet, contact your local Cleaver-Brooks authorized representative for capacity rating.

D. Fan motor is variable speed, DC Brushless Type.

Table B6-7. Model CFH Recommended Steam Nozzle Size

OPERATING PRESSURE	BOILER HP							
PSIG	10	15	20	25	30	40	50	60
6	4	4	4	4	4	6	6	6
15	4	4	4	4	4	6	6	6
30	2	2	2	2.5	2.5	3	4	4
40	2	2	2	2.5	2.5	3	3	4
50	1.5	1.5	2	2	2.5	2.5	3	3
75	1.5	1.5	2	2	2	2.5	3	3
100	1.5	1.5	1.5	2	2	2	3	3
125	1.5	1.5	1.5	2	2	2	3	3

NOTES:

1. Steam nozzle sizes given in inches.

2. Recommended steam nozzle sizes based on 4000 to 5000 fpm steam velocity.

Table B6-8. Model CFH Steam Boiler Safety Valve Outlet Size

BOILER HP	VALVE SETTING			
	15 PSIG STEAM		150 PSIG STEAM	
	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
10	1	1-1/2	1	3/4
15	1	1-1/2	1	3/4
20	1	1-1/2	1	3/4
25	1	2	1	1
30	1	2	1	1
40	1	2-1/2	1	1
50	1	2-1/2	1	1-1/4
60	1	2	1	1-1/4

NOTE: Valve manufacturers are Kunkle, Consolidated or Conbraco, depending on availability.

Table B6-9. Model CFH Gas Pressure Requirements

Boiler HP	Inlet pipe size (inches)	Gas valve size (inches)	Minimum pressure required at gas train connection	Max. pressure inches w.c.
10	1	0.5	7.2" w.c.	28
15	1	0.75	7.3" w.c.	
20	1	0.75	7.5" w.c.	
25	1	1	7.7" w.c.	
30	1.25	1	8.5" w.c.	
40	1.25	1.25	11.0" w.c.	
50	1.5	1.25	10.0" w.c.	
60	1.5	1.25	10.0" w.c.	

Note: For altitudes above 700 feet, contact your local Cleaver-Brooks representative.

Table B6-10. Boiler Room Width (Typical Layout) Model CFH

BOILER HP	10-15	20-25	30-40	50-60
DIM. "A"[1]	68	69	75	76
DIM. "B"[2]	86	89	99	103

NOTES:

1. Recommended minimum distance between boiler and wall. Dimension “A” allows for a “clear” 42 inch aisle between the water column on the boiler and the wall. If space permits, this aisle should be widened.

2. Recommended minimum distance between boilers. Dimension “B” between boilers allows for a “clear” aisle of 42 inches. If space permits, this aisle should be widened.

Also see boiler O&M manual 750-295 for minimum clearance to combustibles.

Figure B6-13. Boiler Room Width

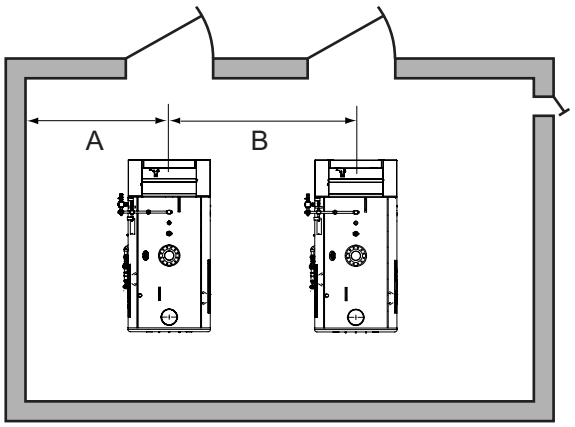


Figure B6-14. Model CFH Lifting Lugs

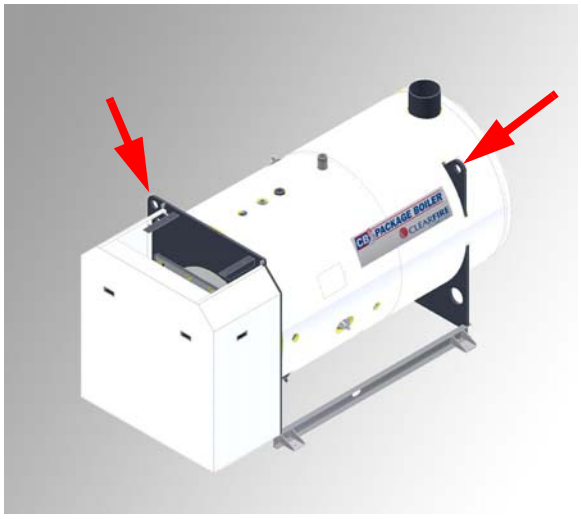
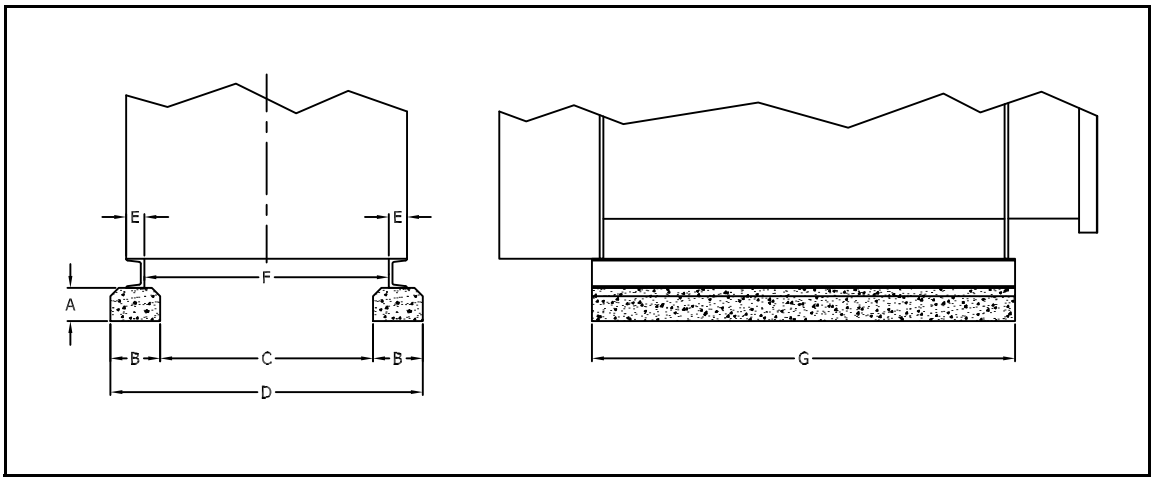


Table B6-11. Model CFH Boiler Mounting Piers

BOILER HP	ALL DIMENSIONS IN INCHES						
	A	B	C	D	E	F	G
10-15	4	6	26.75	38.75	2.25	30.5	56
20-25	4	6	30.25	42.25	2.25	34	58
30	4	6	38.25	50.25	2.25	42	60
40	4	6	38.25	50.25	2.25	42	68
50-60	4	6	44.25	56.25	2.25	48	70

NOTE:
4" high mounting piers recommended for use beneath the boiler base frame. The use of these piers provides increased inspection accessibility to the boiler and added height for washing down the area beneath the boiler.

Figure B6-15. Model CFH Mounting Piers



PERFORMANCE DATA

Table B6-12 shows predicted fuel-to-steam efficiencies for the Model CFH.

Cleaver-Brooks offers an industry leading fuel-to-steam efficiency guarantee for Model CFH boilers. The guarantee is based on the numbers shown in the tables and on the conditions listed below (the efficiency percent number is only meaningful if the specific conditions of the efficiency calculations are clearly stated in the specification).

Cleaver-Brooks will guarantee that, at the time of initial start-up, the boiler will achieve fuel-to-steam efficiency as shown for 25%, 50%, 75% and 100% firing. If the boiler fails to achieve the corresponding efficiency guarantee as published, Cleaver-Brooks will rebate, to the final owner, five thousand dollars ($5,000.00) for every full efficiency point (1.0%) that the actual efficiency is below the guaranteed level. The specified boiler efficiency is based on the following conditions:

- Natural Gas

  Carbon, % by weight = 69.98
  Hydrogen, % by weight = 22.31
  Sulfur, % by weight = 0.0
  Heating Value, Btu/lb = 21,830
- Efficiencies are based on ambient air temperature of 80^{o} F (27 C), relative humidity of 30%, and 15% excess air in the exhaust gas stream.
- Efficiencies are based on the manufacturer's published radiation and convection losses; see Table B6-13.
- Any efficiency verification testing will be based on the stack loss method.
- Nominal feedwater temperature of 190^{0} F (88 C) or greater.

Table B6-12. Model CFH Boilers: Predicted Fuel-to-Steam Efficiencies-Natural Gas

BHP	OPERATING PRESSURE = 10 psig				OPERATING PRESSURE = 125 psig			
	% OF LOAD				% OF LOAD			
	25%	50%	75%	100%	25%	50%	75%	100%
10	84.8	85.5	85.4	85.2	82.0	82.8	82.9	83.0
15	84.6	85.0	84.7	84.3	81.8	82.3	82.2	82.1
20	84.7	85.2	85.0	84.7	81.9	82.5	82.5	82.4
25	84.6	85.0	84.6	84.2	81.8	82.3	82.2	82.0
30	84.8	85.3	85.2	85.0	82.0	82.6	82.7	82.7
40	84.7	85.3	85.1	84.8	81.9	82.6	82.6	82.6
50	84.8	85.5	85.4	85.2	82.0	82.8	82.9	83.0
60	84.8	85.3	85.2	84.9	82.0	82.6	82.7	82.6

Table B6-13. Model CFH Radiation and Convection Losses

BHP	10# Operating Pressure				125# Operating Pressure			
	25%	50%	75%	100%	25%	50%	75%	100%
10	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
15	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
20	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
25	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
30	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
40	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
50	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5
60	1.6	0.7	0.5	0.4	1.9	1.0	0.7	0.5

The emission data included in Table B6-14 consists of typical controlled emission levels of the Model CFH boiler. Because of the premix burner technology, the standard burner provided with the CFH package provides low emissions as standard without the need for external or special devices.

Table B6-15 shows predicted sound levels at high fire.

Table B6-14. Model CFH Boilers: Natural Gas, Estimated Emission Levels

POLLUTANT	UNITS	
CO	ppm*	10
	lb/MMBtu	0.007
NOx	ppm*	20
	lb/MMBtu	0.024
SOx	ppm*	1
	lb/MMBtu	0.001
HC/VOC	ppm*	10
	lb/MMBtu	0.004
PM	ppm*	-
	lb/MMBtu	0.01

* ppm levels are given on a dry volume basis and corrected to 3% oxygen (15% excess air)

Table B6-15. Model CFH Boilers: Predicted sound levels at high fire

BHP	Sound Level - dBA*
10	60
15	65
20	60
25	66
30	62
40	68
50	67
60	69

*At 1 m from front of boiler and 4.5 ft height

ENGINEERING DATA

The following engineering information is provided for the Model CFH steam boiler. Additional information may be obtained from your local Cleaver-Brooks representative.

Feedwater

Steam boilers require make-up water for steam production. This make-up can be a combination of condensate return and raw make-up or in some instances, 100% raw make-up. Proper treatment of make-up water is essential to the longevity and performance of the boiler. Table B6-16 shows the rate of make-up required and Table B6-17 shows the water quality guidelines.

Table B6-16. Model CFH Boiler Feedwater Flow Rates

BHP	Gallons/Hour
10	41
15	62
20	83
25	103
30	124
40	165
50	207
60	248

Table B6-17. Model CFH Boilers Required Water Quality Parameters

QUANTITY	LIMITS
Oxygen	<0.005 ppm
CO2	0 ppm
Hardness	<2.0 ppm
Suspended Solids	<300 ppm
pH	8.5 - 10.5
Sulfite	>50 ppm
Fe	<0.1 ppm
Silica	<150 ppm
Total Alkalinity	<700 ppm
Dissolved Solids	<3,000 ppm

Blowdown

As steam is produced, unwanted solids are left behind in the water and become concentrated within the vessel. If these constituents are allowed to adhere to the heat transfer surfaces they will impede the flow of energy. Their removal requires proper blowdown - either bottom, surface, or both. Table B6-18 shows the recommended blowdown tank requirements for bottom blowdown. The surface blowdown requirement is relative to the water quality and to the level of TDS control desired by the water treatment specialist. Local codes will dictate the manner of treating blowdown affluent.

Some local codes require blowdown tanks to be constructed in accordance with recommendations of the National Board of Boiler and Pressure Vessel Inspectors. The National Board's recommendations base the size of the blowdown tank on the removal of at least 4 inches of water from the boiler.

Table B6-18. Model CFH Blowdown Tank Sizing Information

BOILER HP	WATER (GAL)
10	11
15	11
20	13
25	13
30	16
40	19
50	22
60	22

NOTE: Quantity of water removed from boiler by lowering normal water line 2".

Stack/Breeching Criteria

General - Under ANSI Z21.13 the ClearFire Model CFH can operate as a Category II, III or IV boiler as deemed appropriate for the application.

Proper design and installation of the flue gas venting is critical to efficient and safe operation of the boiler. The vent should be designed with proper supports and clearances from combustible materials. Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

The design of the stack and breeching must provide the required draft at each boiler stack connection as proper draft is critical to safe and efficient burner performance.

Although constant pressure at the flue gas outlet is not required, it is necessary to size the breeching and stack to limit flue gas pressure variations. Consideration of the draft must be given whenever direct combustion air ducting is utilized and lengthy runs of breeching are employed. Please note: The allowable pressure range for design of the stack and breeching is negative 0.25" w.c. (-62 Pa) to a positive 0.25" w.c. (+62 Pa) for proper light offs and combustion. **NOTE:** This pressure range does not pertain to the boiler room; that is, the boiler room must be neutral or slightly positive, never negative when using air from the boiler room for combustion.

Whenever two or more CFH boilers are connected to a common breeching/stack, a mechanical draft control system may be required to ensure proper draft at all times. Cleaver-Brooks recommends individual stacks for multiple boiler installations.

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

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

NFGC) for U.S. installations and CAN/CSA B149.1 and B149.2 for Canadian installations.

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

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

Unconfined Spaces

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

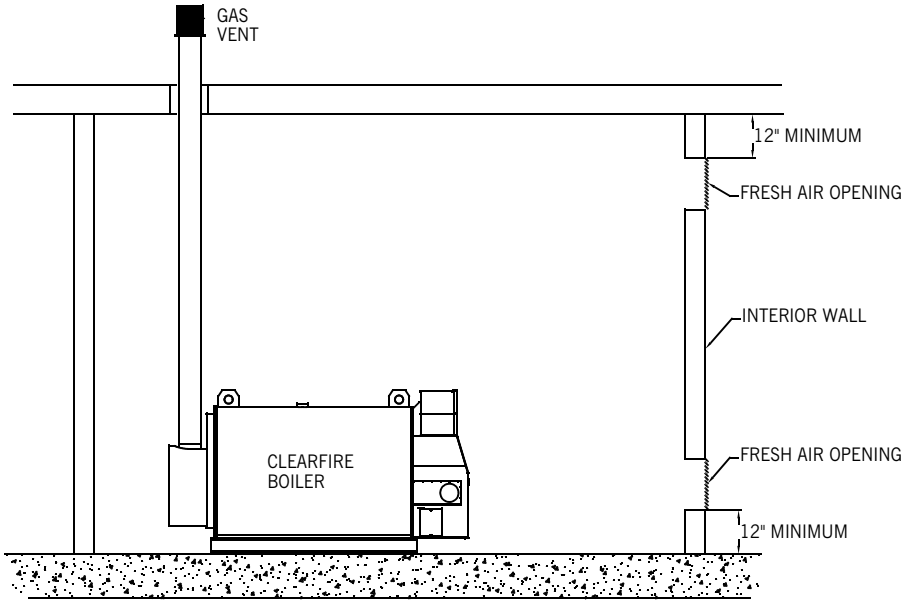
The mechanical equipment room must be provided with two permanent openings linked directly with additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50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

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

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

See Figure B6-16; refer to the NFGC for additional information.

Figure B6-16. Inside Air - Two Opening Method



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

can be used:

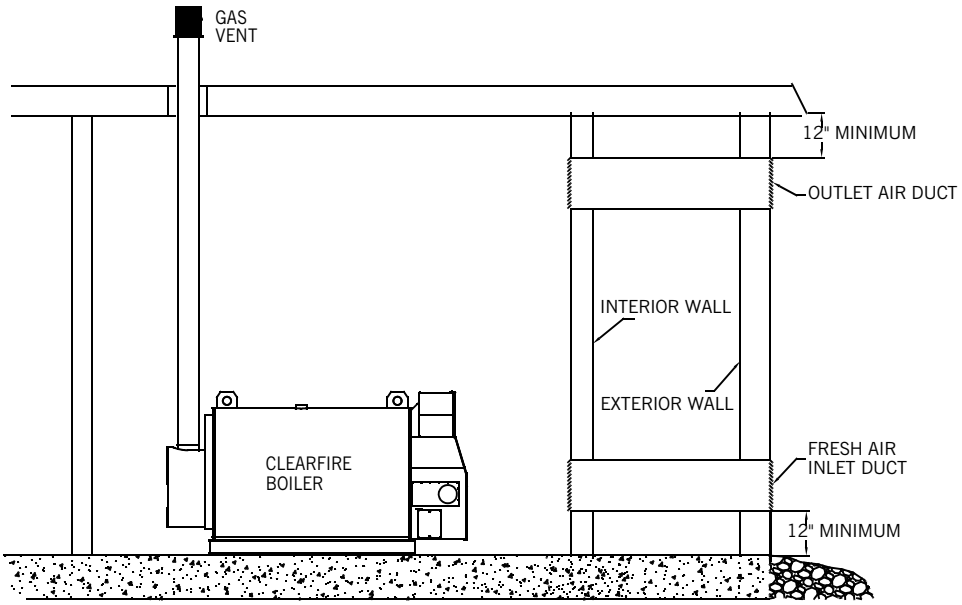
Two Opening Method (Figure B6-17) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

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

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

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

Figure B6-17. Two Opening Ducted Method



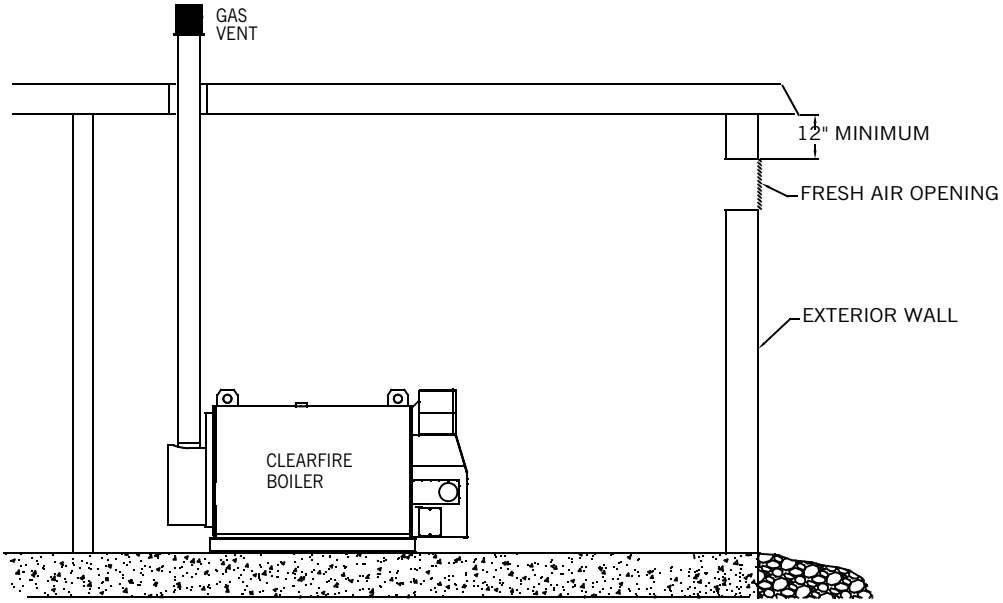
One Opening Method (Figure B6-18) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

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

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

C. Refer to the NFGC for additional information.

Figure B6-18. One Opening Method

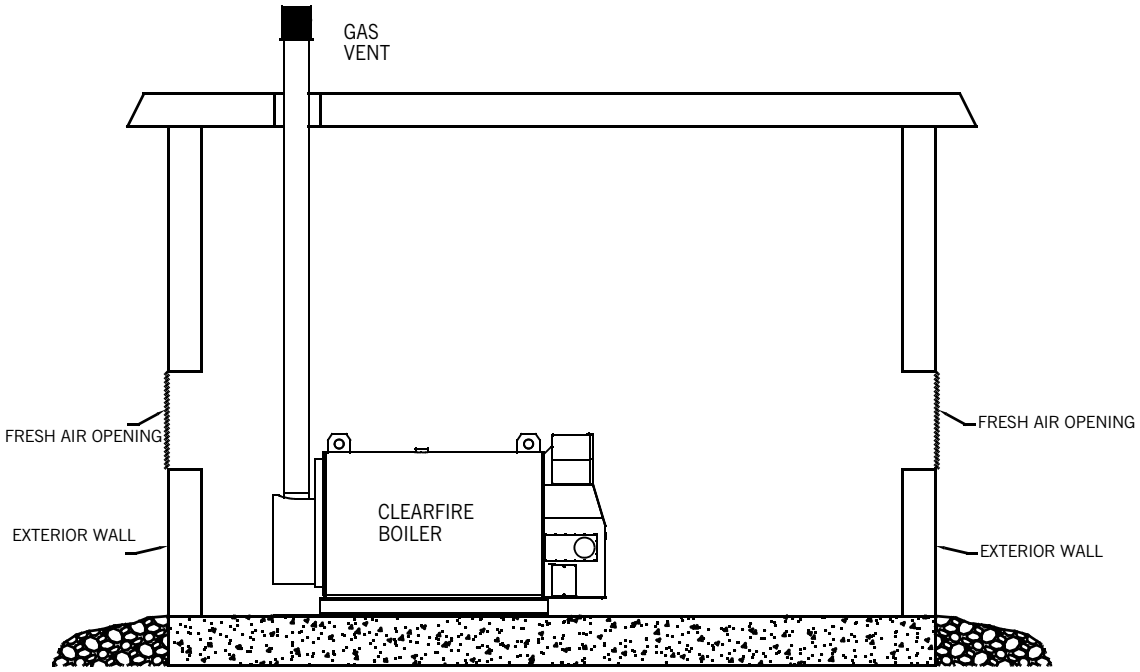


Unconfined Spaces

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

A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler (see Figure B6-19).

Figure B6-19. Engineered Method



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

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

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

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

F. Amount of air required (cfm):

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

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

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

Example of required air openings (Engineered Method):

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

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

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

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

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

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

Notice

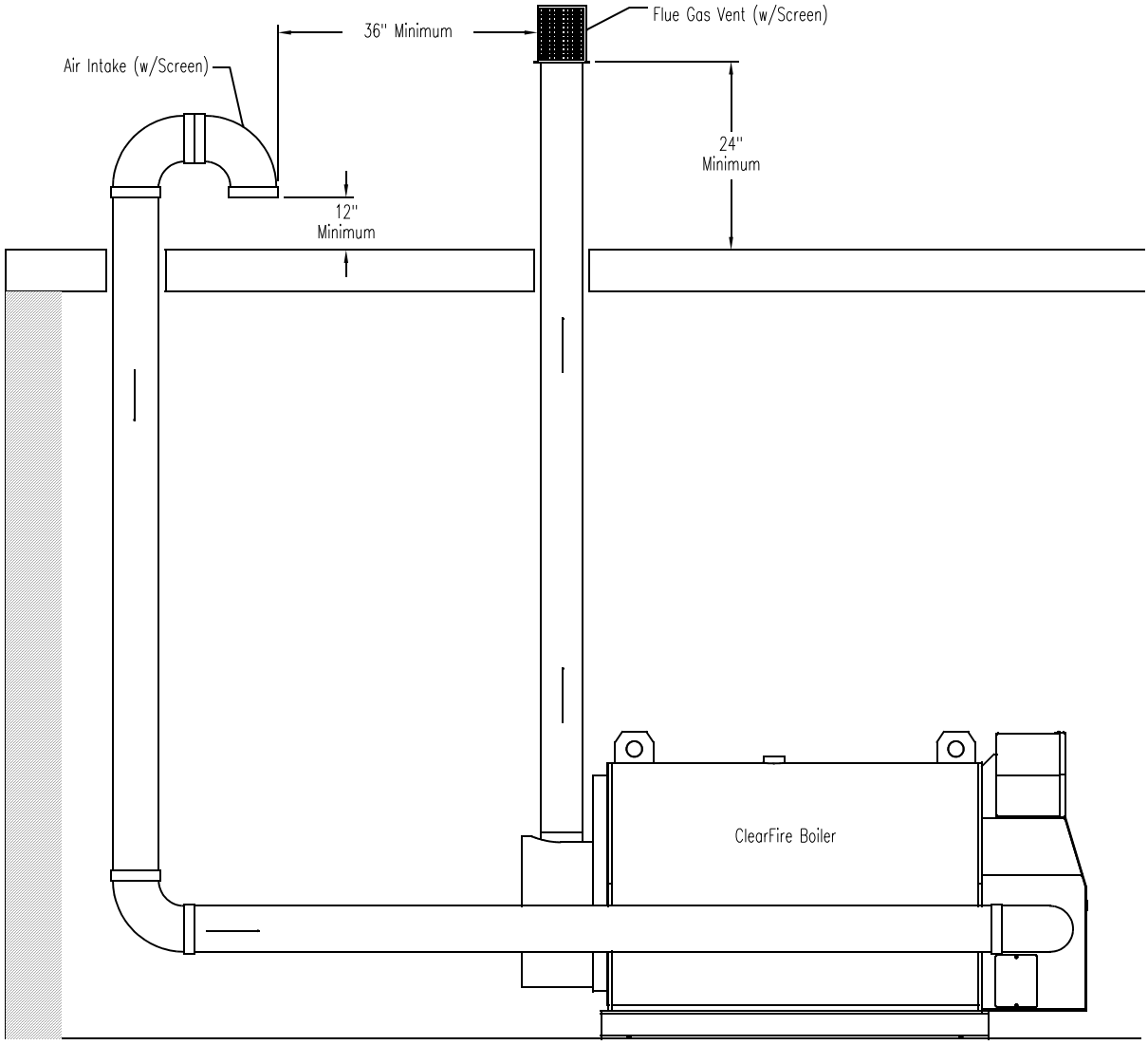
Consult local codes, which may supersede these requirements.

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

1. Install combustion air duct in accordance with local codes and the boiler operating and maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. Duct material can be PVC or metallic vent material. It should be air tight to prevent in leakage of air during operation.

4. Maximum pressure drop for the duct shall not exceed 0.25" w.c. negative. If this pressure drop is exceeded a larger size duct is recommended.
5. Multiple boilers may be connected to a single duct with take-offs to each boiler.
6. If the duct will run horizontally to an outside wall, it is recommended that the duct have a slight downward slope away from the burner intake to prevent collected moisture from draining into the burner connection.
7. If the outside air is dust-laden or the installation is near a heavily traveled roadway, it is recommended that an air filter be installed to prevent intake of contaminants that could accumulate on the burner canister.

Figure B6-20. Direct Vent Combustion



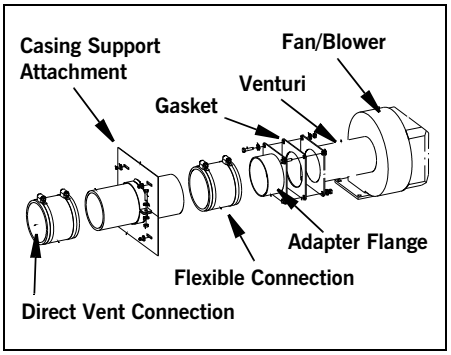


Figure B6-21. Air Inlet Extension kit for Direct Vent combustion

Gas Piping

General - The ClearFire Model CFH gas fired steam boilers are full modulating input units that require appropriate gas supply pressure and volume for proper operation and long burner life. The gas requirements specified in this section must be satisfied to ensure efficient and stable combustion. Installation must follow these guidelines and of the local authorities that have installation jurisdiction.

Gas Train Components - CFH boilers are equipped with a gas train that meets the requirements of UL/cUL and ASME CSD-1, and also the requirements of FM and GE-GAP (formerly IRI). The gas train and its components have been designed and tested to operate for the highest combustion efficiency for the CFH units. Major components are as noted in the current product specifications and O & M manual.

Gas Pressure Requirements - For proper and safe operation, each Model CFH boiler requires a stable gas pressure input. The pressure requirements are listed in the O & M and current specifications and added here for reference purposes.

The minimum inlet supply pressure must be as noted in Table B6-7 when firing the boiler at low fire and high fire. 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 pressure droop 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.

Gas Piping - CFH units are standardly equipped with a gas pressure regulator. If upstream pressure exceeds 1 psig, an additional upstream regulator must be installed along with a pressure relief valve. Note: Gas connection is at the left side of the boiler, left hand side as you face the front of the boiler.

For buildings or boiler rooms with gas supply pressure exceeding 28" w.c. a "full lock-up" type regulator is recommended along with proper overpressure protection (e.g. relief valve). In addition to the regulator, a plug type or "butterball type" gas shutoff cock should 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.

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 for any debris buildup

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

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

The total length of gas piping and all fittings must be considered when sizing the gas piping. Total equivalent length should be calculated from the utility meter or source to the final unit connection. As a minimum guideline, gas piping Tables B6-17 through B6-20 should be used. The data in these tables is from the NFPA 54 source book, 2006 edition.

To verify the input of each device that is connected to the gas piping, obtain the btu/hr input and divide this input by the calorific value of the gas that will be utilized. For instance, a 40 HP unit with 1,613,253 btu/hr input divided by a gas calorific value of 1060 will result in a cfh flow of 1,522. 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 17 that a supply pipe size of 2" should be used as a minimum.

Table B6-19. Gas line capacity - Schedule 40 metallic pipe

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

Table B6-20. Gas line capacity - Schedule 40 metallic pipe

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

Table B6-21. Gas line capacity - Schedule 40 metallic pipe

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

**Fuel: Natural Gas

**Inlet Pressure: 2.0 psi

**Pressure Drop: 1.0 psi

**Specific Gravity: 0.60

Table B6-22. Gas line capacity - Schedule 40 metallic pipe

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

**Fuel: Natural Gas

**Inlet Pressure: 3.0 psi

**Pressure Drop: 2.0 psi

**Specific Gravity: 0.60

Table B6-23. Gas line capacity - Schedule 40 metallic pipe

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

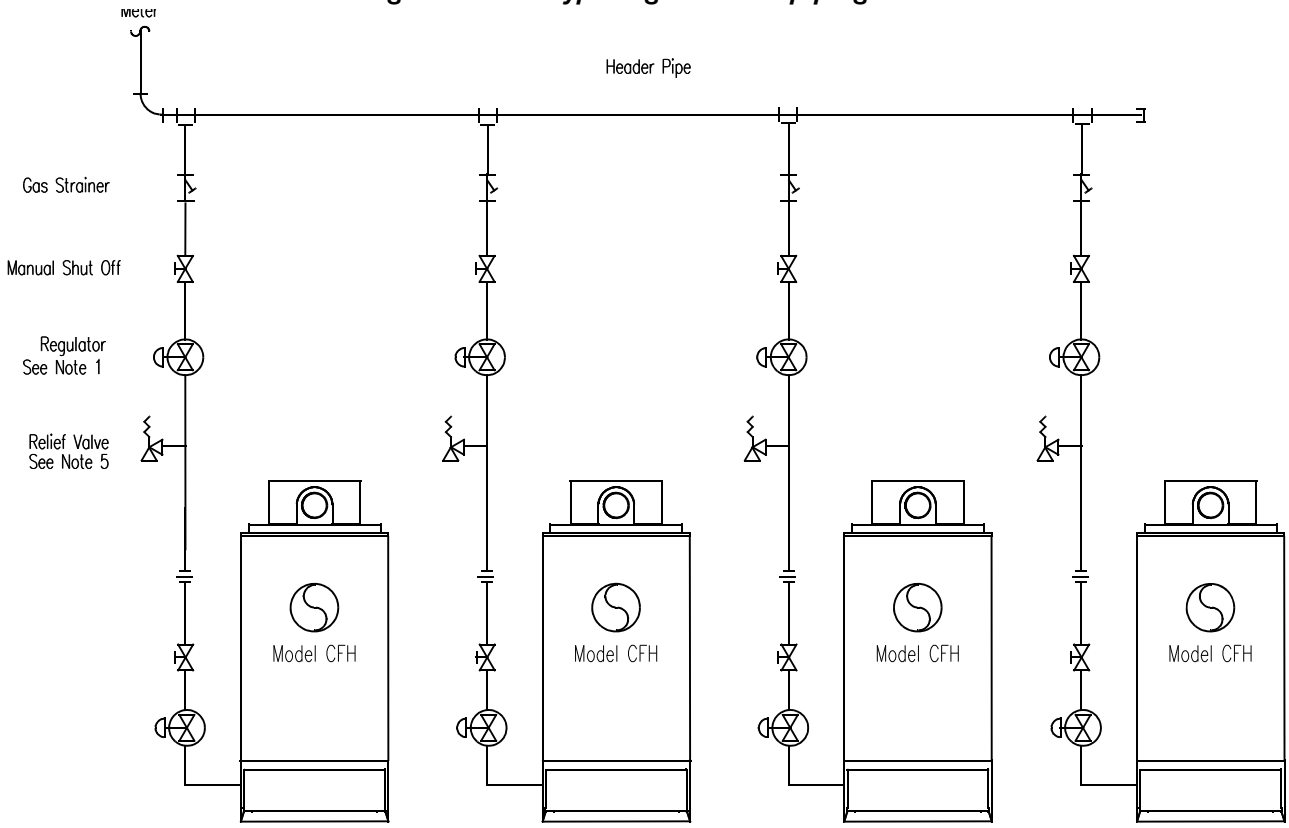
**Fuel: Natural Gas

**Inlet Pressure: 5.0 psi

**Pressure Drop: 3.5 psi

**Specific Gravity: 0.60

Figure B6-22. Typical gas header piping



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

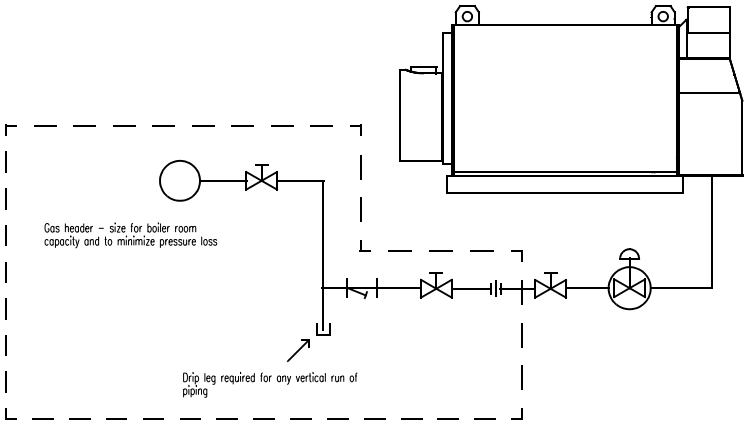


Figure B6-23. Example gas piping <1 psig supply

Gas Header - For multiple unit installations, a single common gas header with individual takeoffs for each boiler is recommended (See Figure B6-22). Boiler gas manifold piping should be sized based on the volume requirements and lengths between boilers and the fuel main header. Tables B6-22 through B6-29 indicate the proper sizing for multiple units of equal size, placed on the factory standard center with the noted take off size. 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. Pipe sizes are based on Table B6-18 with boiler gas line take-off at 20 feet from the header. If pipe runs are greater or if gas pressure is different, refer to the Tables for pipe sizing.

Pipe sizing for multiple unit manifolds

Table B6-24. CFH 10 HP Boilers

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

Table B6-25. CFH 15 HP Boilers

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

Table B6-26. CFH 20 HP Boilers

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

Table B6-27. CFH 25 HP Boilers

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

Table B6-28. CFH 30 HP Boilers

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

Table B6-29. CFH 40 HP Boilers

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

Table B6-30. CFH 50 HP Boilers

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

Table B6-31. CFH 60 HP Boilers

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

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Table B6-32. Speed Setting Recommendations & Max. Input Capacity for Various Altitudes

		700' ASL	2000'	4000'	6000'	8000'	10000'
CFH 60HP	Input (kBtu/h)	2449	2449	2291	2125	1969	1888
	Boiler HP output	60.0	60.0	56.1	52.1	48.2	46.2
	Max Speed	4800	5000	5000	5000	5000	5000
	Min Speed	1000	1100	1200	1300	1400	1500
	Ignition Speed	1800	1800	1900	2000	2100	2200
CFH 50HP	Input (kBtu/h)	2041	2041	1909	1771	1641	1573
	Boiler HP output	50.0	50.0	46.8	43.4	40.2	38.5
	Max Speed	4800	5000	5000	5000	5000	5000
	Min Speed	1000	1100	1200	1300	1400	1500
	Ignition Speed	1800	1800	1900	2000	2100	2200
CFH 40HP	Input (kBtu/h)	1633	1633	1600	1484	1375	1318
	Boiler HP output	40.0	40.0	39.2	36.4	33.7	32.3
	Max Speed	5500	5700	6000	6000	6000	6000
	Min Speed	1200	1200	1300	1400	1500	1600
	Ignition Speed	1800	1800	1900	2000	2100	2200
CFH 30HP	Input (kBtu/h)	1225	1225	1158	1074	995	954
	Boiler HP output	30.0	30.0	28.4	26.3	24.4	23.4
	Max Speed	5700	5900	6000	6000	6000	6000
	Min Speed	1500	1500	1600	1700	1800	1900
	Ignition Speed	2200	2200	2300	2400	2500	2600
CFH 25HP	Input (kBtu/h)	1020	1020	999	927	859	823
	Boiler HP output	25.0	25.0	24.5	22.7	21.0	20.2
	Max Speed	5500	5700	6000	6000	6000	6000
	Min Speed	1500	1500	1600	1700	1800	1900
	Ignition Speed	2200	2200	2300	2400	2500	2600
CFH 20HP	Input (kBtu/h)	816	816	816	816	787	755
	Boiler HP output	20.0	20.0	20.0	20.0	19.3	18.5
	Max Speed	4800	5000	5400	5800	6000	6000
	Min Speed	1200	1200	1300	1400	1500	1600
	Ignition Speed	2000	2100	2200	2300	2400	2500
CFH 15HP	Input (kBtu/h)	612	612	576	534	495	475
	Boiler HP output	15.0	15.0	14.1	13.1	12.1	11.6
	Max Speed	6200	6500	6500	6500	6500	6500
	Min Speed	1600	1600	1700	1800	1900	2000
	Ignition Speed	2400	2400	2500	2600	2700	2800
CFH 10HP	Input (kBtu/h)	408	408	408	381	353	338
	Boiler HP output	10.0	10.0	10.0	9.3	8.6	8.3
	Max Speed	5800	6000	6500	6500	6500	6500
	Min Speed	1800	1800	1900	2000	2100	2200
	Ignition Speed	2400	2400	2500	2600	2700	2800

Please Note:
1. Ratings assume 35% excess air (6% O2), 80F combustion air, and < 0.25" w.c. air intake and draft loss.
2. Blower speed adjustments should be made to match performance and local conditions accordingly.
3. Natural gas heating value of 1000 Btu/SCF assumed.
4. For minimum gas pressure requirements, corrections for altitude should be made per table below.

For minimum req'd gas pressure,	700' ASL	2000	'4000	'6000	'8000	'10000
Gas pressure correction factor:	1.00	1.07	1.16	1.25	1.35	1.45

Example:	CFH 40HP	
Altitude:	5280' ASL	37.4 BHP (derated for altitude)
Min. gas press.:	11" w.c. (normal)	11" w.c. x 1.22 = 13.4" w.c.
Max. speed:	5500 RPM	6000 RPM
Min. speed:	1200 RPM	1400 RPM
Ignition speed:	1800 RPM	2000 RPM

SPECIFICATIONS

ClearFire Model CFH

PRODUCT SPECIFICATIONS

1.0 GENERAL BOILER DESIGN

A. The boiler shall be a Cleaver-Brooks Model CFH 700, single pass horizontal commercial firetube design or approved equal. It shall be mounted on a heavy-duty steel frame with premix forced draft burner and burner controls as a complete package from one manufacturer.

B. Approvals - The complete package including the burner shall be Underwriters Laboratories, Inc. listed and the official UL/cUL label shall be affixed to the package attesting to its certification.

C. As a preassembled package, the standard boiler shall be factory fire tested.

D. The complete package as shipped, shall be ready for connections to water, fuel, blowdown, and exhaust venting. Certain items may be shipped loose to prevent their damage such as the safety valves and gauges.

E. The specified boiler shall have an output rating of _____ horsepower when fired with Natural Gas (LP Gas) with a gas supply pressure of ____" w.c. Power supply to the boiler shall be 115/1/60. Design pressure shall be [15 or 150]# steam. Operating characteristics shall be [___] psig steam. Steam boilers shall be supplied with ____ degrees F make-up water @ ____%.

F. Performance: shall be as specified in Paragraph 5 below.

1.1 BOILER SHELL

A. The boiler shell must be constructed in accordance with the ASME Code, either Section I for high-pressure steam or Section IV for low-pressure steam. The vessel must be subjected to the required inspections of the Code conducted by an independent third party inspector. A signed inspection sheet shall be provided to the purchaser and the appropriate ASME symbol shall be affixed or stamped onto the boiler.

1. Boiler shall be mounted on base rails suitable for transporting by fork lift.
2. Burner housing shall be hinge-mounted to allow tube inspection.
3. Each carbon steel boiler tube shall utilize the AluFer heat transfer design technology for high efficiency and reduction in overall size of the vessel and shall be a minimum of 0.105 tube wall thickness.
4. To facilitate waterside inspection, 3 hand holes shall be provided.
5. An observation port for flame inspection shall be provided.

6. Boiler insulation shall consist of 2-inch fiberglass blanket, which shall be covered with a powder coated sheet metal jacket. This jacket and insulation design shall permit field removal and reattachment if necessary for inspection, etc.
7. The entire boiler and base frame shall be factory painted.
8. Exhaust vent shall be located at the rear of the boiler and shall be a slip connection. Stack support shall be by means other than the boiler connection.

1.2 BOILER SHELL TAPPINGS/OPENINGS

A. The following boiler vessel tappings/openings shall be furnished:
   1. Steam supply by NPT connection for high-pressure steam or flanged for low pressure steam.
   2. Bottom blowdown.
   3. Feedwater make-up.
   4. Surface blowoff.
   5. Chemical Feed.
   6. High Water Level Overflow Drain to discharge water in the boiler if water level reaches an unacceptable level.

2.0 STEAM BOILER TRIM (ALL PIPING AND DEVICES PER ASME CSD-1)

A. Water Column
   1. A water column shall be furnished complete with gauge glass and water column blowdown valve.
      a. Feedwater Pump control - shall be integral with the water column via probe control device and electronics for on/off pump operation.
      b. Low Water cutoff - shall be integral with the water column via probe control device and solid state electronics mounted and wired in the control panel.

B. An Auxiliary Low Water Cutoff shall be provided. It shall be located on the top centerline of the boiler using an internal probe and shall be of the manual reset design.

C. For safety steam pressure lockout a high limit pressure control, manual reset shall be provided. The device shall be mercury free.

D. To provide steam demand tracking a steam pressure transmitter shall be provided that provides an input signal for burner positioning in accordance to steam demand.

E. A 3" Steam Pressure Gauge shall be piped onto the trim piping, including an inspectors test cock.

F. In accordance with the A.S.M.E. Code an approved A.S.M.E. rated and stamped safety valve shall be provided and set at [15 or 150]#.

3.0 BURNER AND BURNER CONTROLS

A. Mode of Operation - To minimize short cycling and provide highest efficiency the burner for the specified boiler shall be of the electronic modulation with a turndown ratio of 5:1 for Natural Gas for sizes of 40 horsepower and greater, and 4:1 for sizes below 40 horsepower. On/off or low/ high burner operation shall not be accepted.

B. B. The burner shall be enclosed in a NEMA 1 type enclosure. A lift off top cover shall be provided to gain access to the burner and controls.

C. C. Design - The burner design shall be of the linkage-less premix technology wherein the fuel and air are mixed in the fan housing assembly prior to entering the burner canister. Separately driven linkage or servo motor driven fuel and air valves shall not be permitted.

1. Fan housing shall utilize non-sparking material and shall be approved for premix operation.
2. The fan shall be driven by a variable speed motor which shall react to output demand requirements via the demand control Motor shall be a high efficiency DC Brushless type. Continuous speed synchronous motors will not be acceptable.

D. Ignition of the fuel shall be of the direct spark design; separate pilot gas train is not required. Dual ignition electrodes shall used for the spark generated from the panel mounted ignition transformer.

E. Combustion shall take place on the surface of the burner canister. The canister shall be constructed of Fecralloy material and stainless steel and shall be warranted for five years against failure from defects or poor workmanship.

F. Air Filter - shall be fitted to the intake air venturi to filter the incoming air supply when using boiler room air. The air filter shall be designed to be easily cleaned and re-used.

G. Fuel - The burner shall be designed for operation with natural gas or LP gas. Gas Train, shall be located at the front of the burner and along the left side of the boiler. In accordance with UL/cUL and ASME CSD-1, the following components shall be furnished:

1. Single body dual solenoid safety shutoff valve incorporating the following:
   a. The valve shall be a 1:1 ratio valve with an integral trim regulator and shall operate in relation to the fan speed. An air sensing line shall be connected from the air inlet venturi (mounted to the fan motor) and to the gas valve for control of gas input.
   b. As fan speed increases a negative pressure will be applied to the valve, allowing the valve to open further, permitting more fuel to flow into the venturi for mixing. As fan speed is reduced, fuel input shall be reduced accordingly. Air shall always lead fuel from low to high or high to low.

2. Manual fuel shutoff valve - shall be located downstream of the gas valve and used for CSD-1 leak testing.
3. Gas Pressure Interlocks - one shall be provided for sensing high gas pressure and one provided to sense low gas pressure. Each control shall be of the manual reset type.
4. Gas Pressure Regulator - shall be provided upstream of the gas valve to provide regulated pressure to the gas train from the gas supply. This regulator shall be suitable for a maximum of 1 psig gas pressure. If gas pressure exceeds 1 psig, a gas pressure relief valve shall be furnished and upstream pressure regulator that is of the full lockup type.
5. Manual Shutoff Valves - shall be provided upstream of the gas regulator to manually close off the gas supply when servicing the gas train or isolating the boiler. A shutoff valve shall be provided at the burner for tightness checking of the gas valve.
6. Combustion Air Proving Switch shall be provided to prove, prior to modulation that the fan is operating properly.

H. Flame Safety

1. Flame sensing shall be accomplished with a flame rod mounted in the burner mounting plate, designed for easy removal for inspection or replacement.

4.0 CONTROL PANEL

A NEMA 1 type enclosure is furnished and located at the front of the boiler to house the following components:

A. The Boiler shall include a Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processor modulating device, complete with sequence indication, fault reset, mode selection, and configurable parameter settings. It shall be mounted at the front of the boiler panel for easy access and viewing. The controller combines flame supervision, burner sequencing, modulating control, and operating limit control.

B. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:

1. Burner sequencing with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
2. Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent 15 faults. The control shall be connected to a touchscreen display interface that will retrieve this information.
3. Safety Shutdown with display of error.
4. Modulating control of the variable speed fan for fuel/air input relative to load requirements.

5. Gas pressure supervision, high and low.
6. Combustion Air Proving Supervision.
7. High Air Pressure (back draft too high) supervision.
8. The active steam pressure and set-point pressure shall be displayed at all times. Output shall be modulating PID set point control via analog signal.
9. Controller shall be capable of Modbus communication to interface with PC or Building Energy Management System.

C. All parameter input control set-points shall be factory pre-configured with jobsite conditions programmed at the time of initial operation.

D. Demand switch.

E. Provide terminals for control interface wiring, customer connections, and connections for incoming power.

F. Install solid state circuit boards for water level controls.

G. Selectable Options: Alarm Light Package to provide indication of Low Water, Flame Failure, Load Demand, Fuel Valve On, including a horn with silencing for alarm conditions.

5.0 PERFORMANCE

The proposed Boiler shall provide the following operating performance targets for Natural Gas:

A. Efficiency - Fuel to Steam Efficiency shall be guaranteed at 85% for 15# steam. For 150# steam operating at 125# the guaranteed Fuel to Steam Efficiency shall be 83% and 85% with optional flue gas economizer. Efficiency rating shall account for radiation and convection losses.

B. Emissions - NOx emissions shall be less than 20 PPM corrected to 3% O2 and less than 10 PPM CO over the operating range of the burner turndown. If emissions exceed this level, the boiler manufacturer shall correct at their expense until this level is achieved on a repeatable basis.

C. Noise - Sound shall not exceed 70 dBA at high fire when measured 3 feet in front of the burner.

D. Radiation losses shall be less than 0.5% of the rated input at maximum firing.

E. Steam quality shall be 99.5% at maximum firing regardless of operating pressure.

6.0 WARRANTY

The package boiler shall be warranted for a period of one year from date of start-up or 18 months from shipment whichever shall occur first.

7.0 OPTIONAL ECONOMIZER PACKAGE

For application with 150# Design Model CFH, an economizer package shall be

factory installed and piped to increase operating efficiency to 85%. The factory installed package shall include an economizer coil located in the rear of the boiler, integral to the stack outlet with integral make-up water supply and outlet piping. A vertical stainless steel feedwater tank complete with a continuous running pump shall be provided with integral piping. This piping shall include the feedwater make-up stop valve, check valve, and on/off electric make up valve. The make-up valve shall be factory wired to the on/off pump control. Feedwater piping shall include by-pass piping so that water circulates through the economizer at all times.