CLEARFIRE MODEL CFW
400-2400 MBH
Hot Water Vertical Boiler

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FEATURES AND BENEFITS

General

The ClearFire Model CFW is a single pass, vertical down-fired durable firetube hydronic 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 CFW burner provides low emissions of <20 PPM NOx.

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 B7-1 and Figure B7-2).

Figure 1. AluFer© Tubes

Figure 2. Tube Cross Section

High Efficiency

With the AluFer© extended heating surface tubes, the Model CFW steam boiler will provide fuel-to-water efficiency of up to 88% depending on operating conditions.

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 hot water boilers (UL 795, CAN1-3.1).

Premix Technology

The ClearFire CFW 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. The CFW burner design readily accommodates direct venting of combustion air.

An inlet air filter is optional.

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 fan speed 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 B9-3.

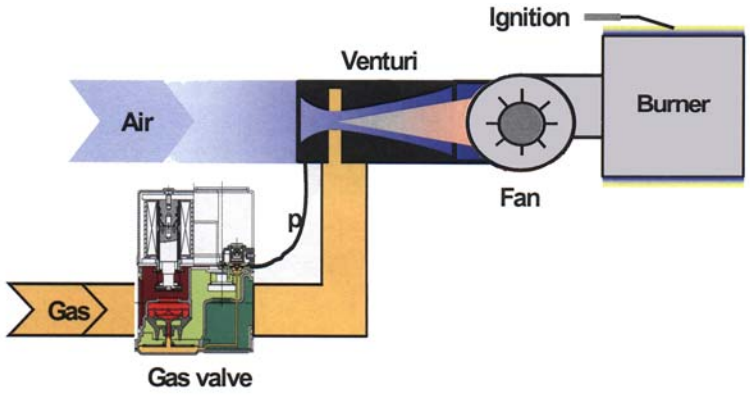


Figure 3. Premix Burner Technology

Ease of Maintenance

The burner is mounted on a hinged assembly to allow inspection or service of the burner canister, tubes, and tube sheets (see Figure B9-4). A union connection provides easy disconnect from the fuel train. All burner components are easily accessed for inspection and maintenance.

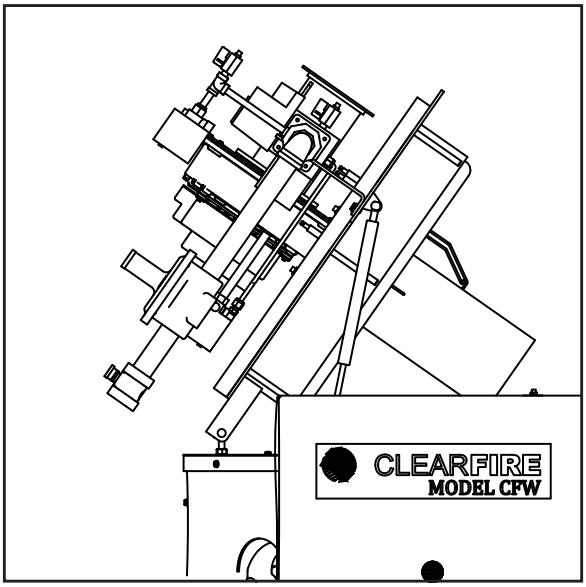


Figure 4. Burner maintenance

Designed for commercial hot water applications

The CFW packaged boiler is designed for 125 psig MAWP (Maximum Allowable Working Pressure) and is constructed of durable ASTM grade steel materials. Figure B9-5 shows the component and connection locations.

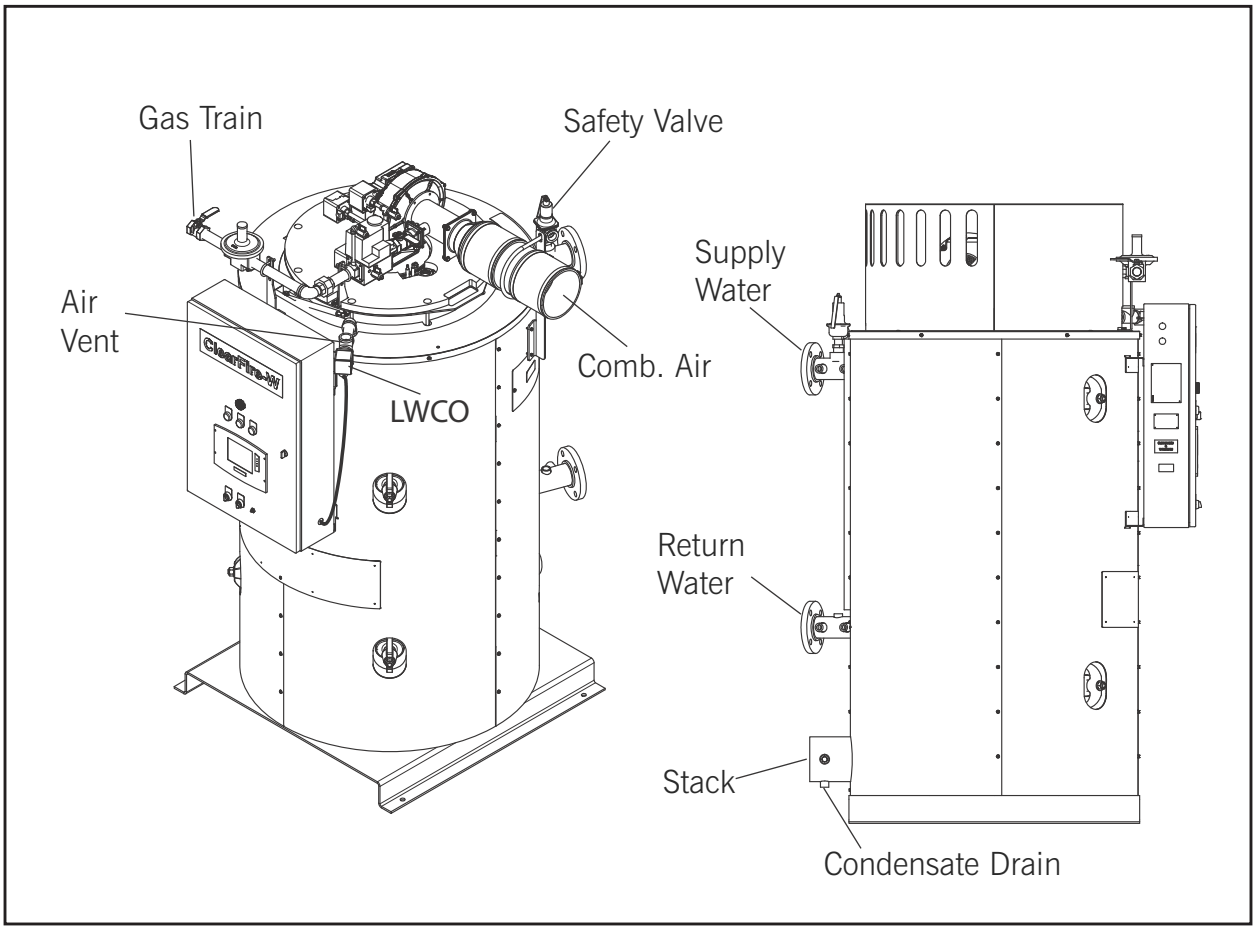


Figure 5. CFW connections and controls

PRODUCT OFFERING

Information in this section applies to boiler sizes ranging from 400 - 2400 MBH for operation on natural gas. Fuel oil operation is not available for the model CFW. 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.

1. The Boiler

A. Each boiler size is designed for a Maximum Allowable Working Pressure (MAWP) of 125 psig, constructed in accordance with the ASME Code Section I and bears the "S" stamp.

B. The insulated boiler is mounted on a base and powder coated steel casing provided.

2. Boiler trim and controls

- Excess Water Temperature Cutoff, manual reset.
- NTC (negative temp. coefficient) sensor for hot water supply temperature.
- NTC sensor for hot water return temperature.
- ASME Safety Relief Valve set @ 125 psig (8.6 Bar).
- Combination Temperature/Pressure Gauge.

3. CB Falcon Control System

A. The CB Falcon is an integrated burner management and modulation control with a touch-screen display/operator interface. Its functions include the following:

- Two (2) heating loops with PID load control
- 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.
- Real-time data trending.
- Modbus communication capability
- Lead/Lag for up to 8 boilers

Table 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	

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

C. Demand switch - Local/Remote/Off.

D. Combustion Air Proving Switch

E. 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.

F. System Configuration - CB Falcon parameters are sorted into the following functional groups:

- System Identification and Access
- Central Heat
- Outdoor Reset
- DHW - Domestic Hot Water
- Warm Weather Shutdown
- Demand Priority
- Modulation
- Pump Configuration
- Statistics
- High Limits
- Stack Limit
- Delta T Limits
- T-Rise Limit
- Heat Exch. High Limit
- Anti-condensation
- Frost Protection
- Annunciation
- Burner Control Interlocks
- Burner Control Timings & Rates
- Burner Control Ignition
- Burner Control Flame Failure
- System Configuration
- Fan Configuration
- Sensor Configuration
- Lead Lag Slave Configuration
- Lead Lag Master Configuration

G. 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. 750-269.

Figure 6. CB Falcon Display/Operator Interface

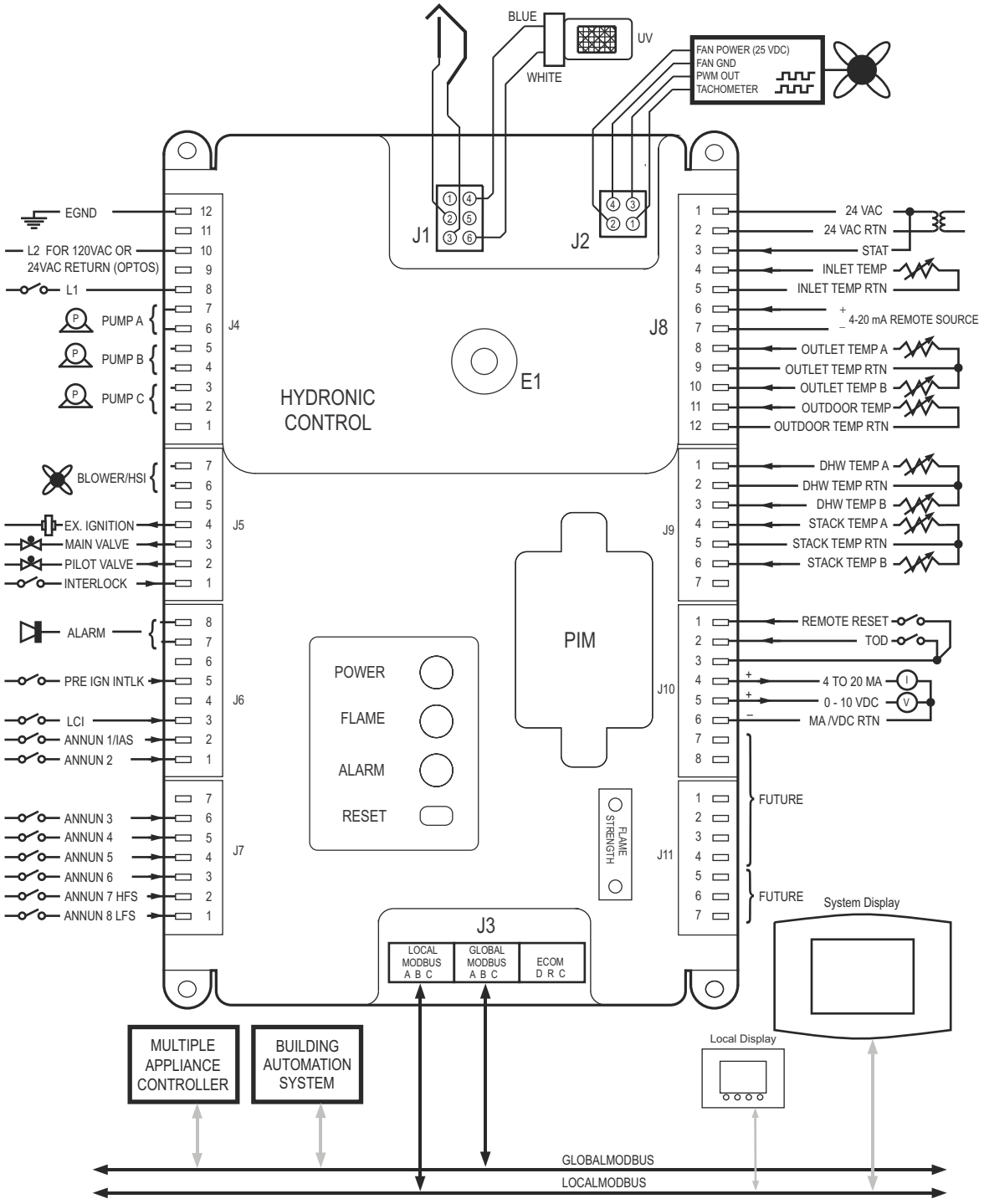


Figure 7. CB Falcon pinout

4. 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 (boiler sizes 1500 to 2400) or 4:1 turndown on sizes 400 to 1000.

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.

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 blower 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 at the top of the boiler.

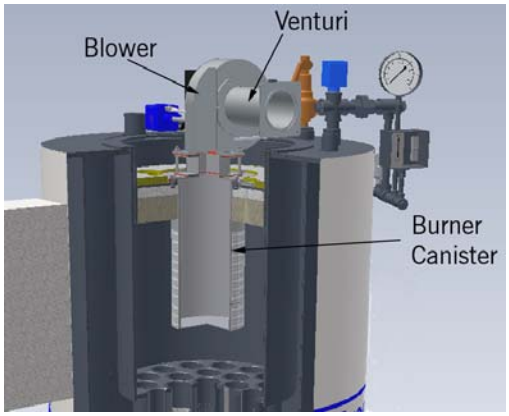


Figure 8. CFW Burner

5. Burner Gas Train

The standard gas train is equipped in accordance with UL 795, ASME, CSD-1, XL-GAP (formerly GE-GAP/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

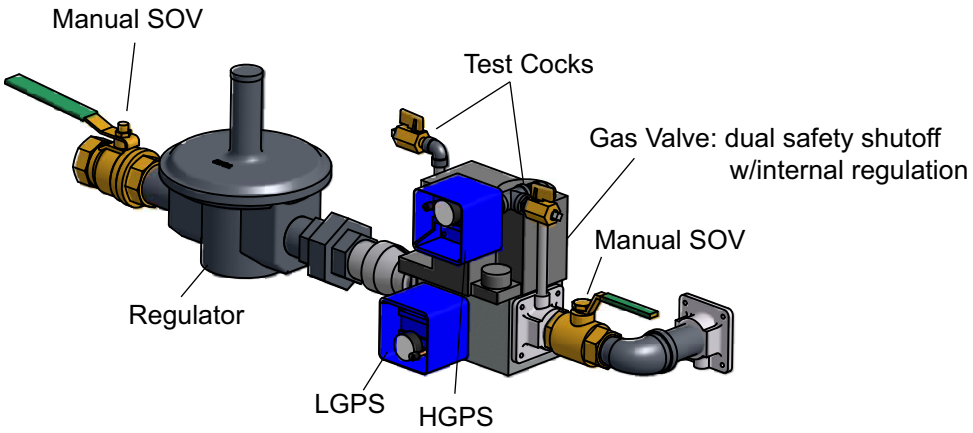


Figure 9. Gas Train

6. Boiler control panel

A standard NEMA 1 type panel enclosure is mounted on the side of the boiler. This panel encloses the CB Falcon control, water level circuit boards, terminals, fuse blocks, and ignition transformer. 115/1/60 terminals are provided for contractor connections.

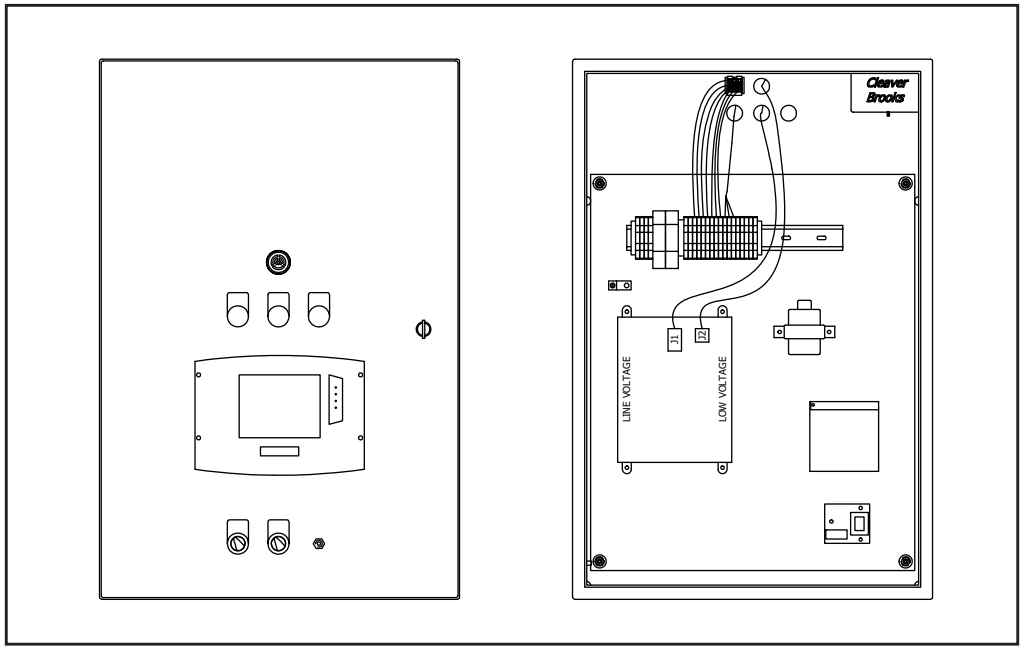


Figure 10. CFW electrical panel

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:

- Aux. Low Water Cutoff, probe type shipped loose for installation in system piping
- Direct vent combustion kit
- Lead/Lag kit - includes header temp. sensor and well, outdoor air sensor, and Falcon Plug-In Module
- Outdoor reset control
- Alarm Horn
- Reusable air filter.

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFW are shown in Figure 11 and Table 2. Connection sizes are given in Table 2 and ratings of each boiler size are noted in Table 3. Additional information is shown in the following tables and illustrations:

Table 4 Minimum required gas pressure
Table 5 Altitude corrections
Table 6 Heating Surface
Table 7 Safety Valve Outlet Size
Table 8 Clearances

Figure 11. Model CFW Dimension Diagram

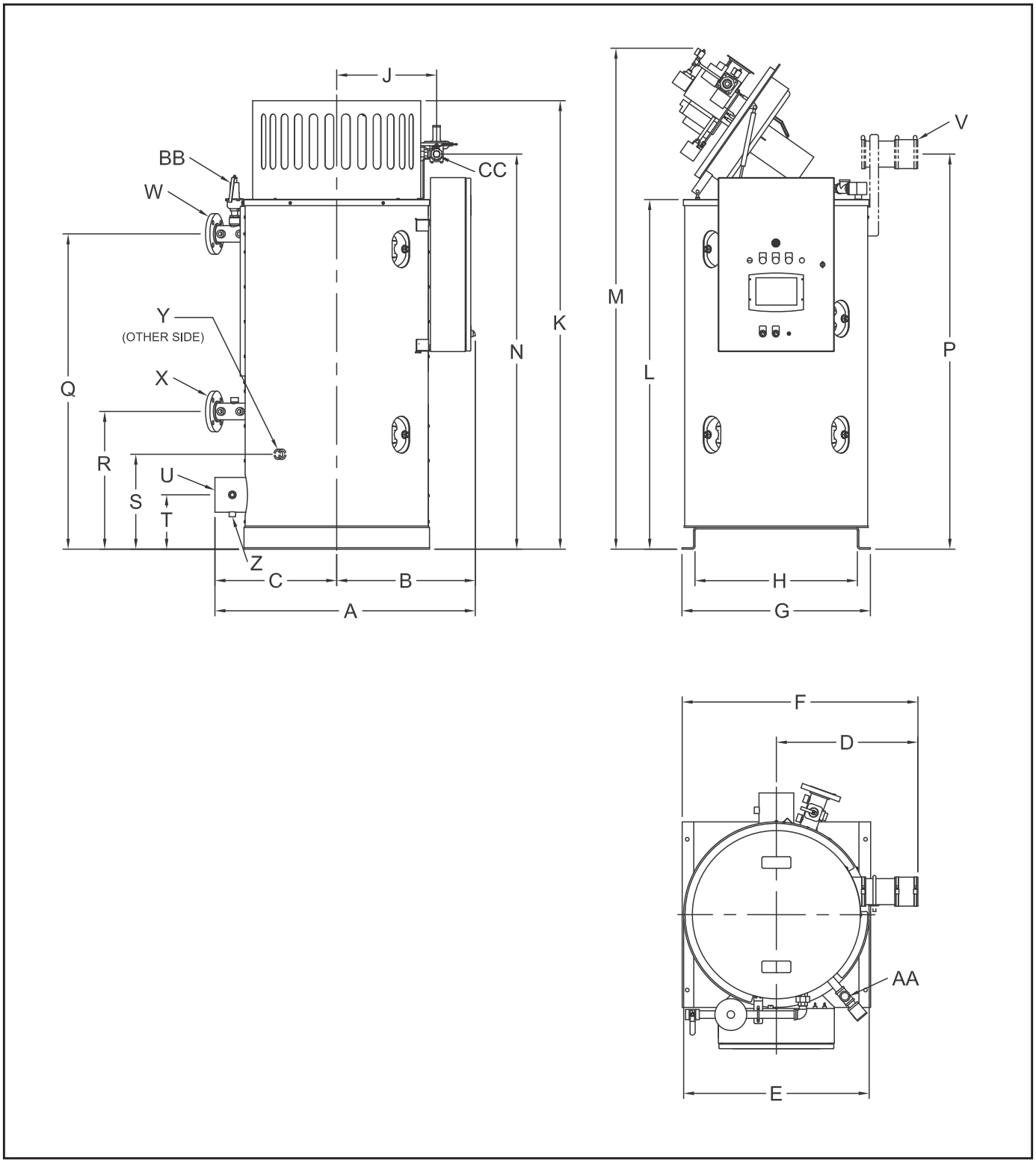


Table 2. Model CFW Dimensions

		BOILER SIZE						
DIMENSIONS		400	500	750	1000	1500	2000	2400
Overall Length	A	45	45	52 1/2	52 1/2	54	60 1/2	60 1/2
Centerline to Boiler Front	B	24	24	27 3/4	27 3/4	29	32	32
Centerline to Stack Outlet	C	21	21	24 3/4	24 3/4	25 1/2	28 1/2	28 1/2
Centerline to Combustion Air Inlet	D	24 1/2	24 1/2	24 1/2	24 1/2	27	37 1/4	37 1/4
Boiler O.D.	E	32	32	39	39	41	47	47
Overall Width	F	40 1/2	40 1/2	44	44	47 1/2	60 3/4	60 3/4
Base, Outside of Base	G	32 1/2	32 1/2	39 1/2	39 1/2	41 1/2	48	48
Base, Inside of Base	H	28	28	35	35	37	43 1/2	43 1/2
Centerline to Gas Inlet	J	17 1/4	17 1/4	19 1/4	19 1/4	20 1/4	22	22
Overall Height	K	77	83	77	83	89	89	95
Vessel Height	L	60	66	60	66	71	68	74
Burner Door Clearance (Open)	M	85 1/2	92	85 1/2	91 1/2	101	102	108
Floor to Gas Inlet	N	68	74	68	74	80 1/2	80	86
Floor to Air Inlet	P	68	74	68	74	80 1/2	79	85
Floor to Supply Connection	Q	54	60	55	61	66	62	68
Floor to Return Connection	R	24	31	26	26	33	32 1/2	35 1/2
Floor to Drain	S	16	16	15	15	18	20	20
Floor to Stack Outlet	T	9	9	9	9	10	11	11
BOILER CONNECTIONS								
Flue/Stack, Nominal OD	U	6	6	6	6	8	10	10
Sealed Combustion, Air	V	4	4	4	4	6	8	8
Supply Water, Flange	W	2 1/2	2 1/2	2 1/2	2 1/2	3	4	4
Return Water, Flange	X	2 1/2	2 1/2	2 1/2	2 1/2	3	4	4
Boiler Drain	Y	1	1	1	1	1	1 1/4	1 1/4
Condensate Drain	Z	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Air Vent	AA	1	1	1	1	1	1	1
Safety Valve, 125# setting	BB	1	1	1	1	1	1	1
Gas Train	CC	1	1	1	1	1 1/2	1 1/2	1 1/2
WEIGHTS - LBS								
Shipping Weight (125#)		1550	1700	2100	2300	2900	3400	3800
Operating Weight (125#)		2205	2460	3260	3630	4330	5105	5780

Table 3. Model CFW Ratings

RATINGS							
Max. Input @ Sea Level to 2000' (Btu/hr)	400,000	500,000	750,000	1,000,000	1,500,000	2,000,000	2,400,000
*Output @ Sea Level to 2000' (Btu/hr)	344,000	430,000	645,000	860,000	1,290,000	1,720,000	2,064,000
Max. Amp. Draw Fan	4.0	4.0	4.0	4.0	8.5	12.0	12.0
Blower Motor Size (Watts)	335	335	335	335	750	1,200	1,200
Fireside Heating Surface (ft^2)	86	105	133	164	263	319	395

*Output based on 86% efficiency with 140°F return and 180°F supply water temperature

Table 4. Gas Pressure Requirements

Required Gas Pressure at Entrance to Standard Gas Trains (upstream of supplied gas pressure regulator)

BOILER RATING	INLET PIPE SIZE (Inches)	PRESSURE REQUIRED	
		MIN. ("WC)	MAX ("WC)
400	1	7	28
500	1	7	
750	1	7	
1000	1	7	
1500	1 1/2	10	
2000	1 1/2	10	
2400	1 1/2	10	

Note: For altitudes up to 700 feet.

Table 5. Altitude Correction for Gas

ALTITUDE (FT)	CORRECTION FACTOR	ALTITUDE (FT)	CORRECTION FACTOR
1000	1.04	6000	1.25
2000	1.07	7000	1.3
3000	1.11	8000	1.35
4000	1.16	9000	1.4
5000	1.21	-	-

To obtain minimum required gas pressure at altitudes above 700 feet, multiply the pressure by the listed factors:
Inches WC x 0.577 = oz/sq-in.
oz/sq-in x 1.732 = inches WC.
Inches WC x 0.0361 = psig.
oz/sq-in x 0.0625 = psig.
psig x 27.71 = Inches WC.
psig x 16.0 = oz/sq-in.

Table 6. Boiler Heating Surface

Boiler Rating	400	500	750	1000	1500	2000	2400
Heating Surface							
Total Waterside (ft^2)	15	15	21	21	30	41	41
Extended (ft^2)	71	90	112	143	233	278	354
Total Fireside (ft^2)	86	105	133	164	263	319	395

Table 7. Safety Valve Outlet Size

Valve Setting	30 PSIG		125 PSIG	
Boiler Rating	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)	NO. OF VALVES REQ'D	OUTLET SIZE (IN.)
400	1	1"	1	1"
500	1	1"	1	1"
750	1	1-1/4"	1	1"
1000	1	1-1/4"	1	1"
1500	1	1-1/4"	1	1"
2000	1	2"	1	1"
2400	1	2"	1	1"

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

Table 8. Clearances

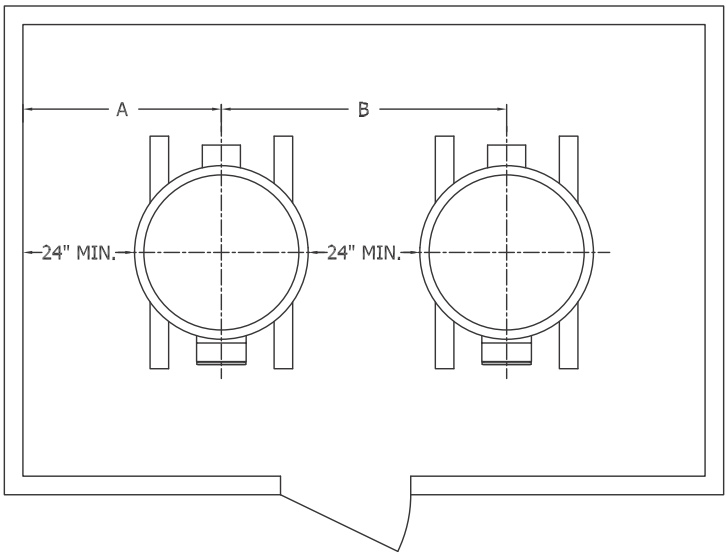
CFW clearances (inches)

Boiler Rating	400-500	750-1000	1500	2000-2400
DIM. "A"	40	44	45	48
DIM. "B"	56	63	65	71

NOTES:
1. Recommended Minimum Distance Between Boiler and Wall (Dimension "A") allows for a clear 24" aisle between the boiler and the wall. If space permits, this aisle should be widened.

2. Recommended Minimum Distance Between Boilers (Dimension "B") allows for a clear aisle of 24". If space permits, this aisle should be widened.

3. Clearance above boiler 36".



PERFORMANCE DATA

Table 9 shows predicted fuel-to-water efficiencies for the Model CFW.

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 80º F (27 C), relative humidity of 30%, and 15% excess air in the exhaust gas stream.
- Any efficiency verification testing will be based on the stack loss method.

Table 9. CFW Predicted Fuel-to-Water Efficiencies

Rating	Supply Temperature = 180°F			
	Gas			
	25%	50%	75%	100%
400	86.9	86.9	86.6	86.3
500	86.8	86.7	86.4	86.0
750	86.5	86.2	85.6	84.9
1000	86.6	86.4	86.0	85.4
1500	86.9	86.9	86.7	86.4
2000	86.5	86.1	85.5	84.8
2400	86.7	86.5	86.0	85.5

The emission data included in Table 10 consists of typical controlled emission levels of the Model CFW boiler. Because of the premix burner technology, the standard burner provided with the CFW package provides low emissions as standard without the need for external or special devices.

Table 10. CFW Estimated Emission Levels

POLLUTANT	UNITS	
CO	ppm[A]	10
	lb/MMBtu	0.04
NOx	ppm[A]	20
	lb/MMBtu	0.024
SOx	ppm[A]	1
	lb/MMBtu	0.001
HC/VOC_5	ppm[A]	4
	lb/MMBtu	0.004
PM	ppm[A]	-
	lb/MMBtu	0.01

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

Table 11 shows predicted sound levels at high fire.

Table 11. Predicted sound levels

Boiler Rating	Sound Level-dbA
400	60
500	65
750	60
1000	66
1500	68
2000	67
2400	69

Sound levels are measured 3 feet from the front of the panel at an elevation of 5 feet from the floor.

ENGINEERING DATA

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

Flow Rates

To maintain rated capacity of the boiler, recommended flow rates should not be exceeded as the flow will remove the heat beyond the capacity of the boiler.

Table 12. CFW Maximum Flow Rates

	System Temperature Drop °F				
	10	20	30	40	50
Boiler Size	**Flow Rate GPM**				
400	69	34	23	17	14
500	86	43	29	21	17
750	129	64	43	32	26
1000	172	86	57	43	34
1500	258	129	86	64	52
2000	344	172	115	86	69
2400	413	206	138	103	83

Water Quality

Table 13. Model CFW Water Quality

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

Pressure Drop

Table 14. Hydraulic Resistance CFW 400

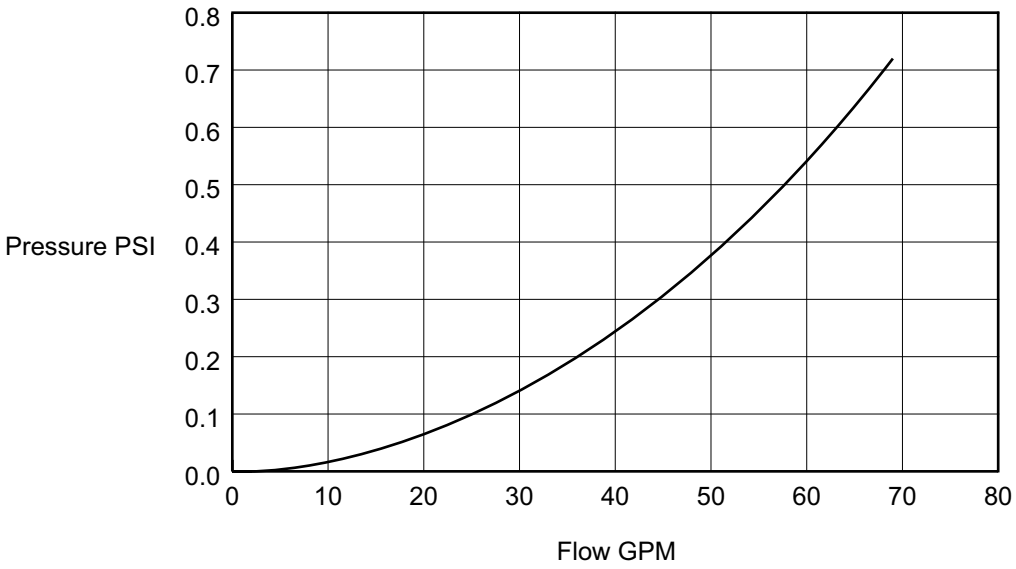


Table 15. Hydraulic Resistance CFW 500

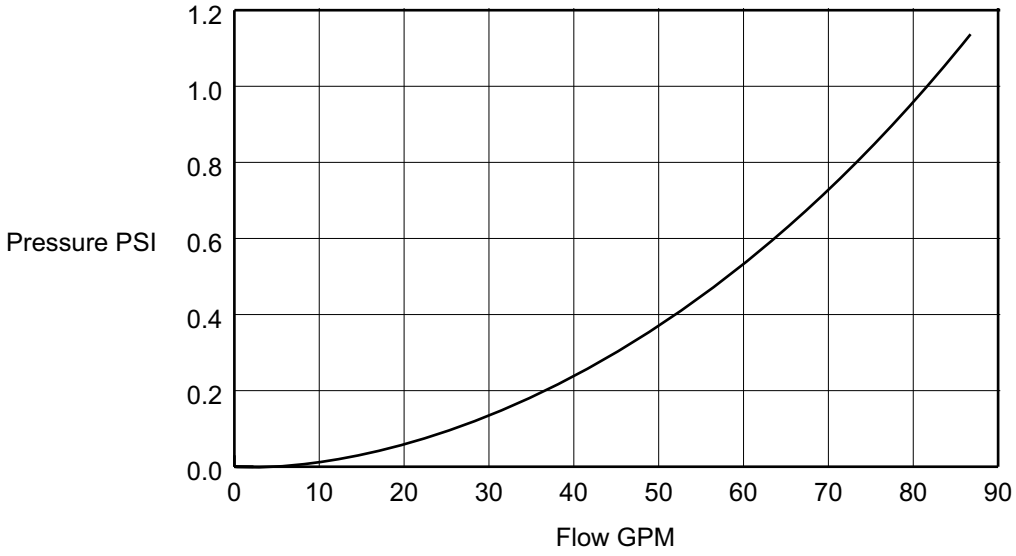


Table 16. Hydraulic Resistance CFW 750

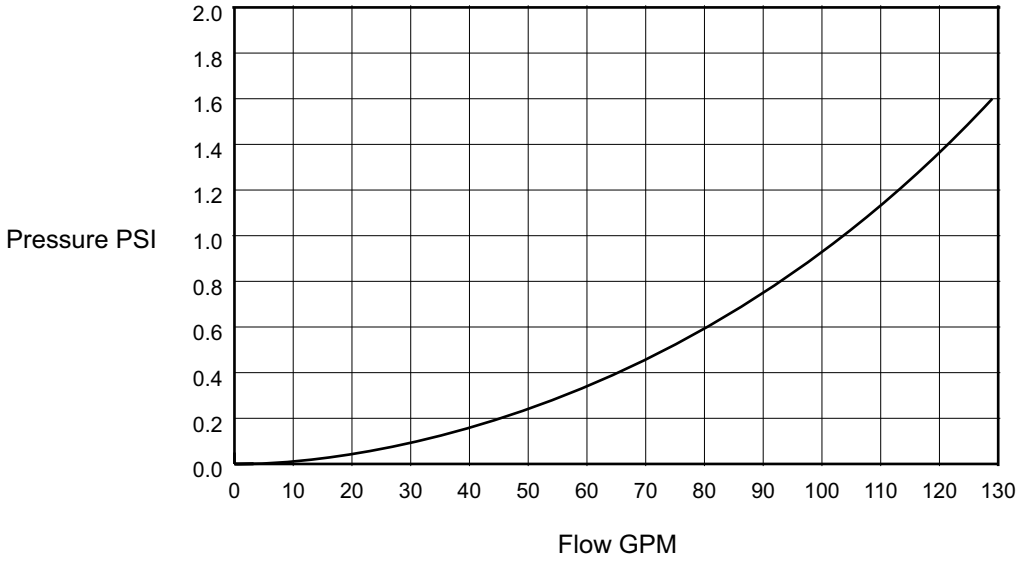


Table 17. Hydraulic Resistance CFW 1000

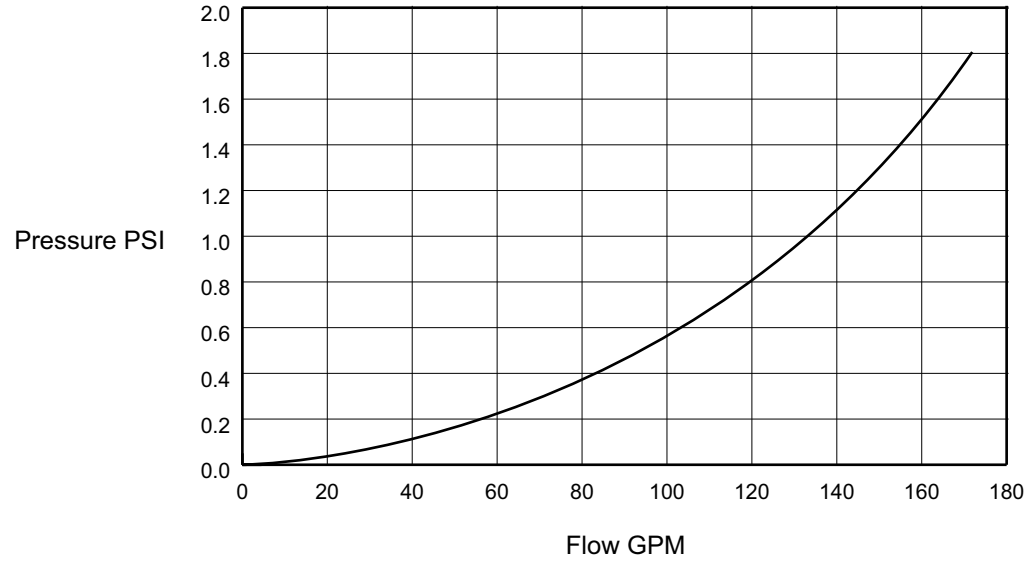


Table 18. Hydraulic Resistance CFW 1500

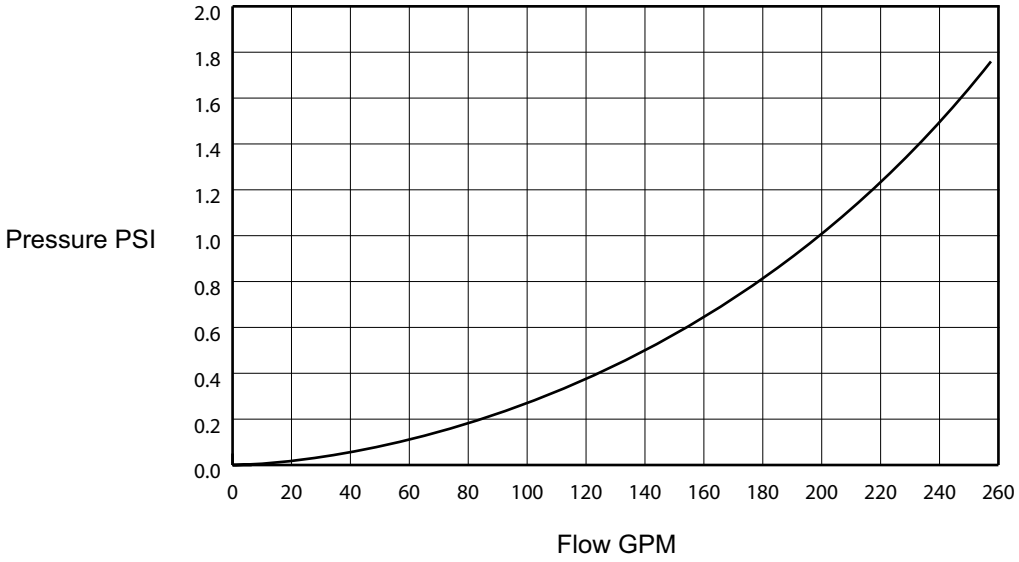


Table 19. Hydraulic Resistance CFW 2000

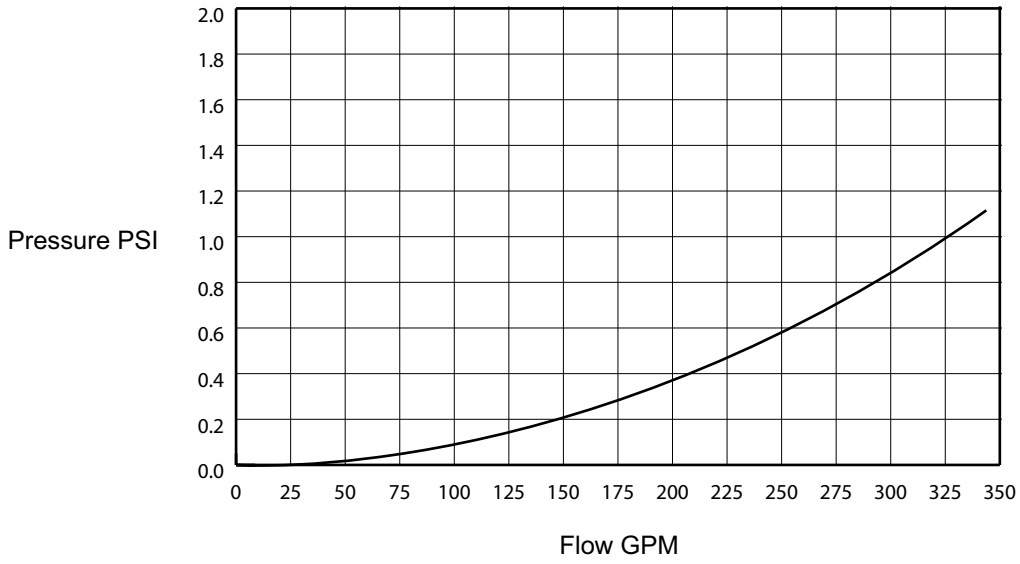
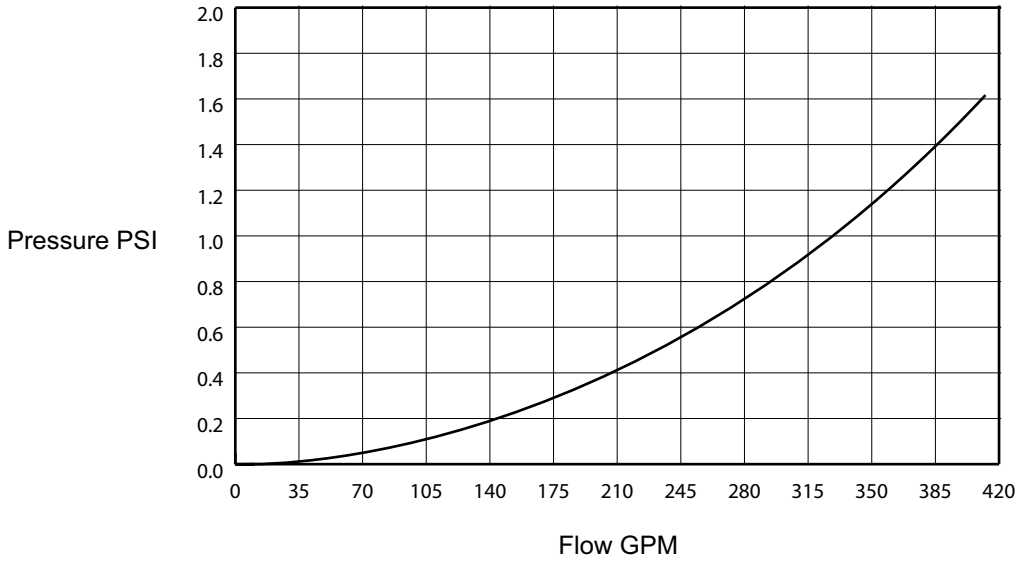


Table 20. Hydraulic Resistance CFW 2400



Stack/Breeching Criteria

General - 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. The Model CFW can be considered one of the following:

Category III - a boiler which operates with a positive vent pressure and with a flue gas temperature that avoids excessive condensate production in the vent

or Category IV - a boiler which operates with a positive vent pressure and with a flue gas temperature that may cause excessive condensate production in the vent.

Depending on the application, the specifying engineer may dictate alternative category flue venting as deemed appropriate. *The CFW should not be operated in a way that allows condensation to occur in the boiler*. However, due to the high efficiency of the CFW condensation may occur in flue venting. Proper consideration for these conditions is the responsibility of the specifying engineer and installer.

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 CFW 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.

Horizontal Thru-Wall Venting - Room Air

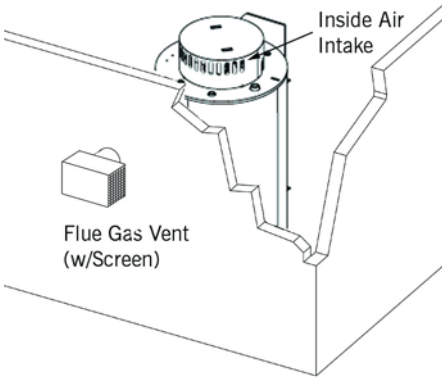


Figure 12. Horizontal Venting Thru-Wall Using Inside Air for Combustion

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

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

Vent termination equivalent lengths should be added to the total venting system length calculations.

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

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

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

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

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

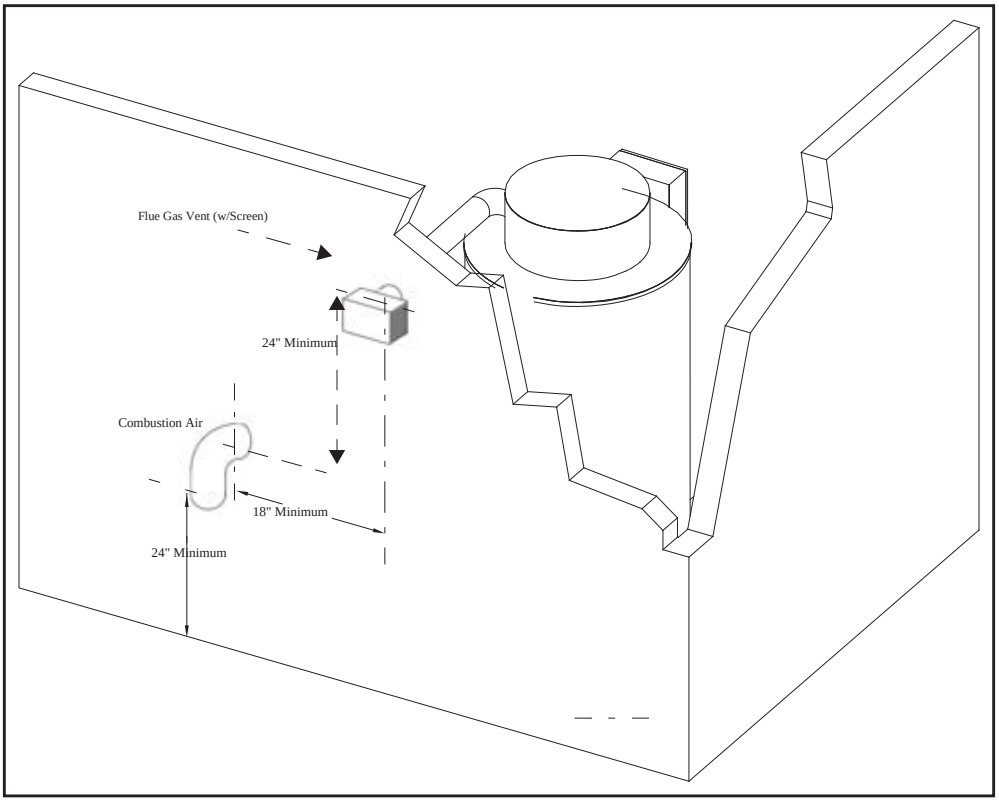


Figure 13. Horizontal Thru-wall Direct Venting Installation

Horizontal Thru-Wall Venting - Outside Air

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

The flue and combustion air vent terminations are not considered in the overall length of the venting system. An equivalent length of each termination should be included in total vent length calculations.

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

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

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

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

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

Vertical Venting - Room Air

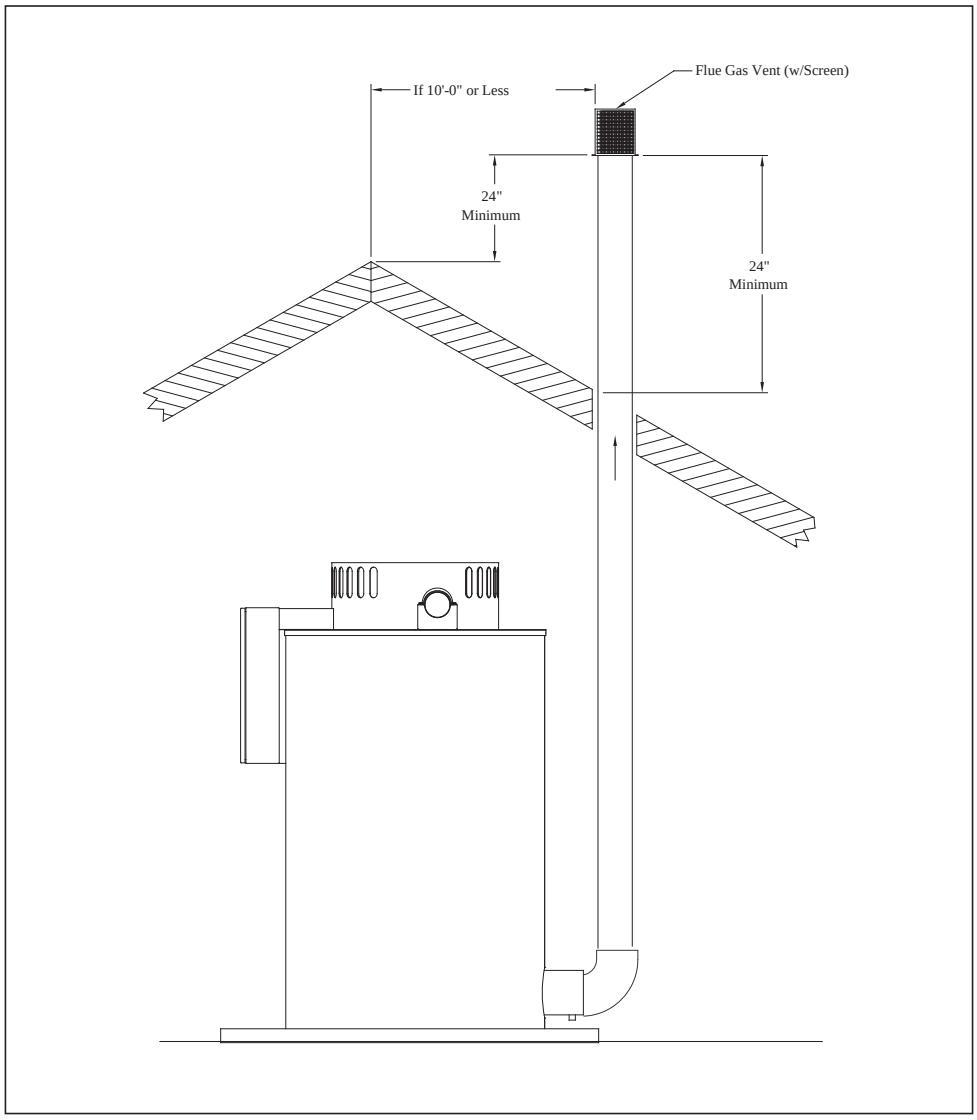


Figure 14. Vertical Stack with Indoor Combustion Air

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

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

Vertical Venting - Outside Air

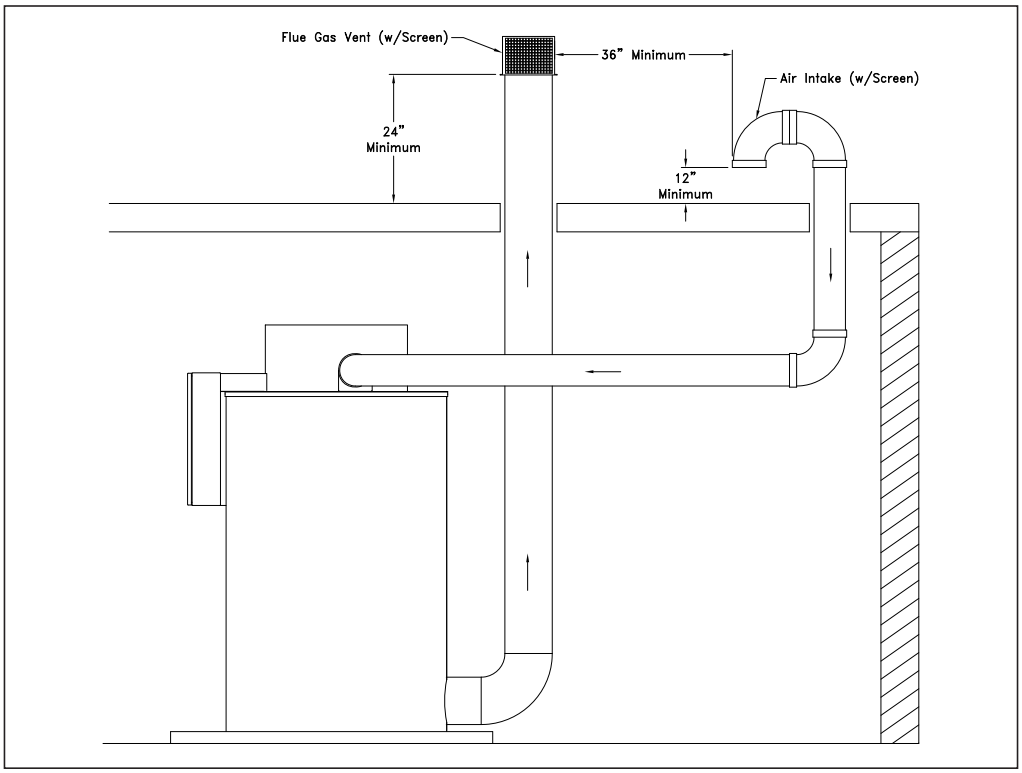


Figure 15. Vertical Stack with Direct Vent Combustion

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

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

Stack And Combustion Air Duct Design Using Direct Vent Combustion

Boiler Size	Stack Connection - Flue Diameter (in)	Combustion Air Duct Diameter (in)	Maximum Flue Length (ft) [SEE NOTES]	Maximum Air Intake Length (ft) [SEE NOTES]
400	6	4	100	100
500	6	4	80	80
750	6	4	70	70
1000	6	6	60	60
1500	8	6	40	40
2000	10	8	60	60
2400	10	8	60	60

NOTES:

1 - Each 90 deg. elbow equals 5 equivalent feet of ductwork. Subtract from the maximum or minimum length accordingly.

2 - Increasing the diameter of the air intake will reduce the pressure drop and thereby allow longer total vent lengths.

Maximum allowable pressure drop in combustion air intake duct is -0.25" w.c.

3 - Vent termination equivalent lengths should be added to the total length calculations. If unknown, use:

Each vent termination = 10 equivalent ft.

4 - Allowable combustion air temperature range is 32 deg F - 122 deg F. Combustion air at lower temperatures should be tempered to within this range. *Combustion air that is too cold or too hot can adversely affect performance and can lead to equipment damage.*

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:

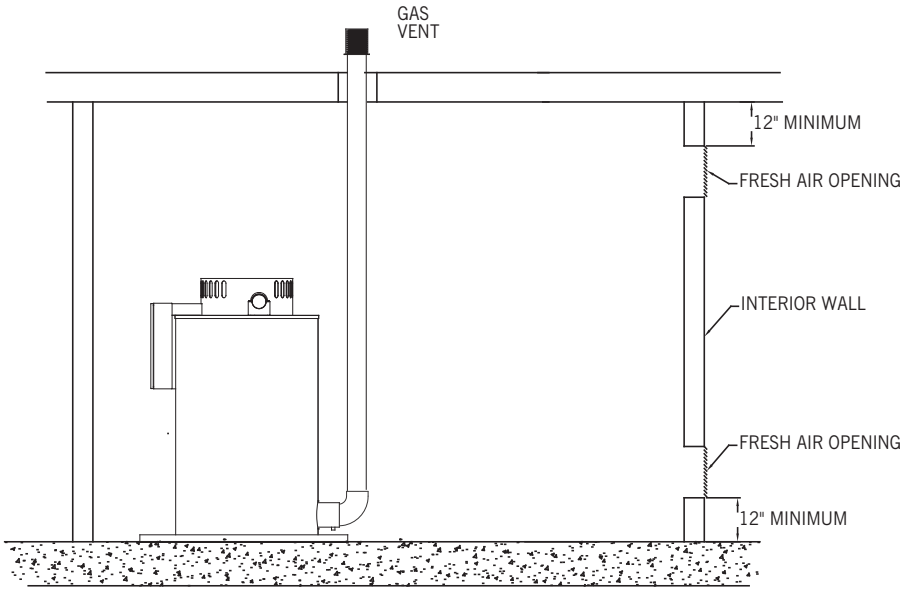
The mechanical equipment room must be provided with two permanent openings linked directly with additional room(s) of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50 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 16; refer to the NFGC for additional information.

Figure 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:

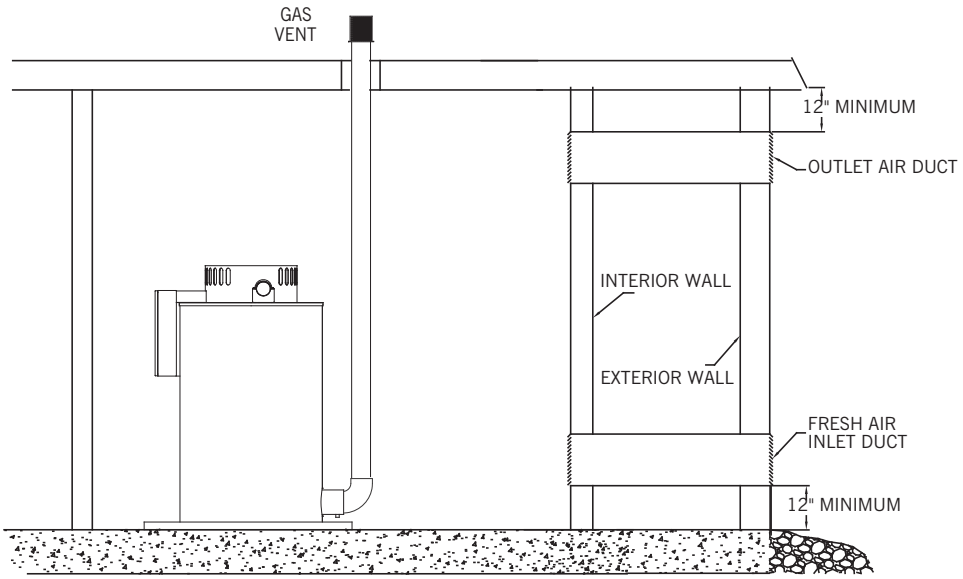
Two Opening Method (Figure 17) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches from the bottom of the room.

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 17. Two Opening Ducted Method



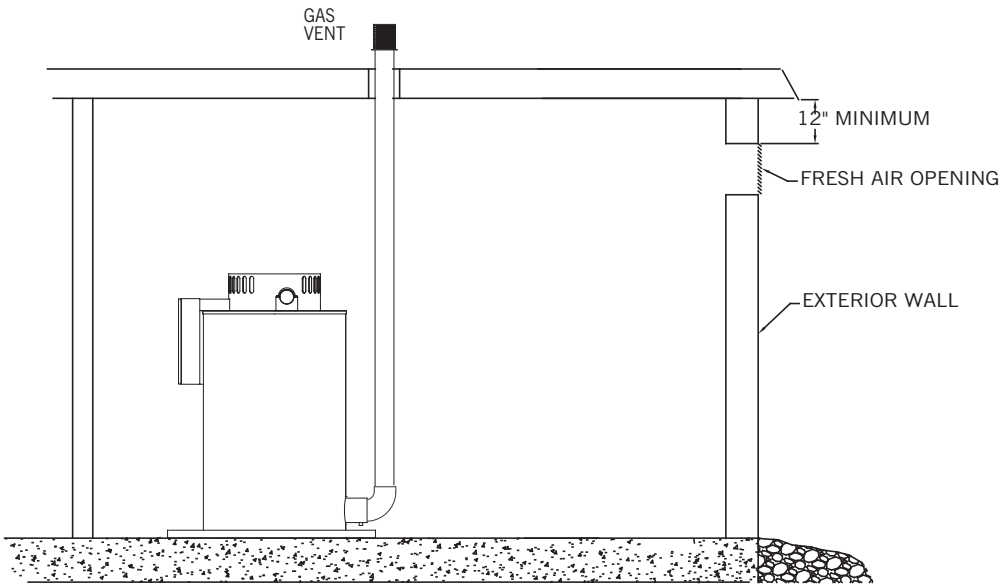
One Opening Method (Figure 18) - One permanent opening, commencing within 12 inches of the top of the room shall be provided.

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 18. One Opening Method

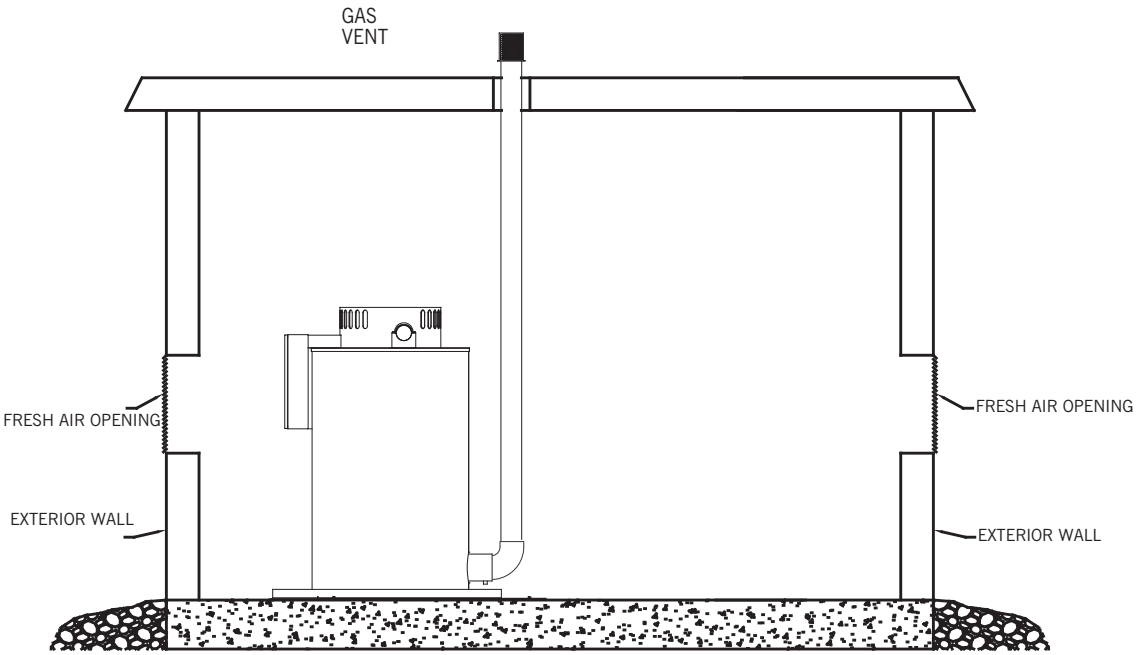


Unconfined Spaces

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 19).

Figure 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 = 0.25 cfm/kBtuh.
2. Ventilation Air = 0.05 cfm/kBtuh.
3. Total Air = 0.3 cfm/kBtuh (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) CFW 2000 boilers at 750 feet elevation. The air openings will be 5 feet above the floor level.

- Air required: 2000 x 2 = 4000 kBtuh. From F3 above, 4000 x 0.3 = 1200 cfm.
- Air Velocity: Up to 7 feet = 250 fpm from G1 above.
- Area required: Area = cfm/fpm = 1200/250 = 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 (direct vent combustion, sometimes called "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.

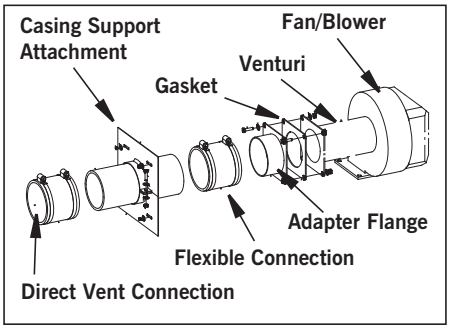


Figure 20. Direct Vent Combustion kit

Gas Piping

General - The ClearFire Model CFW 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 - CFW 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 XL-GAP (formerly GE-GAP/IRI). The gas train and its components have been designed and tested to operate for the highest combustion efficiency for the CFW 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 CFW boiler requires a stable gas pressure input. The pressure requirements are listed in the O&M manual and current specifications and are added here (Table B9-4) for reference purposes.

The minimum inlet supply pressure must be as noted in Table B9-4 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 3" at the test location described. Fluctuating gas pressure readings could be indicative of a faulty supply regulator or improper gas train size to the boiler.

Gas Piping - CFW units are standardly equipped with a gas pressure regulator. If upstream pressure exceeds 1 psig, an additional upstream regulator must be installed along with overpressure protection. 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 be removable without disassembling any gas piping. The connected piping to the boiler should be supported from pipe supports and not supported by the boiler gas train or the bottom of the drip leg.

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

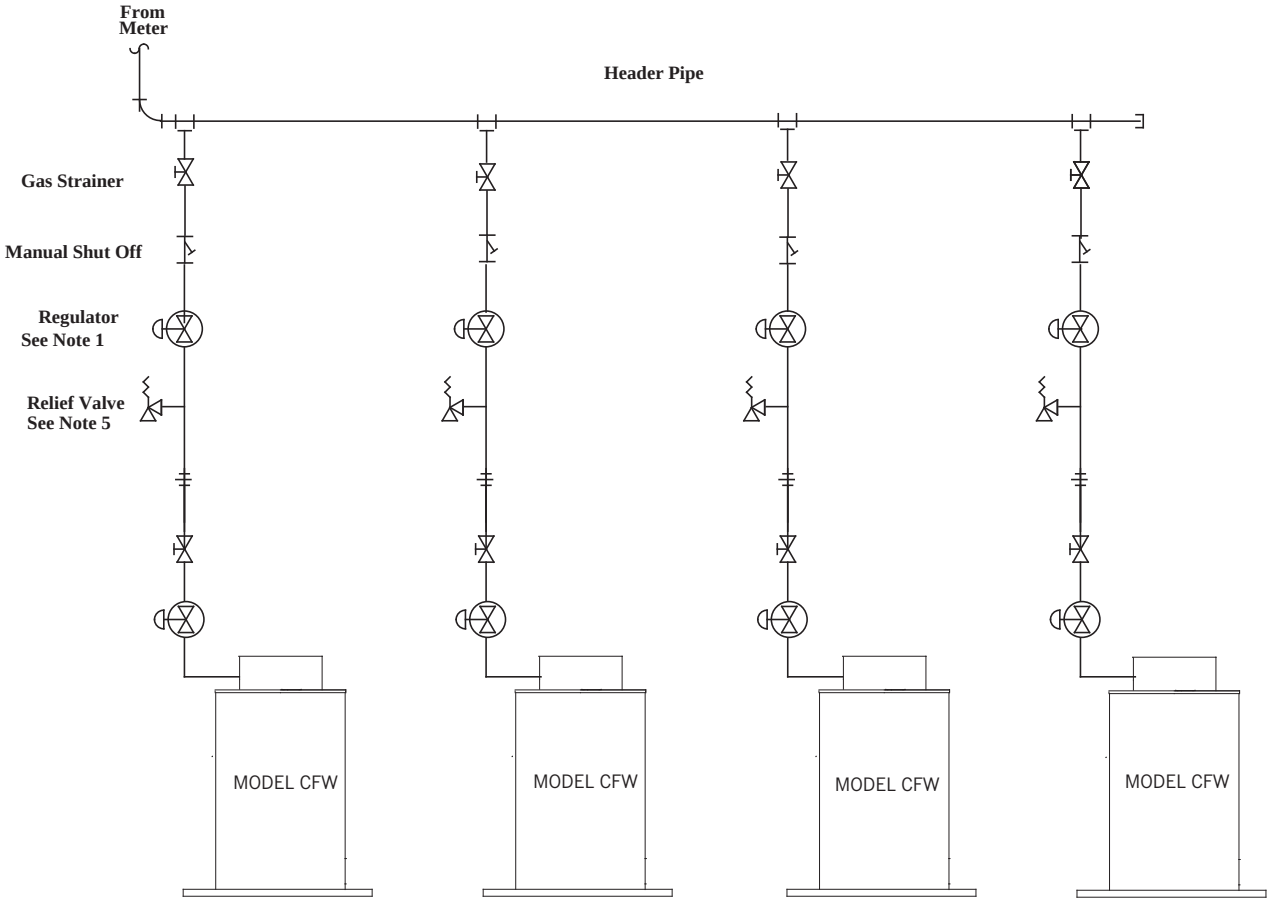
Gas Supply Pipe Sizing - For proper operation of a single unit or a multiple unit installation, we recommend that the gas pipe sizing be sized to allow no more than 0.3" w.c. pressure drop from the source (gas header or utility meter) to the final unit location. The gas supplier (utility) should be consulted 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 B9-14 and B9-15 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 unit with 1,500,000 btu/hr input divided by a gas calorific value of 1060 will result in a cfh flow of 1,415. 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 B9-21 that a supply pipe size of 2" should be used as a minimum.

Figure 21. 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.

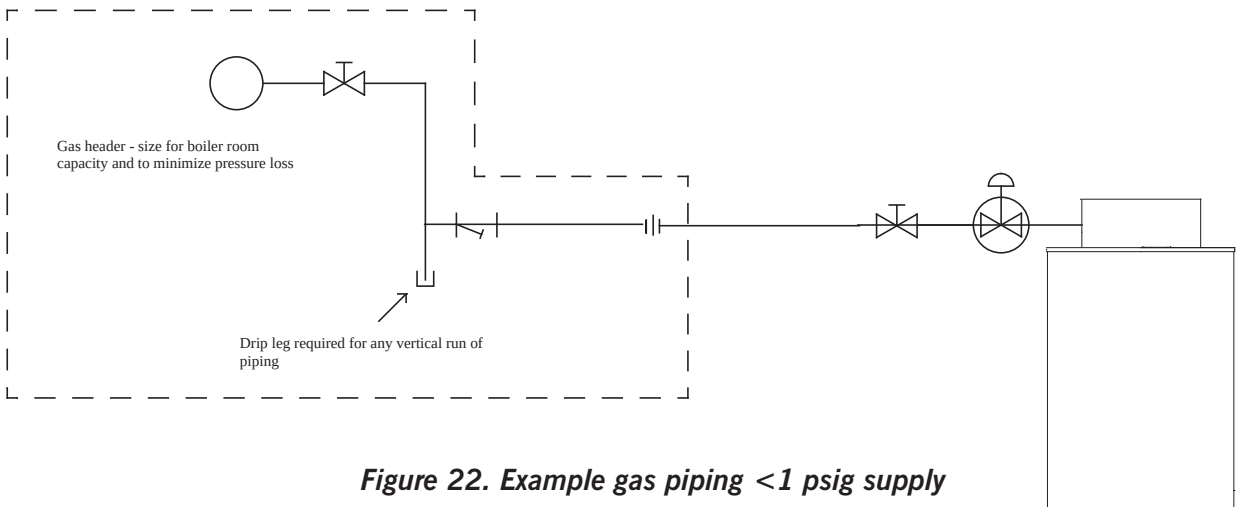


Figure 22. Example gas piping <1 psig supply

Table 21. 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 (CFW)						
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 22. 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 (CFW)						
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							

Gas Header - For multiple unit installations, a single common gas header is recommended with individual takeoffs for each boiler (See Figure 21). Boiler gas manifold piping should be sized based on volume requirements and lengths between each boiler and the fuel main header. Table 23 indicates the proper sizing for multiple units of equal size, placed on the factory standard center with the indicated take off size. For installations with a mixed sized use, determine the flow of each unit and total the input. With the total input, 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 21 with boiler gas line take-off at 20 feet from the header.

Table 23. Gas pipe sizing for multiple unit manifolds

CFW 400				
# 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"

CFW 500				
# 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"

CFW 750				
# 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"

CFW 1000				
# 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"

CFW 1500				
# of Units	**1**	**2**	**3**	**4**
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2"	2-1/2"	3"	4"

CFW 2000				
# of Units	**1**	**2**	**3**	**4**
Pipe Size To Boiler	2"	2"	2"	2"
Header Pipe Size	2"	3"	3"	4"

CFW 2400				
# 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"