Model CFC ClearFire Condensing Boiler

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MODEL CFC FEATURES AND BENEFITS

Compact Firetube Design

The Model CFC boiler is a single pass, vertical down fired durable firetube boiler. The internal extended-heating surface tubes provide very high levels of performance in a compact space, offering over 10 square feet of heating surface per boiler horsepower, providing many years of trouble free performance.

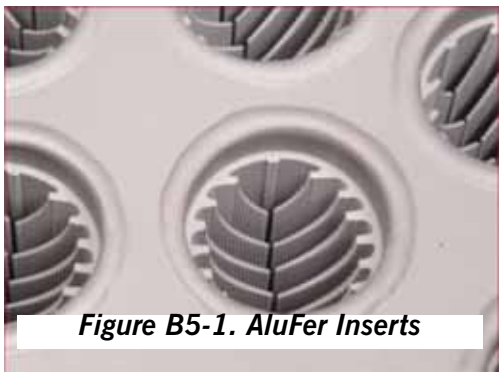


Figure B5-1. AluFer Inserts

Advanced Technology

Tubes and tube sheets are constructed from UNS S32101 duplex stainless steel. Tubes feature AluFer tube inserts for optimal heat transfer.

Advanced Construction

The extended heating surface design provides the ideal solution for the demands of a condensing boiler and helps to recover virtually all the latent heat of the flue gas. Each tube consists of an outer stainless steel tube (waterside) and the AluFer extended surface profile on the flue gas side.

High Efficiency

With the extended heating surface tubes the CFC boiler will provide fuel to water efficiency of up to 99% at low fire and 97% at high fire with 80 degrees F return water temperature.

Ease of Maintenance

The powder coated steel casing is designed for easy removal and re-assembly. As shown in Figure B5-2, the burner is hinged and is provided with hydraulic pistons for simple opening for service of the spark electrode, inspection of the burner cylinder, tubes and tube sheet on Models CFC1000 and larger. (On the CFC500 and 750, the burner is hinged only). A front mounted service platform is provided for easy access to the burner components and controls.

Figure B5-2. Fireside Access

Quality Construction

ISO 9001:2001 certified manufacturing process ensures the highest degree of manufacturing standards are always followed.

ASME Code construction ensures high quality design, safety, third party inspection, and reliability, and is stamped accordingly.

Premix Technology

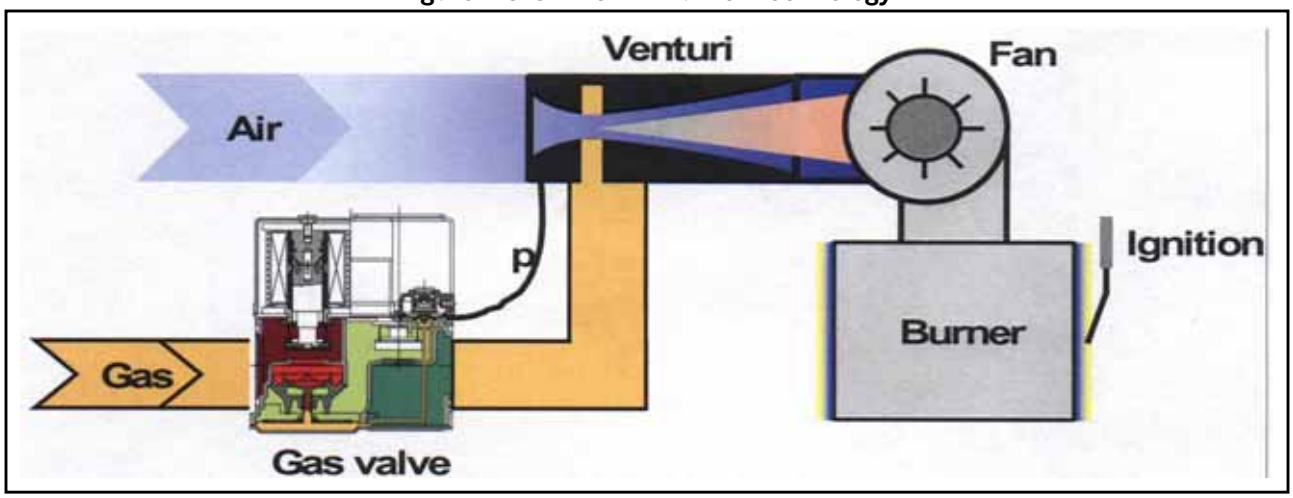
The burner utilizes "Premix" technology to mix both gas fuel and combustion air prior to entering the burner canister, with air "leading" during burner firing transitions.

Combined with a variable speed fan, this technology provides very low emission levels, exceptionally safe operation, and nearly 100% combustion efficiency.

Full Modulation

The variable speed fan provides modulated firing for reduced on/off cycling, excellent load tracking, and reduced operating costs. The burner does not require mechanical linkage connections between the fuel input valve and air control. Instead, the microprocessor control positions the fan speed in accordance with system demand, and this determines the fuel input without mechanical device positioning - that is, linkage-less fuel/air ratio control. This eliminates linkage slippage, minimizes burner maintenance, and provides control repeatability. This is shown schematically in Figure B5-3.

Figure B5-3. Premix Burner Technology



Designed For Heating Applications

The pressure vessel is designed for 125 psig MAWP (Max. Allowable Working Pressure) and is constructed of durable ASTM Grade Steel and Stainless Steel materials. Figure B5-4 shows the counter flow heat exchanger design that gives optimal heat transfer. The design also prevents hot spots, does not require a minimum flow for thermal shock protection, and does not require a minimum return water temperature. In fact, the design carries a 20-year thermal shock warranty.

Because of its design characteristics, the Model CFC is well suited for applications utilizing indoor/outdoor reset controls, radiant floor heating, snow melt systems, ground source heat pump systems and systems that utilize variable speed circulating pumps. It may also be employed in standard hot water systems that require higher heated water at colder outdoor temperatures but then require minimum temperatures during warmer heating days, realizing fuel efficiency savings over traditional hot water boilers.

While the design does not lend itself to the direct supply of potable water, a separate storage tank with an internal heat exchanger can be employed, as the microprocessor control permits domestic water programming. Therefore, the Model CFC can service both hydronic heating and domestic water source heating.

Dual Return

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

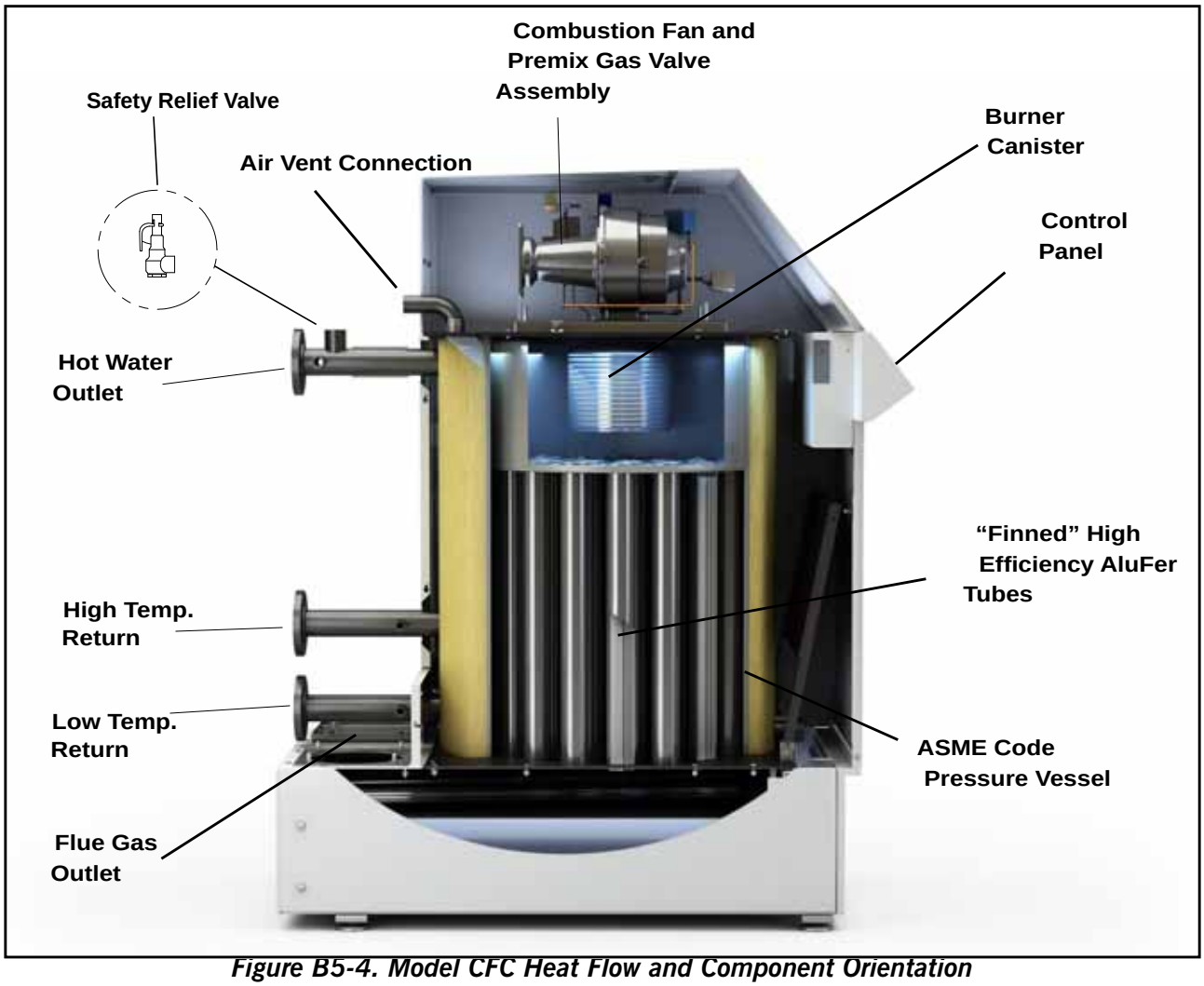


Figure B5-4. Model CFC Heat Flow and Component Orientation

MODEL CFC PRODUCT OFFERING

Information in this section applies to condensing hot water boiler sizes ranging from 500,000 Btu input through 3,300,000 Btu input for operation on Natural Gas or LP Gas only. Installation is for indoor use only.

Dimensions, ratings, and product information may change to meet current market requirements and product improvements. Therefore, use this information as a guide.

Standard Equipment

Equipment described below is for the standard boiler offering:

1. The Boiler
   A. Each boiler size is designed for a Maximum Allowable Working Pressure (MAWP) of 125 psig (8.6 Bar), constructed in accordance with the ASME Code Section IV and bear the "H" stamp.
   B. The insulated boiler is mounted on a base and powder coated steel casing provided.
   C. A drain valve connection is provided at the front bottom for field piping of a boiler drain valve, which can be furnished as an option.
2. Boiler Trim and Controls
   - The following items are furnished:
   - Probe Type Low Water Cutoff control, manual reset.
   - 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. Burner Control
   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.
      - Burner sequencing with safe start check, pre-purge, direct spark ignition (pilot ignition CFC-3300), and post purge.
      - Electronic ignition.
      - Flame Supervision.
      - Safety shutdown with time-stamped display of lockout condition.
      - Variable speed control of the combustion fan.
      - Supervision of low and high gas pressure, air proving, stack back pressure, high limit, and low water.
      - First-out annunciator.
      - Real-time data trending.
      - (3) pump/auxiliary relay outputs.
      - Modbus communication capability.
      - Outdoor temperature reset.
      - Remote firing rate or setpoint control
      - Setback/time-of-day setpoint
      - Lead/Lag for up to 8 boilers

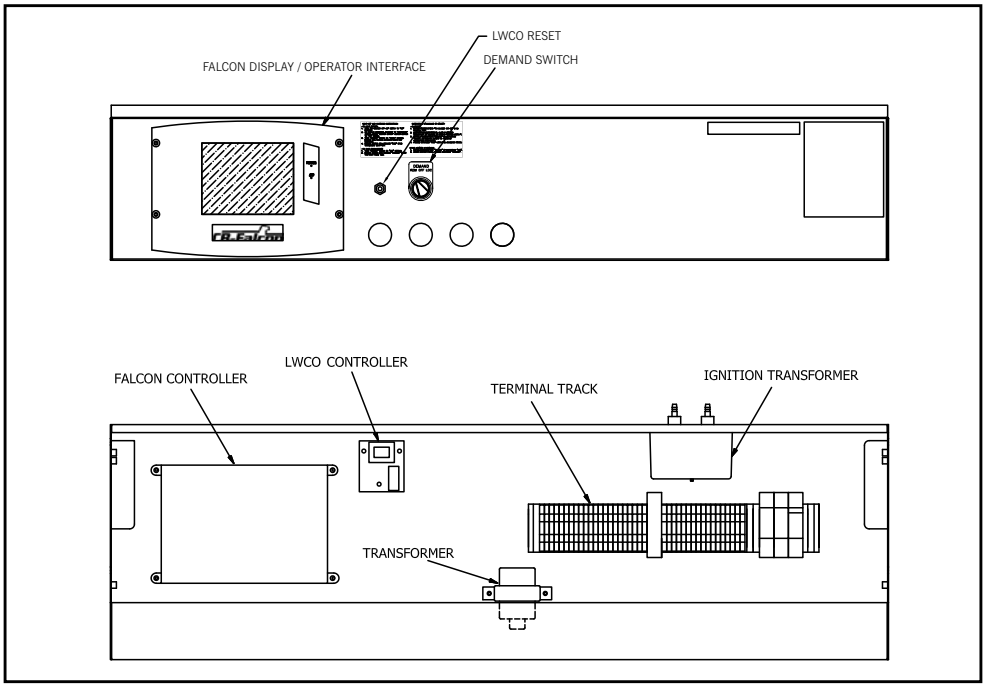


Figure B5-5. ClearFire Control Panel (1500/1800 shown)

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.
   B. Full modulation is accomplished with a variable speed fan for 5:1 turndown ratio.
   C. For near flameless combustion, the burner utilizes a Fecralloy-metal fiber head.
   D. Noise level at maximum firing is less than 70 dBA regardless of boiler size.
   E. Operating on Natural Gas, NOx emissions will be less than 20 PPM regardless of boiler size and the boiler is certified for California and Texas for Low NOx emissions.
   F. As an option, the burner is capable of direct vent combustion.
   G. Ignition of the main flame is via direct spark, utilizing high voltage electrodes and a separate electrode for flame supervision (CFC-3300 uses gas pilot ignition and UV scanner 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 furnished.
   I. A High Air Pressure Switch is provided to ensure burner lockout if excessive back pressure due to a blocked stack occurs.
   J. For ease of maintenance and inspection, the burner is furnished with hydraulic rods and easy opening lockdown nuts, which permit the burner to swing up (except 500 and 750, which are hinged only). This provides full access to the burner and electrodes, as well, to the tube sheet and tubes.
5. Burner Gas Train

The standard gas train is equipped in accordance with UL certification and complies with ASME CSD-1. 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.

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:

A. Dual gas train for quick and easy fuel switchover.
B. Reusable air filter.
C. Condensate neutralization tank assembly - consists of neutralizing media, filter, and PVC condensate holding tank with integral drain trap. This assembly can be mounted beneath the boiler.
D. Outside air intake for direct vent combustion.
E. Outdoor temperature sensor for indoor/outdoor control.
F. Header temperature sensor for multiple boiler Lead/Lag operation.
G. Auxiliary Low Water Control (shipped loose) for field piping by others into the system piping.
H. Alarm Horn for safety shutdown.
I. Relays for output signal for burner on, fuel valve open.
J. Stack Thermometer.
K. Stack temperature limit-sensor.
L. Auto air vent.
M. Boiler drain valve.

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFC are shown in Table B5-1 (US Dimensions) and Table B5-2 (Metric Dimensions) including the various pipe connection sizes for supply and return water, drain, and vent. The performance ratings for the boiler are shown in Table B5-3.

Altitude

Relative to the ratings shown, installation of the boiler above 2000 feet elevation will result in input capacity reduction. Please refer to Table B5-4 for input ratings of the boiler at various elevations.

PERFORMANCE DATA

Efficiency

The Model CFC is a "full condensing" boiler realizing efficiency gain at variable operating conditions. It is designed to extract the latent heat of condensation over a greater range than other designs. This can be seen in Figure B5-7, which depicts nominal stack temperatures of the boiler versus other designs. The nominal point of condensation is approximately 132◦ F (55.5 C). The ClearFire, due to its more efficient heat transfer design and lower stack temperature, is able to capture the latent heat of condensation over a broader range.

Fuel-to-water efficiency is relative to specific operating conditions. Operating efficiency will be greater in the "condensing" mode of operation as noted above, yet with its inherently greater heat transfer surfaces and superior pre-mix burner, the ClearFire's efficiency under "traditional" hot water conditions is also outstanding. Table B5-6 through Table B5-9 show the guaranteed efficiencies at various operating conditions and firing rates for Natural Gas. It should be noted that the efficiency is exceptional at high fire and low fire versus other designs where high efficiency is realized only with low fire or minimal firing rates and low temperature returns.

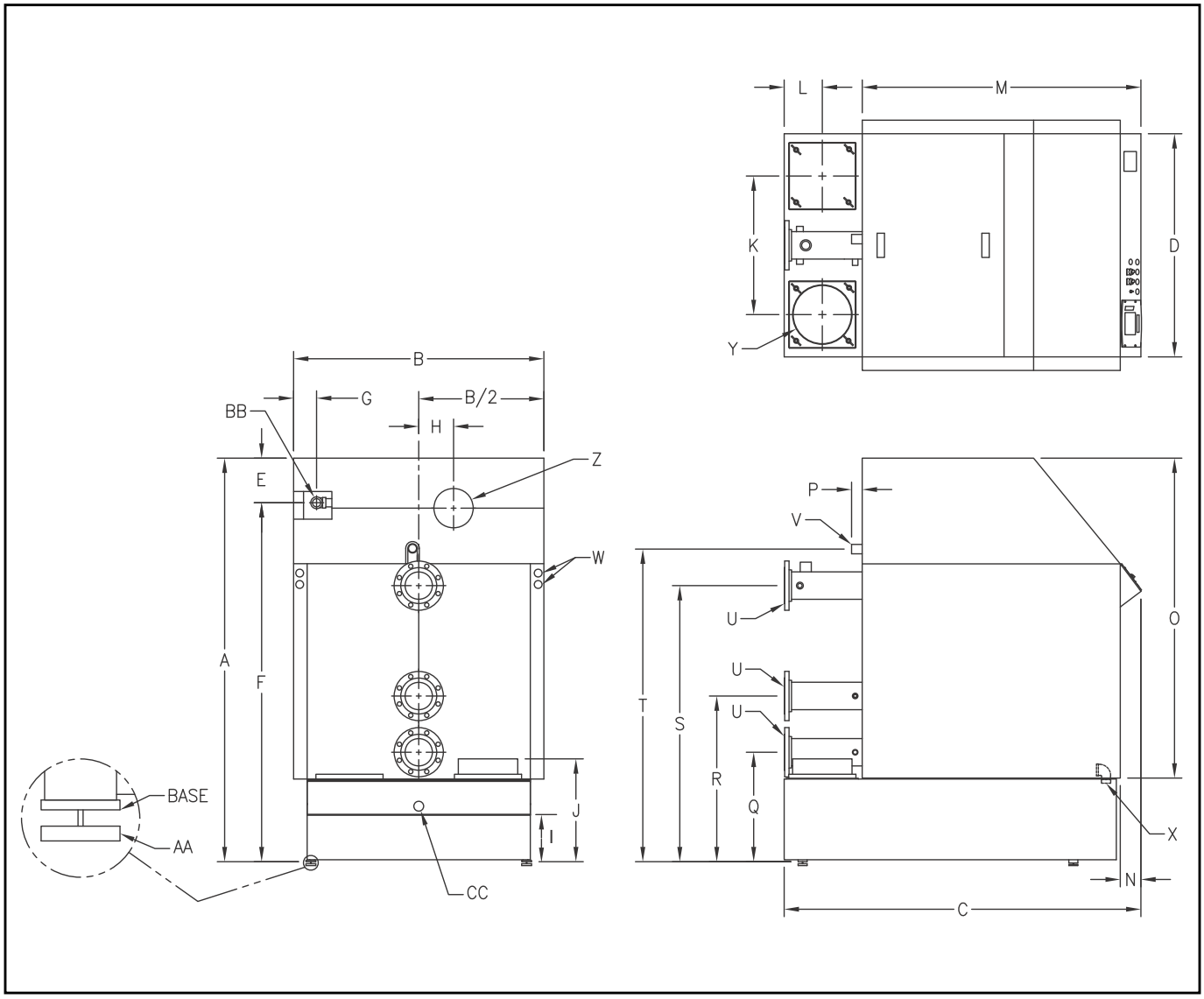


Figure B5-6. Model CFC Dimensional Views

Table B5-1. U.S. Standard Dimensions Model CFC Boiler

ITEM	DIMENSIONS (inches)	500	750	1000	1500	1800	2500	3300
A	Overall Height	71.8	71.8	75.7	81.6	81.6	82.2	85.0
B	Overall Width	32.3	32.3	36.6	43.7	43.7	50.8	61.3
C	Overall Depth	48.8	48.8	62.6	65.6	65.6	72.6	86.3
D	Width Less Casing	26.8	26.8	31.1	38.2	38.2	45.3	55.5
E	Gas Connection to Top of Casing	8.1	8.1	9.5	12.5	10.2	9.4	10.0
F	Gas Connection to Floor	63.7	63.7	66.2	69.1	71.4	72.8	75.0
G	Side of Casing to Gas Connection	2.3	2.3	4.3	3.4	5.2	4.7	5.1
H	Boiler Centerline to Air Inlet Centerline	4.0	4.0	4.0	4.9	7.1	7.1	7.1
I	Floor to Bottom of Base	10.3	10.3	10.3	10.3	10.3	10.3	10.3
J	Floor to Top of Stack Connection	18.6	18.6	18.1	19.1	19.1	20.9	21.4
K	Centerline to Centerline of Stack Stub	15.4	15.4	16.9	21.0	21.0	28.1	35.8
L	Rear of Boiler to Centerline of Stack Stub	5.4	5.4	7.5	8.1	8.1	8.6	10.0
M	Front of Boiler to Rear of Casing	38.8	38.8	49.4	49.5	49.5	56.5	67.0
N	Control Panel Projection	4.1	4.1	4.1	4.1	4.1	4.1	4.3
O	Casing Height	56.2	56.2	60.0	65.4	65.4	65.4	67.0
P	Air Vent Line Projection from Rear of Casing	7.8	7.8	7.3	8.1	8.1	8.7	4.7
Q	Floor to Centerline of Lower Return	19.5	19.5	19.6	20.7	21.3	22.4	24.1
R	Floor to Centerline of Upper Return	28.2	28.7	30.5	20.3	32.3	33.8	35.5
S	Floor to Centerline of Supply Connection	54.3	54.3	56.2	57.1	56.2	56.2	59.1
T	Floor to Centerline of Air Vent	59.9	59.9	62.3	63.1	63.1	63.6	66.4
AA	Boiler Adjustment Foot Height	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Height Above Boiler for Burner Service	14.0	14.0	14.0	14.0	14.0	14.0	18.0
CONNECTIONS								
U	Water Supply/Return, 150# RF Flg	2-1/2"	2-1/2"	2-1/2"	3"	4"	5"	5"
V	Boiler Air Vent, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
W	Electrical Conduit, left or right	1.6"	1.6"	1.6"	1.6"	1.6"	1.6"	1.6"
X	Boiler Drain, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Y	Flue Gas Nominal OD, Left or Right option	6"	6"	8"	10"	12"	12"	12"
Z	Combustion Air Option	4" OR 6"	4" OR 6"	4" OR 6"	6" OR 8"	6" OR 8"	8"	8"
BB	Gas Connection, NPT	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"	2"
CC	Condensate Drain, FPT	3/4"	3/4"	3/4"	3/4"	3/4"	1"	1"
	Relief Valve outlet @ 125 # Setting	1"	1"	1"	1"	1"	1"	1"
	Voltage Fan Motor	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	208-240/ 3/60
	Voltage Control Circuit	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60

Table B5-2. Metric Dimensions Model CFC Boiler

		Boiler Size						
ITEM	DIMENSIONS (mm)	500	750	1000	1500	1800	2500	3300
A	Overall Height	1824	1824	1923	2073	2073	2088	2159
B	Overall Width	820	820	930	1110	1110	1290	1557
C	Overall Depth	1240	1240	1590	1666	1666	1844	2192
D	Width Less Casing	681	681	790	970	970	1151	1410
E	Gas Connection to Top of Casing	206	206	241	318	259	239	254
F	Gas Connection to Floor	1618	1618	1681	1755	1814	1849	1905
G	Side of Casing to Gas Connection	58	58	109	86	132	119	130
H	Boiler Centerline to Air Inlet Centerline	102	102	102	124	180	180	180
I	Floor to Bottom of Base	262	262	262	262	262	262	262
J	Floor to Top of Stack Connection	472	472	460	485	485	531	544
K	Centerline to Centerline of Stack Stub	391	391	429	533	533	714	909
L	Rear of Boiler to Centerline of Stack Stub	137	137	191	206	206	218	254
M	Front of Boiler to Rear of Casing	986	986	1255	1257	1257	1435	1702
N	Control Panel Projection	104	104	104	104	104	104	109
O	Casing Height	1427	1427	1524	1661	1661	1661	1702
P	Air Vent Line Projection from Rear of Casing	198	198	185	206	206	221	119
Q	Floor to Centerline of Lower Return	495	495	498	526	541	569	612
R	Floor to Centerline of Upper Return	716	729	775	516	820	859	902
S	Floor to Centerline of Supply Connection	1379	1379	1427	1450	1427	1427	1501
T	Floor to Centerline of Air Vent	1521	1521	1582	1603	1603	1615	1687
AA	Boiler Adjustment Foot Height	64	64	64	64	64	64	64
	Height Above Boiler for Burner Service	356	356	356	356	356	356	457
CONNECTIONS (inches)								
U	Water Supply/Return, 150# RF Flg	2-1/2"	2-1/2"	2-1/2"	3"	4"	5"	5"
V	Boiler Air Vent, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
W	Electrical Conduit, left or right	1.6"	1.6"	1.6"	1.6"	1.6"	1.6"	1.6"
X	Boiler Drain, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Y	Flue Gas Nominal OD, Left or Right option	6"	6"	8"	10"	12"	12"	12"
Z	Combustion Air Option	4"	4" OR 6"	4" OR 6"	6"	6"	6" OR 8"	8"
BB	Gas Connection, NPT	1	"1	"1	"1-1/2	"1-1/2	"1-1/2	"2"
CC	Condensate Drain, FPT	3/4	"3/4	"3/4	"3/4	"3/4	"3/4	"1"
	Relief Valve outlet @ 125 # Setting	1	"1	"1	"1	"1	"1	"1"
	Voltage Fan Motor	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	208-240/ 3/60
	Voltage Control Circuit	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60

Table B5-3. Model CFC Boiler Ratings (Sea Level to 2000 Feet)

Description	Units	500	750	1000	1500	1800	2500	3300
Input Max.	BTU/Hr.	500,000	750,000	1,000,000	1,500,000	1,800,000	2,500,000	3,300,000
	KCAL/Hr.	126,000	189,000	252,000	378,000	453,600	630,000	831,600
Natural Gas (1000 Btu/ft3)	FT3/Hr	500	750	1000	1500	1800	2500	3300
Propane (2500 Btu/ft3)	FT3/Hr	200	300	400	600	720	1000	1320
Natural Gas	M3/Hr	14.2	21.2	28.3	42.5	50.9	70.8	93.4
Propane	M3/Hr	5.7	8.5	11.3	17.0	20.4	28.3	37.4
Output at 104/86 F [40/30 C] 100% Firing	BTU/Hr.	480,000	720,000	960,000	1,440,000	1,728,000	2,400,000	3,168,000
	KCAL/Hr.	120,960	181,440	241,920	362,880	435,456	604,800	798,336
	BHP	14.3	21.5	28.7	43.0	51.6	71.7	94.6
	KW	141	211	281	422	506	703	928
Output at 176/140 F [80/60 C] 100% Firing	BTU/Hr.	435,000	652,500	870,000	1,305,000	1,566,000	2,175,000	2,871,000
	KCAL/Hr.	109,620	164,430	219,240	328,860	394,632	548,100	723,492
	BHP	13.0	19.5	26.0	39.0	46.8	65.0	85.8
	KW	127	191	255	382	459	637	841
MAWP	PSI	125	125	125	125	125	125	125
	BAR	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Operating Temp., Max.	°F	194	194	194	194	194	194	194
	°C	90	90	90	90	90	90	90
Water Content	Gallons	51	51	90	113	99	126	209
	Liters	193	193	341	428	375	477	791
Weight w/o Water	Pounds	1,160	1,160	1,795	2,225	2,505	3,640	4,835
	Kg	526	526	814	1009	1136	1651	2193
Operating Weight	Pounds	1,585	1,585	2,545	3,165	3,325	4,685	6,570
	Kg	719	719	1154	1436	1508	2125	2980
Weight, Shipping	Pounds	1,210	1,210	1,850	2,300	2,600	3,725	5,000
	Kg	549	549	839	1043	1179	1690	2268
Fireside Heating Surface	ft2	185	185	307	445	596	937	1,258
	m2	17.1	17.2	28.5	41.3	55.4	87.0	117
Standby Heat Loss	BTU/Hr	1,206	1,639	1,912	2,459	2,561	3,415	4,620
	Watts	353	480	560	720	750	1000	1353
Fan Motor Size	Watts	335	335	335	750	1,200	1,200	2,200
Operating Voltage, Fan	Volts/Ph/ Hz	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	208-240/ 3/60
Control Circuit	Volts/Ph/ Hz	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60
Current Draw, Fan	Amperes	4	4	4	8.5	12	12	6.9
Current Draw Cont. Ckt.	Amperes	1.5	1.5	1.5	1.5	2	2	2.3
Condensate Quantity Firing Nat. Gas & operating @ 104/86 F.	Gal/Hr.	4	5	6.5	10	12	16.5	22
	l/Hr.	15	19	25	38	45	62	83
Condensate Value	PH	4.5 - 5.5	4.5 - 5.5	4.5 - 5.5	4.5 - 5.5	4.5 - 5.5	4.5 - 5.5	4.5 - 5.5
Flue Gas Mass Flow @ 100% Firing (Natural Gas)	lb/hr	557	835	1,113	1,670	2,004	2,783	3674
	kg/h	253	379	505	758	909	1262	1667
Flue Gas Temp. Oper. 176/140 F [80/60 C]	°F	155	180	160	170	170	160	160
	°C	68	82	71	77	77	71	71
Flue Gas Temp. Oper. 104/86 F [40/30 C]	°F	105	125	110	108	108	110	110
	°C	41	52	43	42	42	43	43

Table B5-4. Altitude Correction for Input Capacity at Various Altitude Levels

Natural Gas

	700' ASL	2000'	4000'	6000'	8000'	10000'
CFC 3300	3300 kBTU/h	3300	3300	3300	3057	2930
CFC 2500	2500	2418	2245	2083	1930	1850
CFC 1800	1800	1800	1800	1666	1544	1480
CFC 1500	1500	1500	1500	1415	1311	1257
CFC 1000	1000	1000	1000	943	874	838
CFC 750	750	750	750	707	655	628
CFC 500	500	500	490	454	421	404

Ratings assume 35% excess air, 80F combustion air.
Blower speed adjustments should be made to match performance and local conditions accordingly.
For minimum gas supply pressures see Table B5-24. Altitude corrections for supply pressure should be made per Table B5-25.
Natural gas heating value of 1000 BTU/SCF assumed.

LP Gas

	700' ASL	2000'	4000'	6000'	8000'	10000'
CFC 3300	3300 kBTU/h	3300	3300	3300	3057	2930
CFC 2500	2500	2500	2339	2169	2010	1927
CFC 1800	1800	1800	1800	1704	1579	1514
CFC 1500	1500	1500	1500	1500	1390	1332
CFC 1000	1000	1000	1000	1000	926	888
CFC 750	750	750	750	750	695	666
CFC 500	500	500	500	481	445	427

Ratings assume 40% excess air, 80F combustion air.
Blower speed adjustments should be made to match performance and local conditions accordingly.
For minimum gas supply pressures see Table B5-24. Altitude corrections for supply pressure should be made per Table B5-25.
LP (propane) gas heating value of 2500 BTU/SCF assumed.

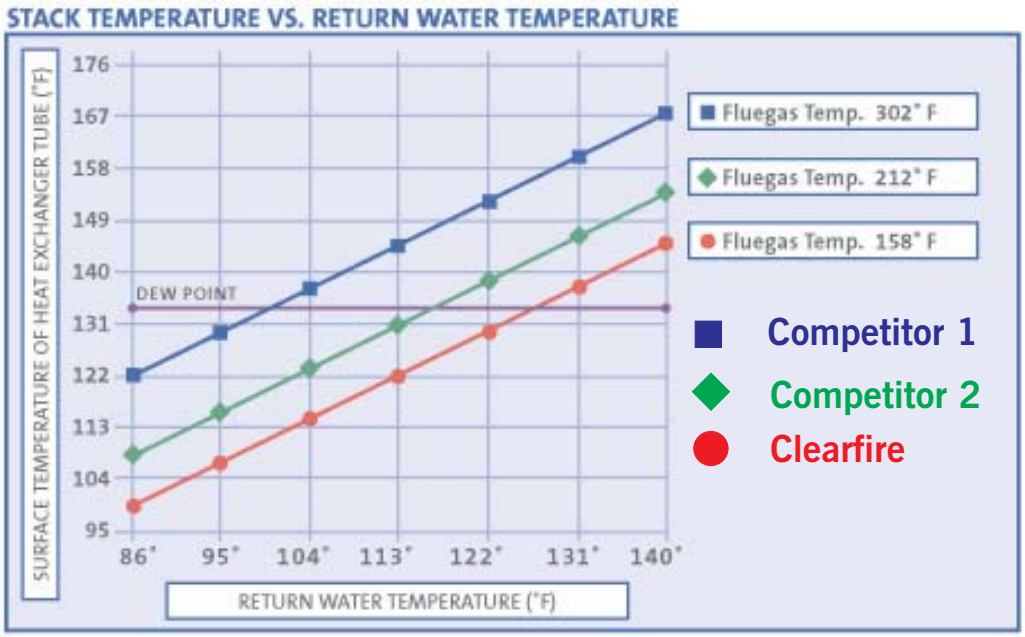


Figure B5-7. Competitive Condensation Analysis

ClearFire Efficiencies

The Tables below depict the operating efficiencies of each size Model CFC boiler, including radiation losses. As the Model CFC is a fully condensing boiler, maximum efficiency is obtained when operating within the condensing mode, utilizing the latent heat of condensation.

Table B5-5. CFC 500 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99.0	98.8	97.5	94.8	92.0	88.5	88.0
50	97.4	96.2	95.0	92.2	90.5	88.5	88.0
75	97.0	95.6	93.0	90.5	89.0	88.5	88.0
100	96.0	94.6	92.0	89.0	88.5	88.4	87.9

Table B5-6. CFC 750 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	98.3	97.1	93.6	91.7	90	88.0	87.5
50	96.5	95.3	91.8	89.9	88.5	88.0	87.5
75	96	94.9	91	89	88	87.5	86.5
100	94	92.7	90.5	88.5	87.8	87.0	86

Table B5-7. CFC 1000 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	97.8	94.3	92.4	90.1	88.5	88
50	98.5	96.5	93.5	90.8	89.5	88.5	87.5
75	97.5	96.2	92.5	89.5	88.3	88	87.3
100	96.5	95.8	91.5	88.9	88	87.5	87

Table B5-8. CFC 1500 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	98	96.2	94	91	88.7	88.2
50	98.2	97.5	94.3	92	90	88.5	88.2
75	98	96.5	92.1	91	89	88.5	88.2
100	97	95.3	91.5	90	88.1	87.8	87.5

Table B5-9. CFC 1800 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	98	96.5	94	91	88.5	88
50	98.3	96	93.8	91	89.8	88.5	87.6
75	98	95	93	89.5	88.9	88.3	87.3
100	97.2	94	91.5	88.9	88	87.5	87

Table B5-10. CFC 2500 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	99	97.5	95	92	88.5	88
50	99	98.5	96	93	91	88.3	88
75	98	97	95	92	89	88	87.5
100	98	97	94	91	88.5	87.6	87

Table B5-11. CFC 3300 ClearFire Efficiency

Firing Rate %	Return Water Temperature F^0 (C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20	99	98	95.7	93	90.2	88.5	88
50	98.6	97.5	94.1	92	89.6	88.5	88
75	98	96.5	93.5	91	89.2	88.5	87.9
100	97	95	93.1	89.8	89	88.3	87.8

Emissions

The Model CFC Boiler has been tested by an independent testing lab for Low NOx certification in California under the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1146. Meeting the requirements of SCAQMD also qualifies the boiler for meeting the NOx requirements in the state of Texas.

By means of the Pre-mix burner, the Clearfire boiler provides environmentally friendly emissions when firing natural gas; emission data are shown in Figure B5-8 through Figure B5-13.

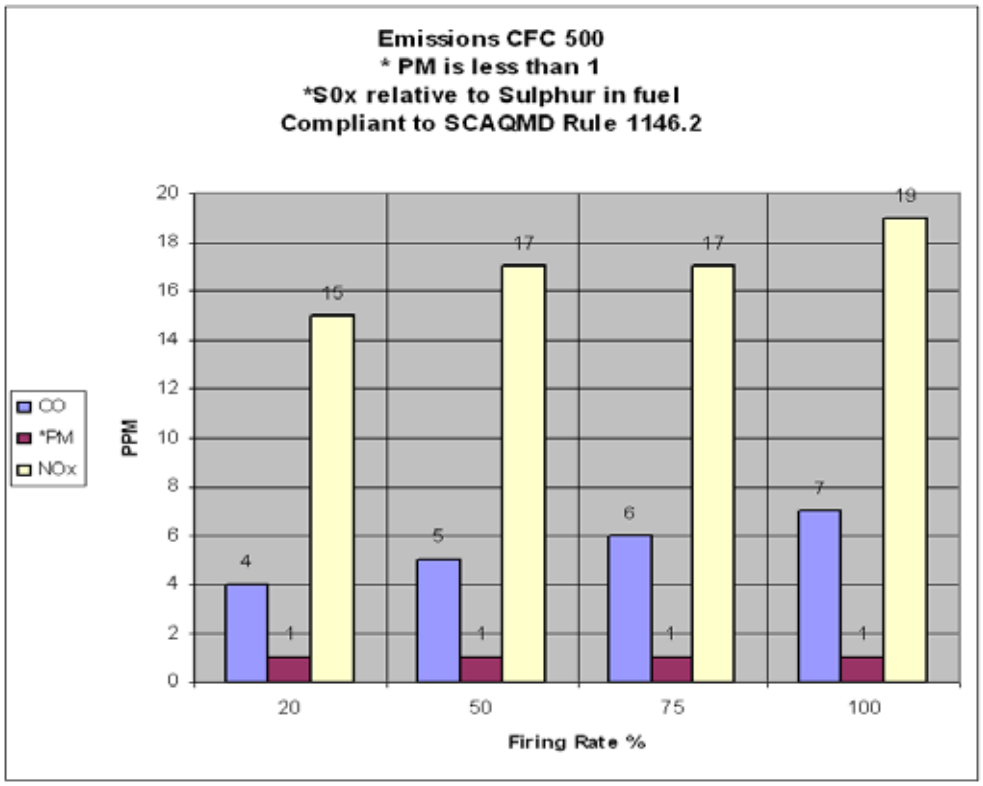


Figure B5-8. Emissions Data Clearfire Model CFC 500

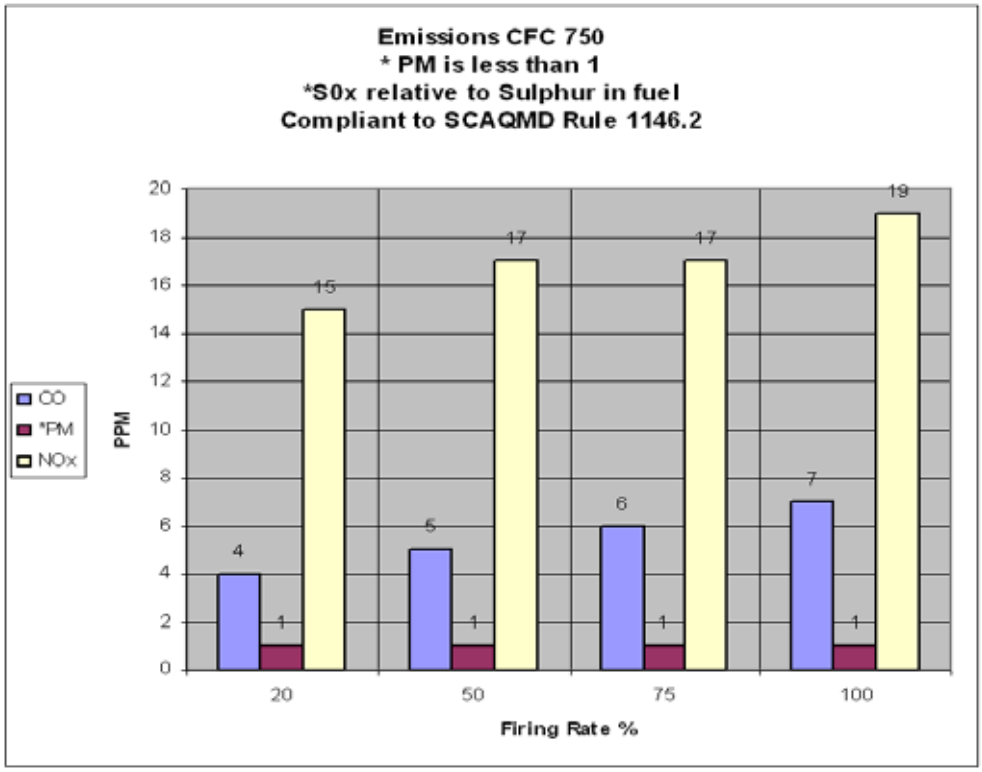


Figure B5-9. Emissions Data ClearFire Model CFC 750

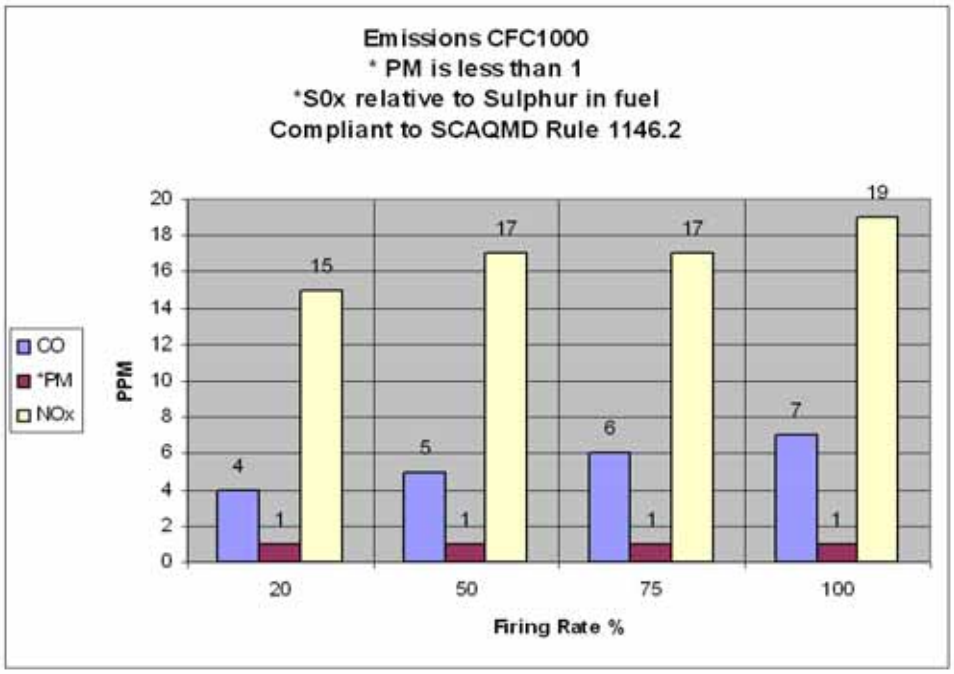


Figure B5-10. Emissions Data ClearFire Model CFC 1000

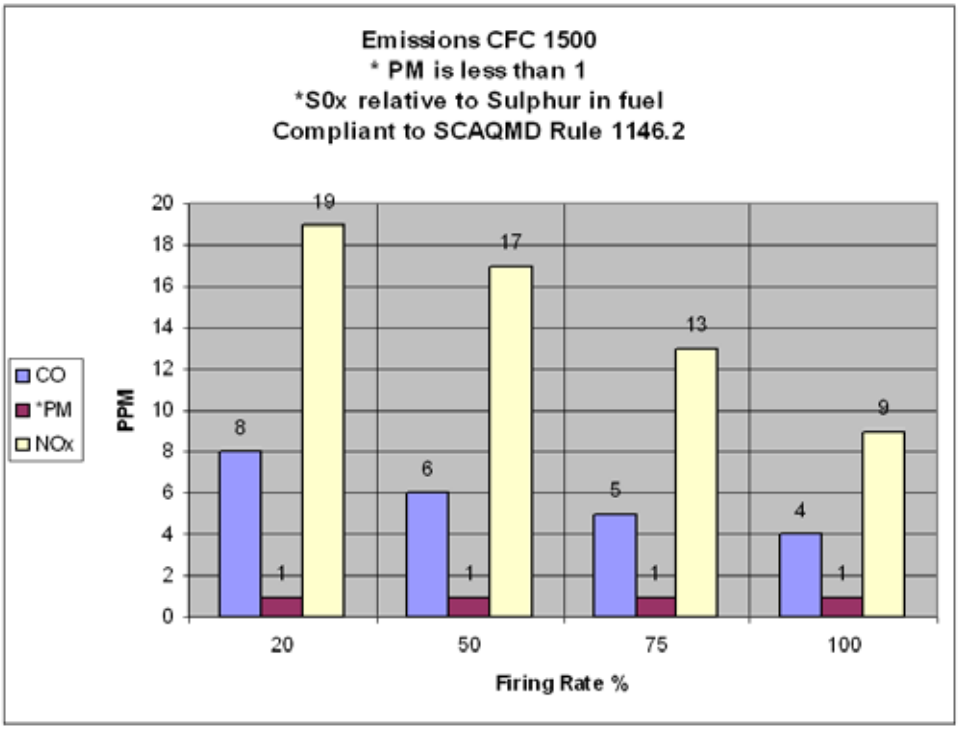


Figure B5-11. Emissions Data ClearFire Model CFC 1500

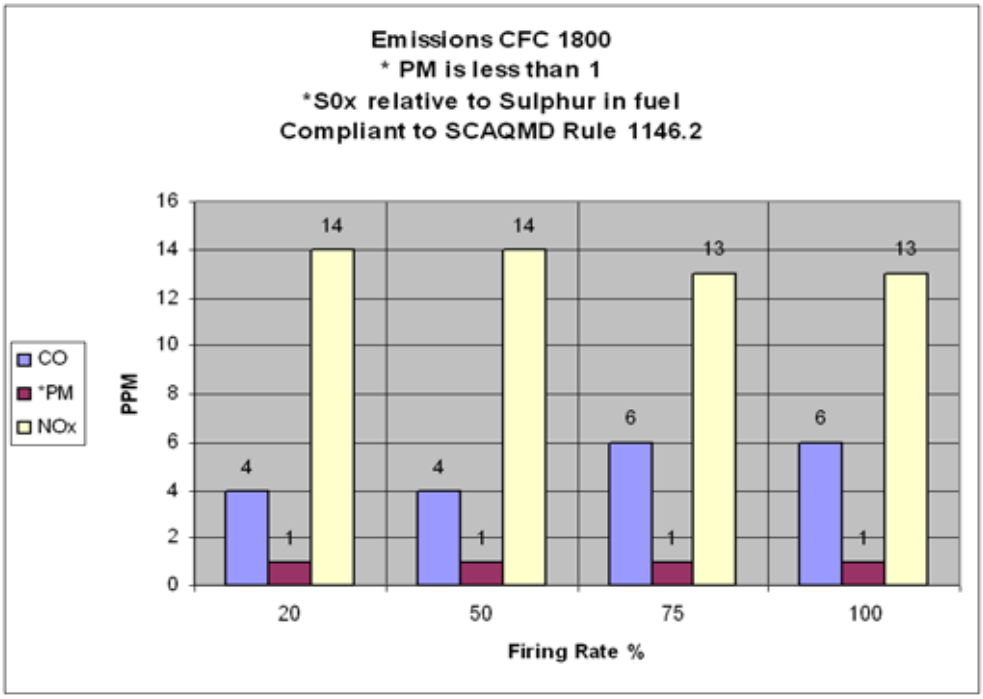


Figure B5-12. Emissions Data ClearFire Model CFC 1800

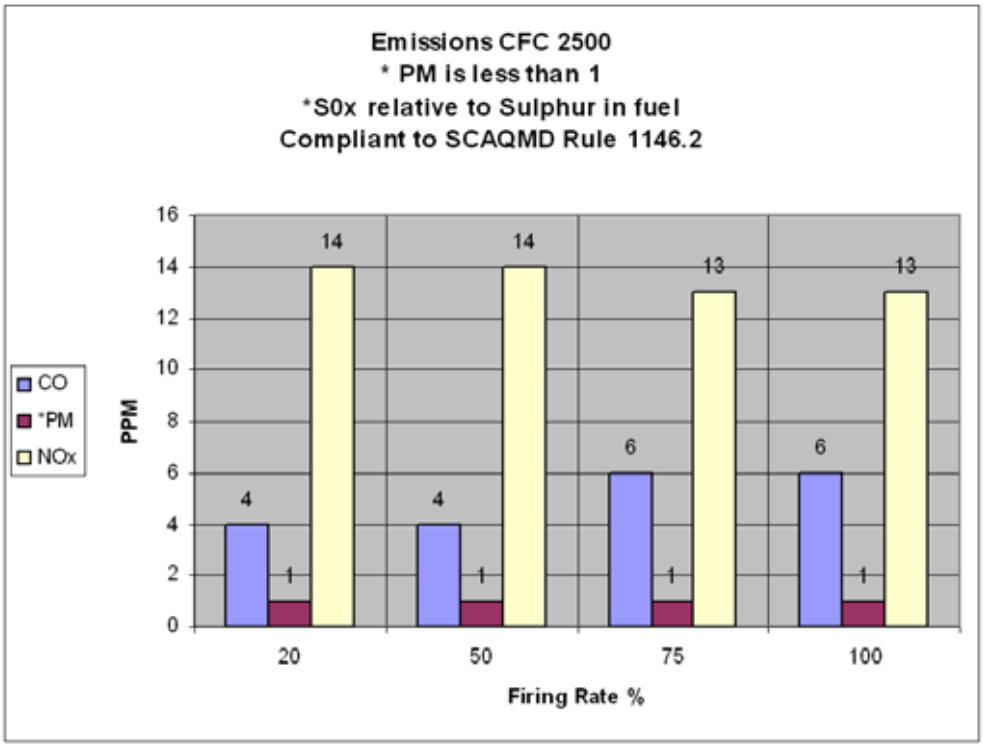


Figure B5-13. Emissions Data ClearFire Model CFC 2500

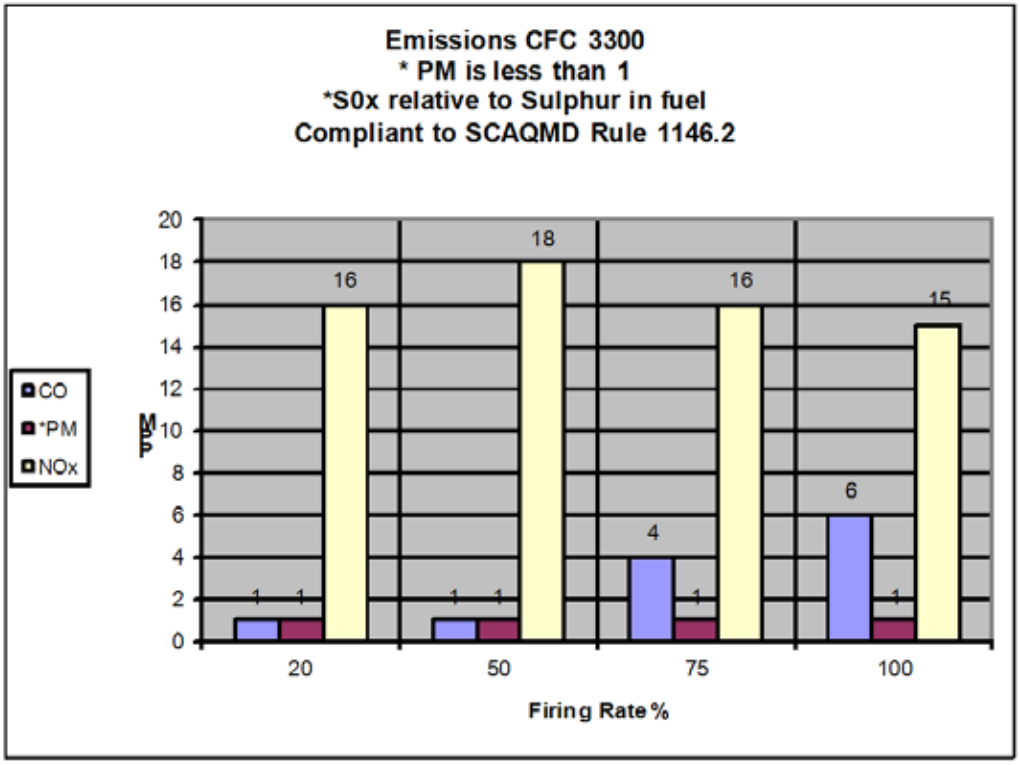


Figure B5-14. Emissions Data ClearFire Model CFC 3300

Noise Level

The Model CFC is extremely quiet at all operating levels, does not require any sound level modifications to provide ultra low noise levels, and is virtually vibration free. Thus, it is very suitable in applications that demand low noise levels.

Table B5-11 shows the noise levels of the Clearfire at various firing rates.

	20% Firing	60% Firing	100% Firing
CFC 500	39	48	60
CFC 750	41	51	62
CFC 1000	43	57	66
CFC 1500	40	50	64
CFC 1800	45	56	66
CFC 2500	45	57	68
CFC 3300	63	73	78

Table B5-11. Noise Level (dBA) measured 3 feet in front of boiler

ENGINEERING DATA

Boiler Information

The Model CFC boiler is designed for service in any closed hydronic system and can be used to augment any hot water system. It can be put into operation as a single stand-alone unit with 5:1 turndown or in multiple units for larger turndown and capacity.

Clearfire boilers may be utilized in water heating systems with temperatures from 40◦ F (4.4◦ C) to 195◦ F (90.5◦ C); ideal for ground water source heat pump applications, etc. Because the Clearfire is a full condensing boiler, low water temperature (below the dewpoint) restrictions do not apply. In fact, the lower the return the better the fuel savings.

Variable temperature differentials can be designed to make use of changing outdoor conditions and thus, the Clearfire is not restricted to a nominal 20◦ F (10 C) differential. The boiler is designed to withstand thermal stresses with supply and return temperature differences up to 100◦ F (55◦ C), without the use of a boiler-circulating pump, blend pump or minimum water flow.

Note: The Clearfire does not require a minimum flow or continuous flow through it during operation. However, the load imposed on the boiler must be considered when sizing the system flow so that the flow does not exceed the capacity of the boiler or the demand.

Flow Rates and Pressure Drops

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 B5-12 through Table B5-13 can be used to determine the full boiler output relative to system temperature drop and the maximum recommended system pump flow. Knowing the flow rate, the pressure drop through the boiler can be found in Figure B5-14 through Figure B5-19.

System Operating Parameters

To prevent water flashing to steam within the boiler or system, hot water boilers must operate with proper over-pressure. System over-pressure requirements are shown in Table B5-14.

Note: The ASME Code Section IV limits the maximum setting of the excess temperature control to 210° F (98.9° C) for boilers constructed with stainless steel. This is to ensure that water temperature will not reach the boiling point (steaming) and therefore, so as not to exceed the maximum limit of this control and in compliance with the Code, the operating limit of 195° F

(90.5° C) is set for normal boiler operation.

While proper overpressure is required, a means to relieve excess pressure at or beyond the design pressure of the boiler must be provided. As boiler water is heated, expansion occurs. And this expansion must be accounted for either with an expansion tank (air filled) or with a bladder type tank. These devices permit the water pressure to expand outside of the boiler and not impact the pressure vessel or pressure relieving device. But, in accordance with Code, each boiler is equipped with an ASME approved safety relieving device should pressure build-up occur (See Table B5-16 and Table B5-15).

Air Venting

The elimination of entrained air is required. It is recommended that each unit be piped to an expansion tank. If this is not possible, then an auto air vent should be provided on the vent connection of the boiler. The caveat in using an auto vent is that free oxygen can be introduced to the vesel as the boiler cools, or in some instances the vent can become plugged.

Table B5-12. CFC Flow Rates

System Temperature Drop ^{0} F												
	10	20	30	40	50	60	70	80	90	100	110	120
Boiler Size	**Flow Rate GPM**											
500	95	48	33	24	19	16	12	11	10.5	9	8	7
750	131	66	44	33	26	22	19	16	15	13	12	11
1000	176	88	59	44	35	29	25	22	20	18	16	15
1500	260	130	87	65	52	43	37	33	29	26	24	23
1800	351	176	117	88	70	59	50	44	39	35	32	30
2500	470	235	157	118	95	79	67	59	52	48	43	39
3300	620	310	207	155	124	103	89	78	69	62	56	52

Flow rate as a function of Delta T at 94% efficiency and maximum firing capacity

Table B5-13. CFC Flow Rates (Metric)

System Temperature Drop ^{0} C												
	5	11	17	22	27	33	38	45	50	55	61	64
Boiler Size	Flow Rate m^3 /hr.											
500	21.6	10.9	7.5	5.4	4.3	3.6	2.7	2.5	2.3	2	1.8	1.6
750	29.75	15	10	7.5	6	5	4.3	3.6	3.4	2.9	2.7	2.5
1000	40	20	14	10	8	7	6	5	4.5	4	3.6	3.4
1500	59	29.5	20	15	12	10	8.4	7.5	6.6	6	5.4	5.2
1800	80	40	27	20	16	13	11.3	10	9	8	7.3	6.8
2500	106.7	53.4	36.7	26.8	21.6	17.9	15.2	13.4	11.8	10.9	9.8	8.8
3300	141	70	47	35	28	23	20	18	16	14	13	12

Flow rate as a function of Delta T at 94% efficiency and maximum firing capacity

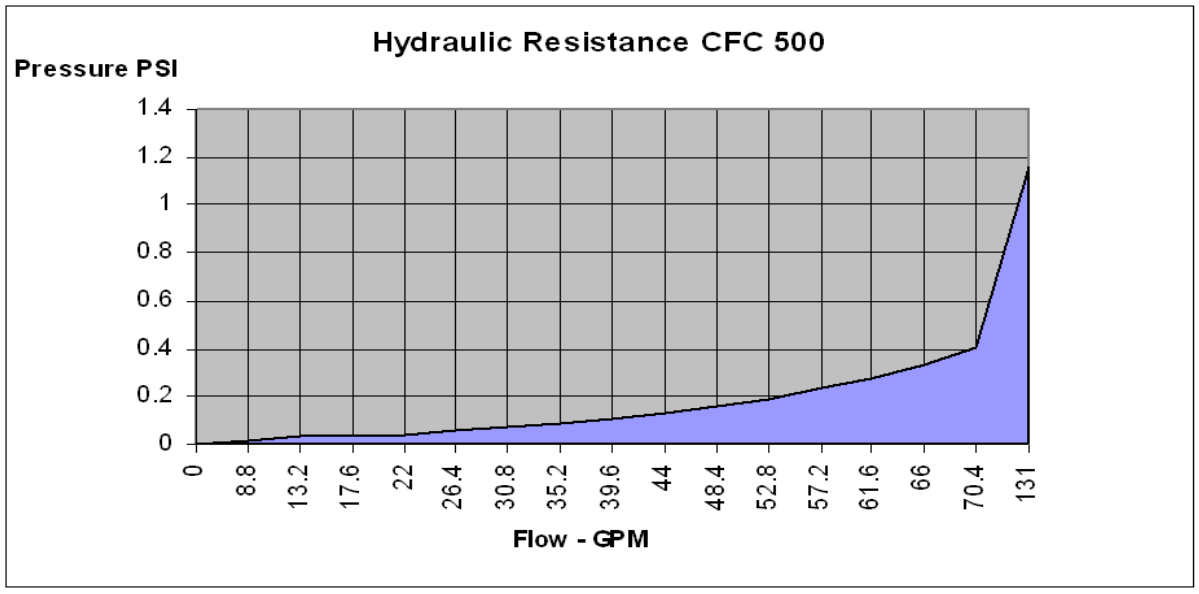


Figure B5-15. Pressure Drop Curve ClearFire Boiler Size 500

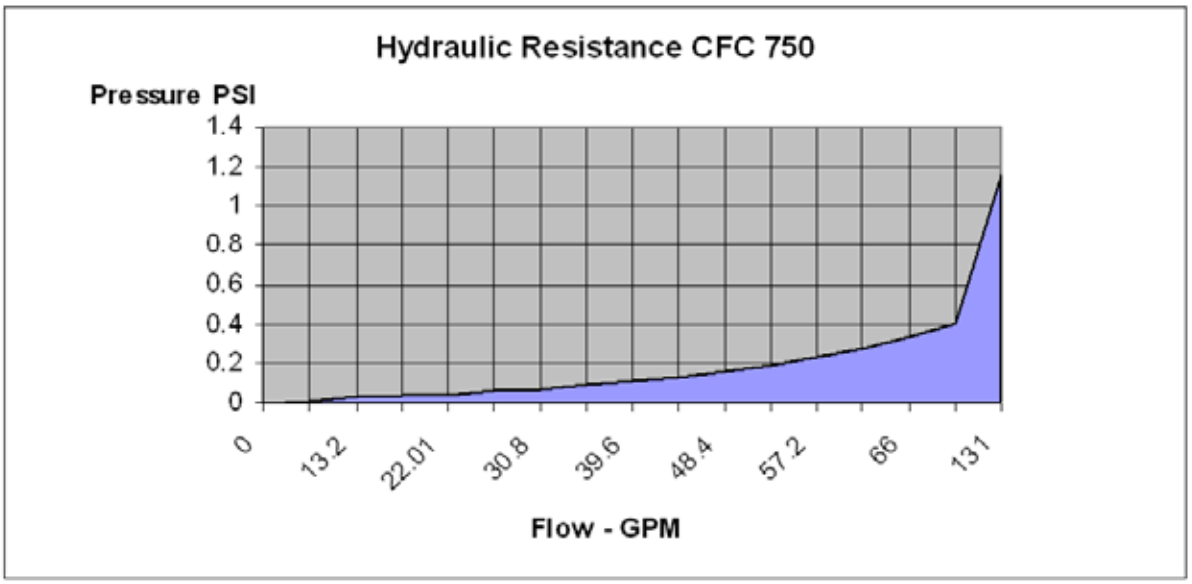


Figure B5-16. Pressure Drop Curve ClearFire Boiler Size 750

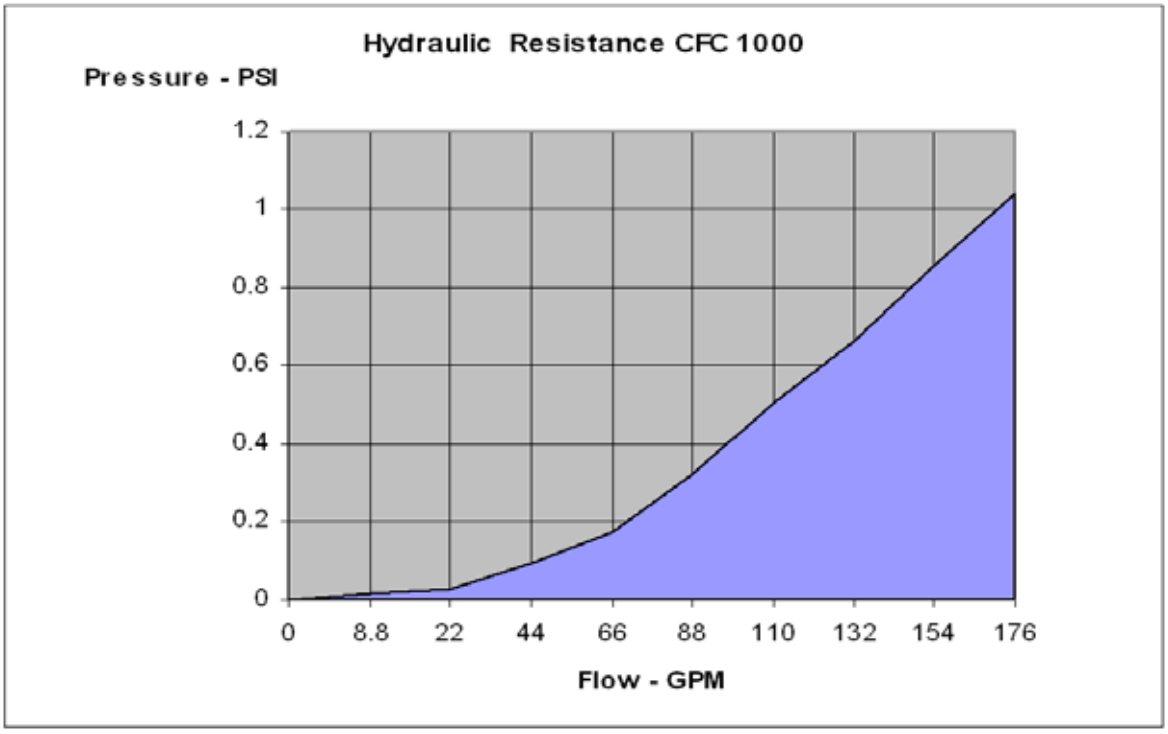


Figure B5-17. Pressure Drop Curve ClearFire Boiler Size 1000

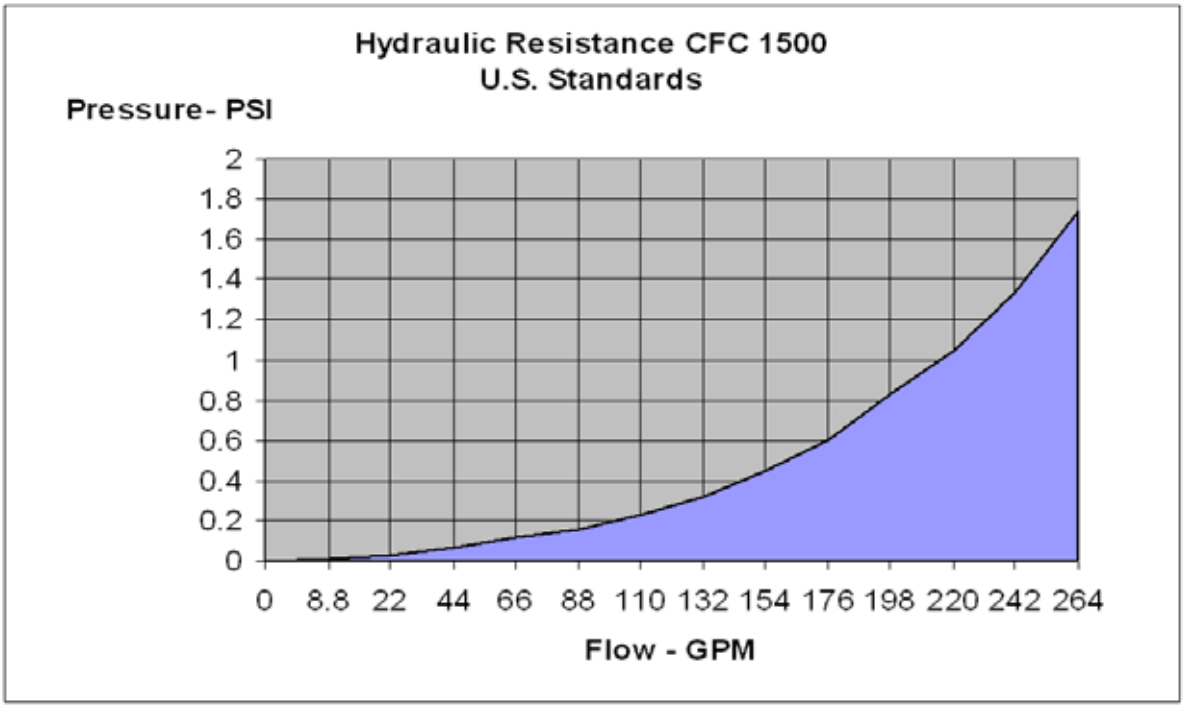


Figure B5-18. Pressure Drop Curve ClearFire Boiler Size 1500

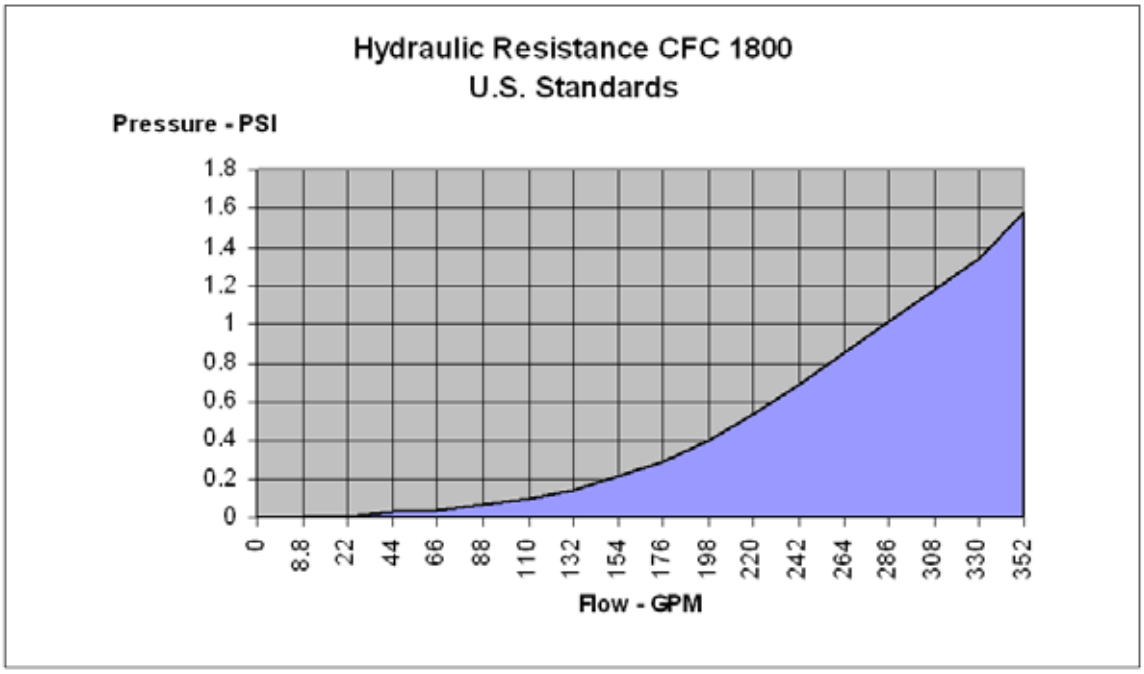


Figure B5-19. Pressure Drop Curve ClearFire Boiler Size 1800

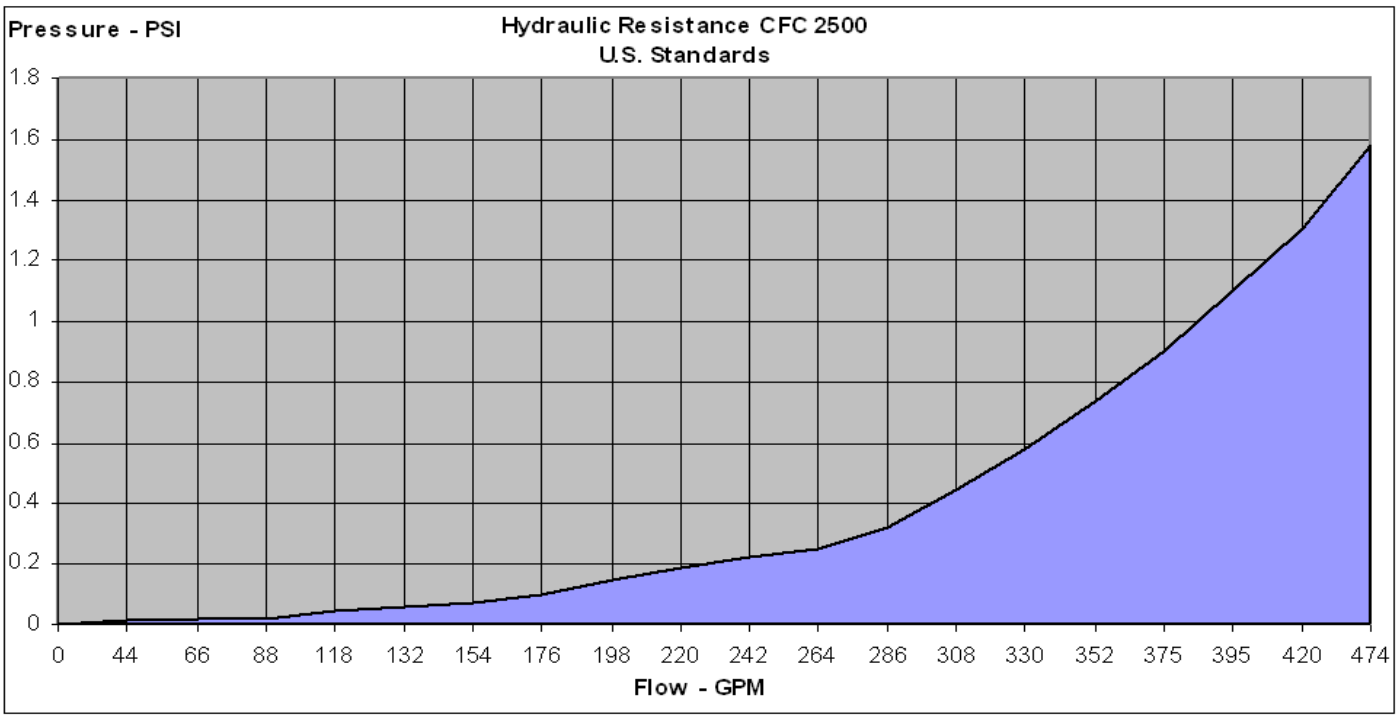


Figure B5-20. Pressure Drop Curve ClearFire Boiler Size 2500

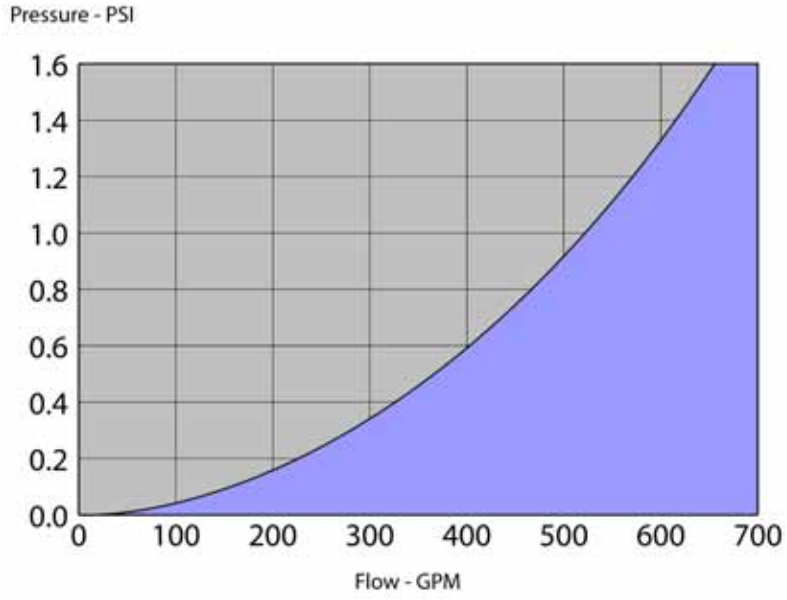


Figure B5-21. Pressure Drop Curve ClearFire Boiler Size 3300

Table B5-14. Model CFC Minimum Over Pressure Requirements

Outlet Water Temperature ^{0} F (C)	Minimum System Pressure PSIG (Bar)
80 - 180 (27 - 82)	12 (0.83)
181 - 185 (83 - 85)	15 (1.03)
186 - 195 (86 - 91)	18 (1.24)

Table B5-15. Model CFC Boiler Safety Valve Information @ 125 PSIG

Boiler Size	Valve Connection @ Boiler	Valve Setting 125 psig		Relie Valve Capacity (MBH)
		No. Valves Req'd	Outlet Size	
500	3/4”	1	1”	3364
750	3/4”	1	1”	3364
1000	3/4”	1	1”	3364
1500	3/4”	1	1”	3364
1800	3/4”	1	1”	3364
2500	3/4”	1	1”	3364
3300	3/4”	1	1”	3364

Table B5-16. Model CFC Boiler Safety Valve Information @ 60 PSIG

Boiler Size	Valve Connection @ Boiler	Valve Setting 60 psig		Relief Valve Capacity (MBH)
		No. Valves Req'd	Outlet Size	
500	3/4"	1	1"	1784
750	3/4"	1	1"	1784
1000	3/4"	1	1"	1784
1500	3/4"	1	1"	1784
1800	1"	1	1-1/4"	2788
2500	1"	1	1-1/4"	2788
3300	1-1/2”	1	2”	5913

Water Treatment

Even though hot water systems are "closed", some amount of make-up water (up to 10%) will be introduced. This more often than not happens from seal leaks of pumps, or other minimal leaks from valves etc., that go unnoticed. Therefore, proper water chemistry of a hot water boiler is necessary for good operation and longevity, particularly to ensure that free oxygen is removed to prevent waterside corrosion (see Table B5-17).

Table B5-17. Model CFC Water Chemistry Requirements in accordance with ABMA

Parameter	Limit
Glycol	50%
pH	8.3 - 9.5
Nitrates	50 mg/liter
Sulphates	50 mg/liter
Chloride	30 mg/liter
Oxygen	0.1 mg/liter
Specific Conductivity	3500 mmho/cm
Total Hardness	<10 ppm

Glycol

The Model CFC boiler may be operated with a solution of glycol and water. Where glycols are added, the system must first be cleaned and flushed. Correct glycol selection and regular monitoring of the in-use concentration and its stability is essential to ensure adequate, long-term freeze protection, as well as protection from the effects of glycol-derived corrosion resulting from glycol degradation.

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

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

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

1) Maximum allowable antifreeze proportion (volume %):
   50% antifreeze (glycol)
   50% water

2) The glycol concentration determines the maximum allowable firing rate and output of the boiler(s). Please refer to the firing rate limitation and corresponding high fire speed settings vs. glycol % in the charts below.
3) Maximum allowable boiler outlet/supply temperature: 185 deg F (85 deg C).
4) Minimum water circulation through the boiler:
   a) The minimum water circulation must be defined in such a way that the temperature difference between the boiler outlet/supply and inlet/return is a maximum of 40 deg F (22 deg C), defined as DT (Delta T). A DT Limit algorithm should be enabled in the boiler controller.
   b) Independent from the hydraulics of the heating system, constant water circulation through each boiler is required. (Requires a dedicated boiler pump if in a primary/secondary loop arrangement.) Refer to table below for minimum boiler circulation rates.
5) Minimum over-pressure at the boiler:
   For outlet temperatures up to the maximum of 185 deg F (85 deg C), a minimum operating pressure of 30 psig (2.1 bar) is required.
6) pH level should be maintained between 8.3 and 9.5

Table B5-18. Glycol Application Guidelnes - Model CFC

Minimum required boiler circulation rate (gpm) at maximum firing rate.				
ClearFire	System ΔT (˚F)			
Model-Size	ΔT = 10˚	ΔT = 20˚	ΔT = 30˚	ΔT = 40˚
CFC-500	88	44	29	22
CFC-750	131	66	44	33
CFC-1000	175	88	58	44
CFC-1500	263	131	88	66
CFC-1800	316	158	105	79
CFC-2500	438	219	146	110
CFC-3300	578	289	193	145

Notes/Limitations:
1. Maximum firing rate determined by ClearFire CFC - Glycol Firing Rate Limitation chart (below). Maximum high fire blower speed should be set according to chart.
2. Glycol concentration limit of 25%-50%. Minimum required system operating pressure is 30 psig.
3. Maximum system operating temperature of 180 ˚F. Maximum ΔT of 40˚.
4. Circulation rates correlate with boiler output based on 92% nominal efficiency.
5. Standard altitude (<1000' ASL). Contact C-B for high altitude applications.
6. Pumps should be sized based on system design ΔT and minimum required flow rates.
7. At minimum firing rate, the minimum circulation rate should correspond to the boiler's turndown.

Table B5-19. Max Firing Rate vs. Glycol Concentration

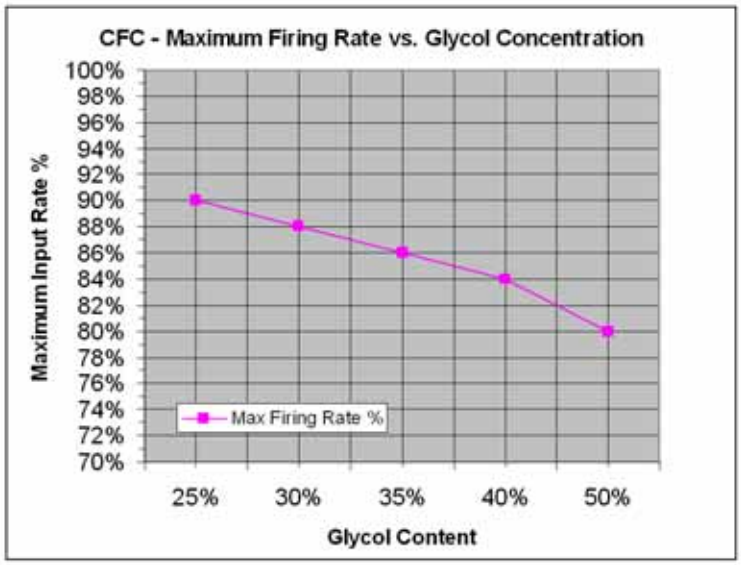
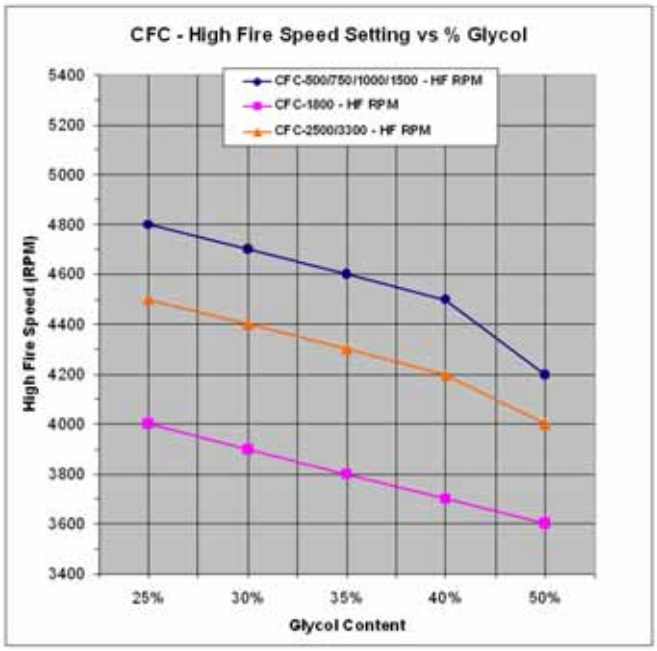


Table B5-20. HF Speed Settings vs. Glycol Content



Condensation

As the Model CFC boiler is a full condensing boiler, condensation will develop during startup of a cold boiler or at any time when the return water temperature is below the dew point or approximately 132◦ F (55.5 C).

The condensation collects in the lower portion of the boiler from the tube surfaces and from the stack, and must be discharged to a drain. A Condensate trap must be piped on the boiler and must be field piped to either a drain or to the optional condensate treatment kit. Table B5-21 provides the amount of condensation that will form when the boiler operates in the full condensing mode.

Table B5-21. Model CFC Maximum Condensation

Boiler Size	Gallons Per Hour - GPH (Liters Per Hour - L/H)
500	3.5 (13.2)
750	5 (18.9)
1000	7 (26.5)
1500	9 (34)
1800	12 (45.4)
2500	17 (64.4)
3300	22 (83.3)

Boiler Operating @ maximum in full condensing mode.

As prescribed by local codes, this condensate may be discharged directly to the drain or treated using an optional treatment assembly. Figure B5-21 depicts piping without the treatment assembly and Figure B5-22 shows the optional treatment assembly.

Condensate Piping for Multiple Boilers

The number of condensate treatment tanks required for multiple boiler installations depends on the total amount of condensate produced by the system. As a general rule, CB recommends one tank per 5 million BTU/hr of boiler capacity (5.0 MMBTU/hr). Model CFC capacities are in Table B5-22.

Table B5-22. CFC capacities

CFC Model	BTU/hr
3300	3,300,000
2500	2,500,000
1800	1,800,000
1500	1,500,000
1000	1,000,000
750	750,000
500	500,000

See Figure B5-23 and Figure B5-24 for suggested piping. A drain trap is built into the condensate tank. Make-up water must be supplied at the connection shown in order to prevent flue gas from entering an idle boiler. An internal float in the condensate tank activates the make-up water valve.

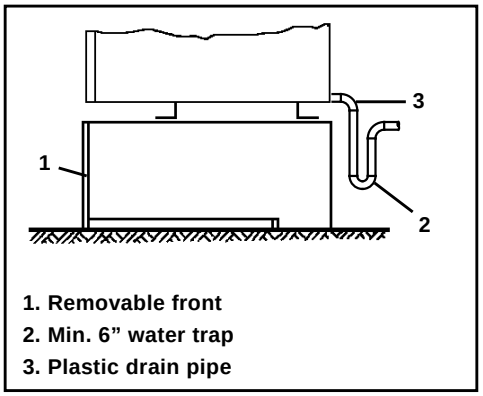


Figure B5-22. Condensate Piping Direct To Drain

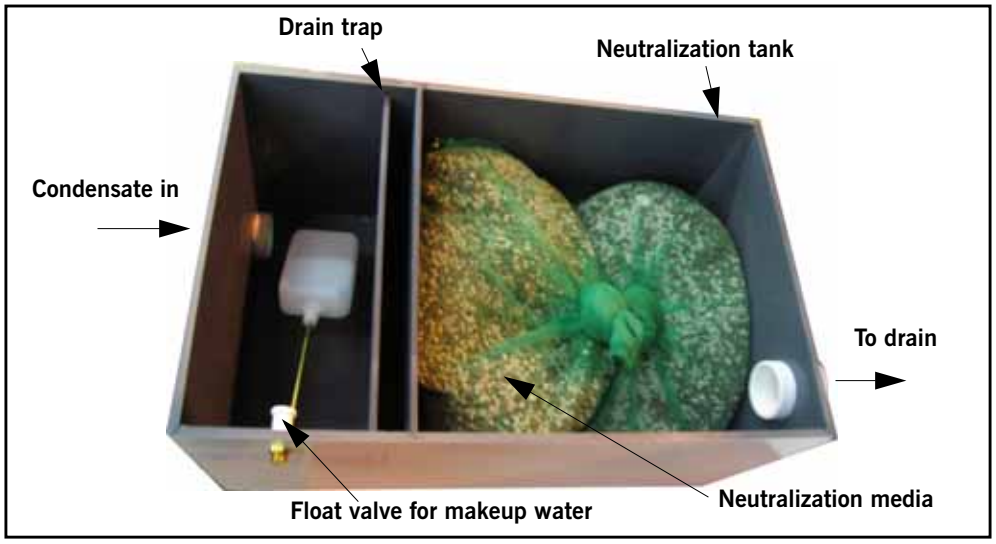


Figure B5-23. Optional Condensate Treatment Assembly

Notice

If a treatment kit is utilized, clearance at the front of the boiler must be provided for servicing the assembly and for periodically adding the neutralizing granules.

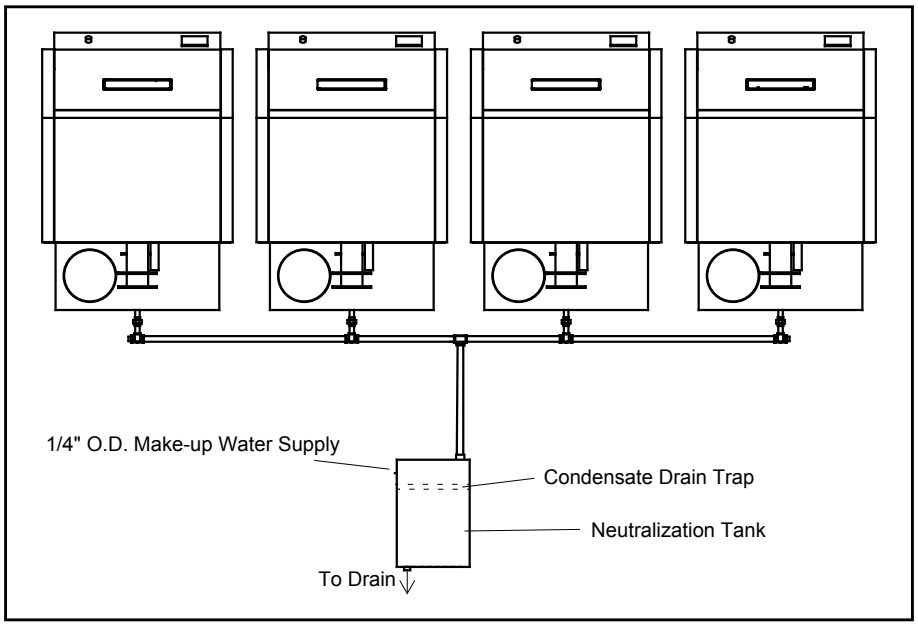


Figure B5-24. Condensate Piping for Multiple Boilers

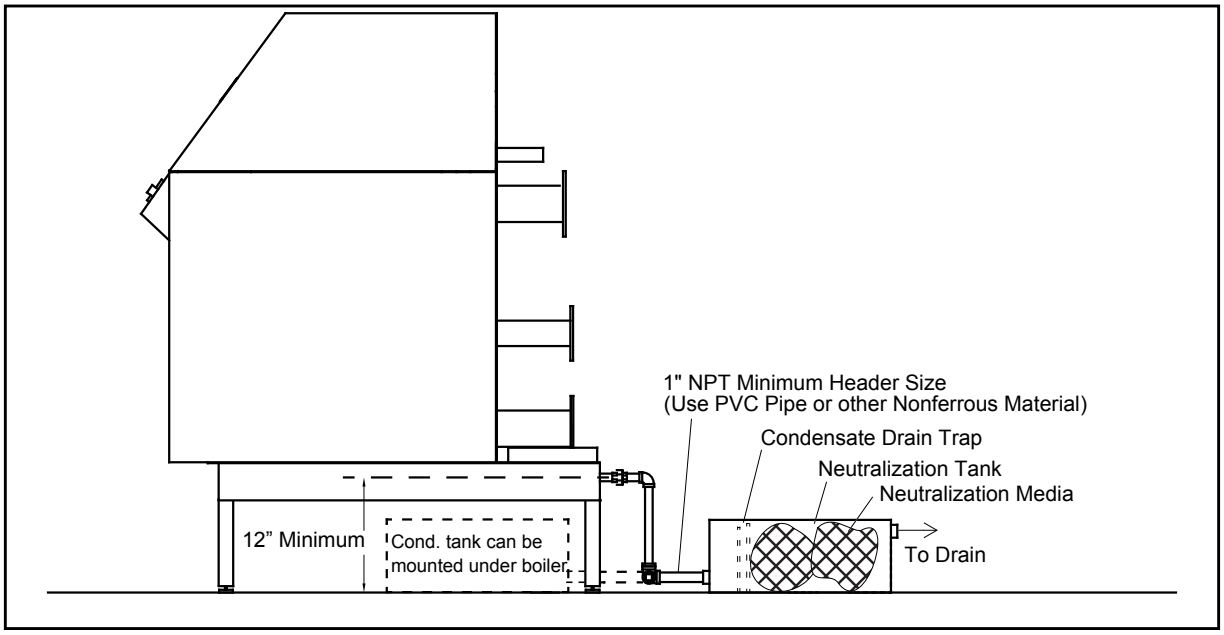


Figure B5-25. Condensate Treatment Tank for Multiple Boilers

Gas Fuel Connections

The local Gas Company should be consulted for the requirements for installation and inspection of gas supply piping. Installation of gas supply piping and venting must be in accordance with all applicable engineering guidelines and regulatory codes. All connections made to the boiler must be arranged so that all components are accessible for inspection, cleaning, and maintenance.

A ***drip leg*** should be installed in the supply line before the connection to the boiler. The drip leg should be at least as large as the gas piping connection on the boiler. See Figure B5-25, and Figure B5-26 for piping suggestions.

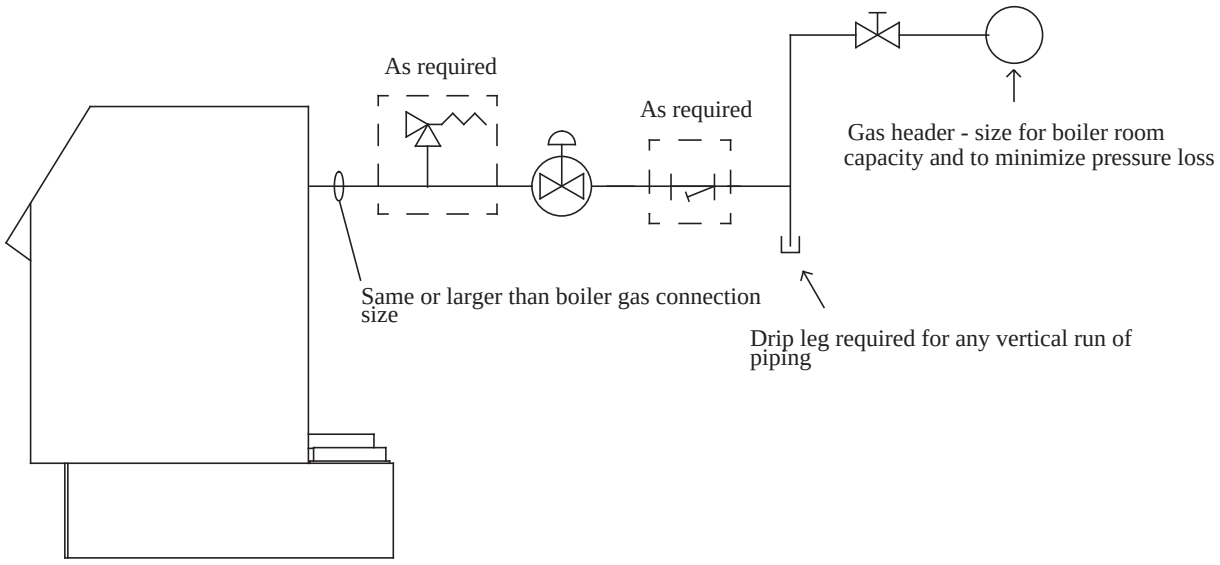
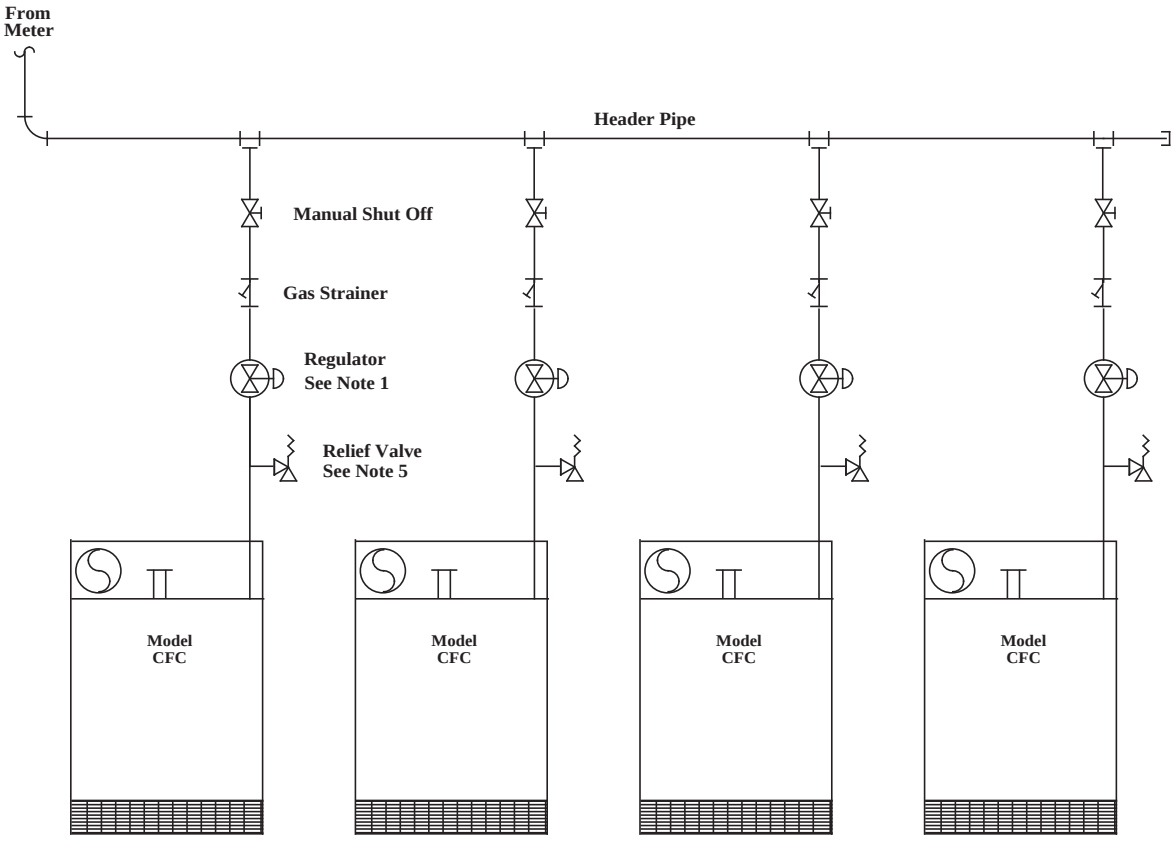


Figure B5-26. Gas Piping Schematic

Consideration of volume and pressure requirements must be given when selecting gas supply piping.

Connections to the burner gas train must include a union so that the burner may be opened for inspection and maintenance.

A. Gas supply connection is at the rear of the boiler near the top. To permit burner opening, gas piping must not traverse the top of the boiler.
B. Table B5-23 shows the gas pressure required at the inlet of the gas line. Note: a pressure regulator is not furnished and if gas pressure exceeds 14" W.C. a pressure regulator is recommended.
C. Table B5-24 shows the correction factors for gas pressure at elevations at 2000 feet and higher above sea level.



Gas Header Piping, Typical

NOTES:
1. Dedicated gas pressure regulator required for each boiler.
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 B5-27. Gas Header Piping

Table B5-24. Model CFC Minimum and Maximum Gas Pressure

Boiler Model	Minimum pressure required at gas train connection		Max. pressure
	Natural Gas	LP Gas	
500	7" w.c.	11" w.c.	28" w.c.
750	7" w.c.	11" w.c.	
1000	7" w.c.	11" w.c.	
1500	10" w.c.	11" w.c.	
1800	7" w.c.	11" w.c.	
2500	9.5" w.c.	11" w.c.	
3300	6.8" w.c.	11" w.c.	5 psi

Table B5-25. Model CFC Minimum Required Gas Pressure Altitude Correction

Altitude in Feet	Correction Factor	Altitude in Feet	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 inlet pressure, select altitude of installation and multiply the pressure shown in Table B5-24 by the correction factor corresponding to the altitude listed above.

Boiler Room Information

The boiler must be installed on a level non-combustible surface. If the surface is not level, piers or a raised pad, slightly larger than the length and width of the boiler base dimensions, will make boiler leveling possible. Installing the boiler on a raised pad or piers will make boiler drain connections more accessible and will keep water from splashing onto the boiler whenever the boiler room floor is washed.

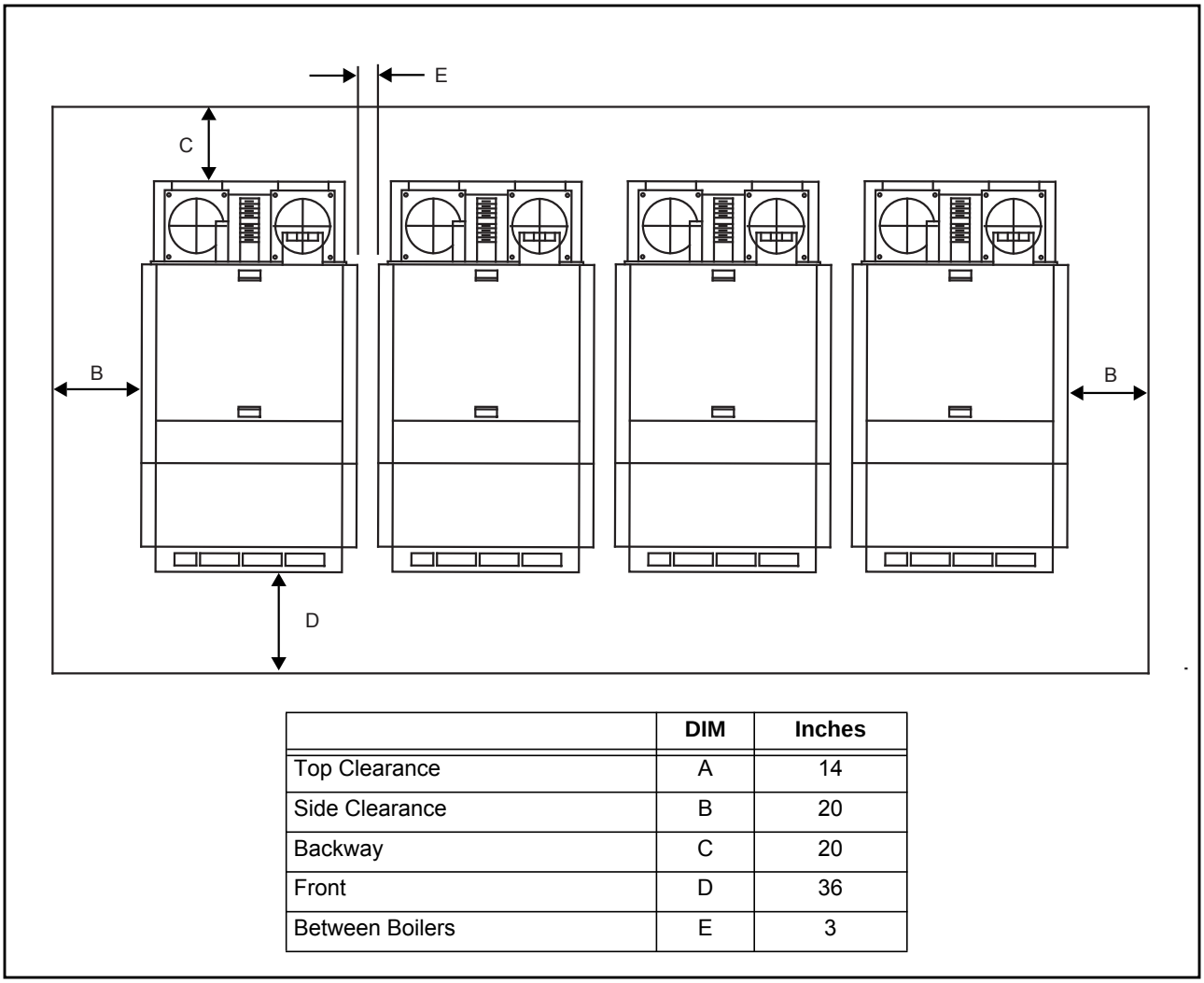
Note: The pad or piers must be of sufficient load bearing strength to safely support the operating weight of the boiler and any additional equipment installed with it. Approximate operating weights are shown in Dimensions and Ratings.

Leveling

Once the boiler is placed, it must be leveled side to side and front to back using the supply and return nozzles for horizontal and vertical positions. If shims are required to level the boiler, the weight of the boiler must be evenly distributed at all points of support. The legs may also be used for leveling.

Clearances

The boiler must be installed so that all components remain accessible; ensure no overhead obstructions so the burner may be opened. Refer to Figure B5-28.



	DIM	Inches
Top Clearance	A	14
Side Clearance	B	20
Backway	C	20
Front	D	36
Between Boilers	E	3

Figure B5-28. Model CFC Minimum Room Clearance Dimensions

Seismic Legs Seismic mounting details shown below.

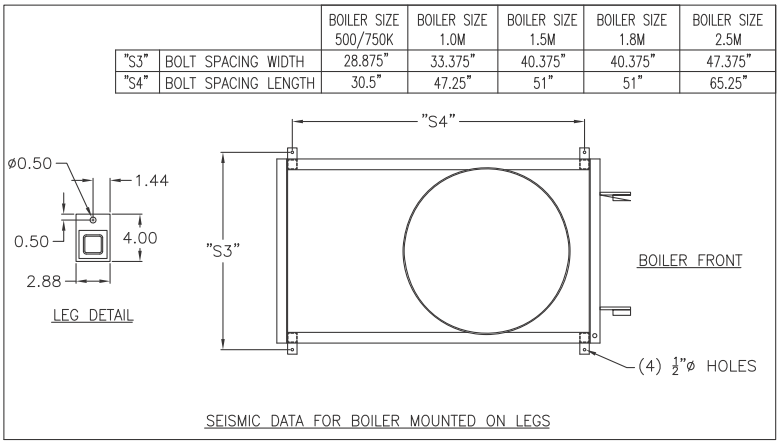


Figure B5-29. CFC Seismic Mounting

Hot Water Piping

Primary/secondary pumps are not necessary with the Model CFC boiler. As its design is such that no minimum flow is required, variable speed or on/off pumps may be employed in the piping scheme.

Typical piping arrangements are shown in figures B5-33 through B5-45.

Note: These diagrams are generic and are not intended for use in a specific design without consultation with your local Cleaver-Brooks sales representative

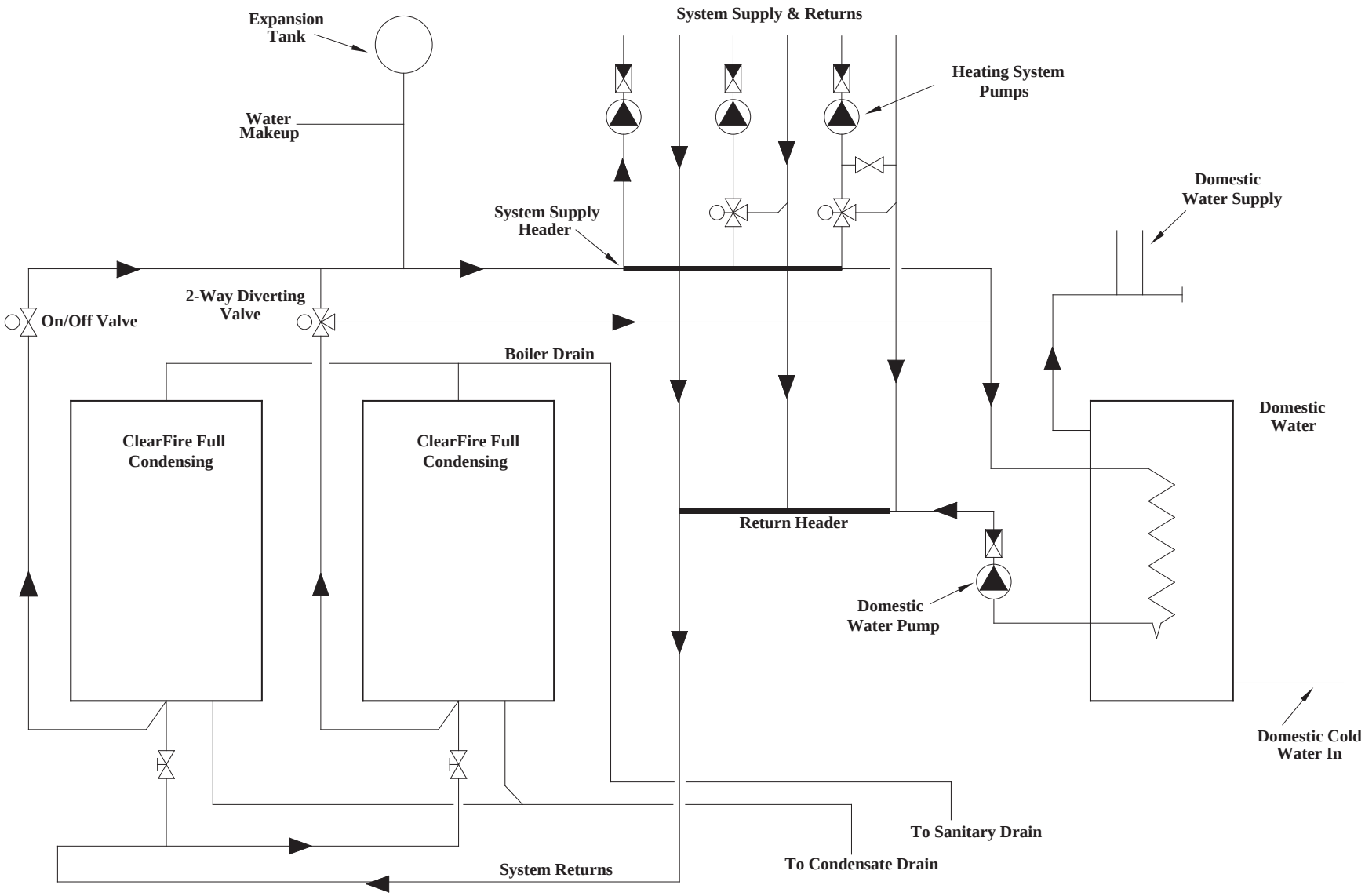


Figure B5-33. No primary Loop with Domestic Water and 2-Way Divert Valve

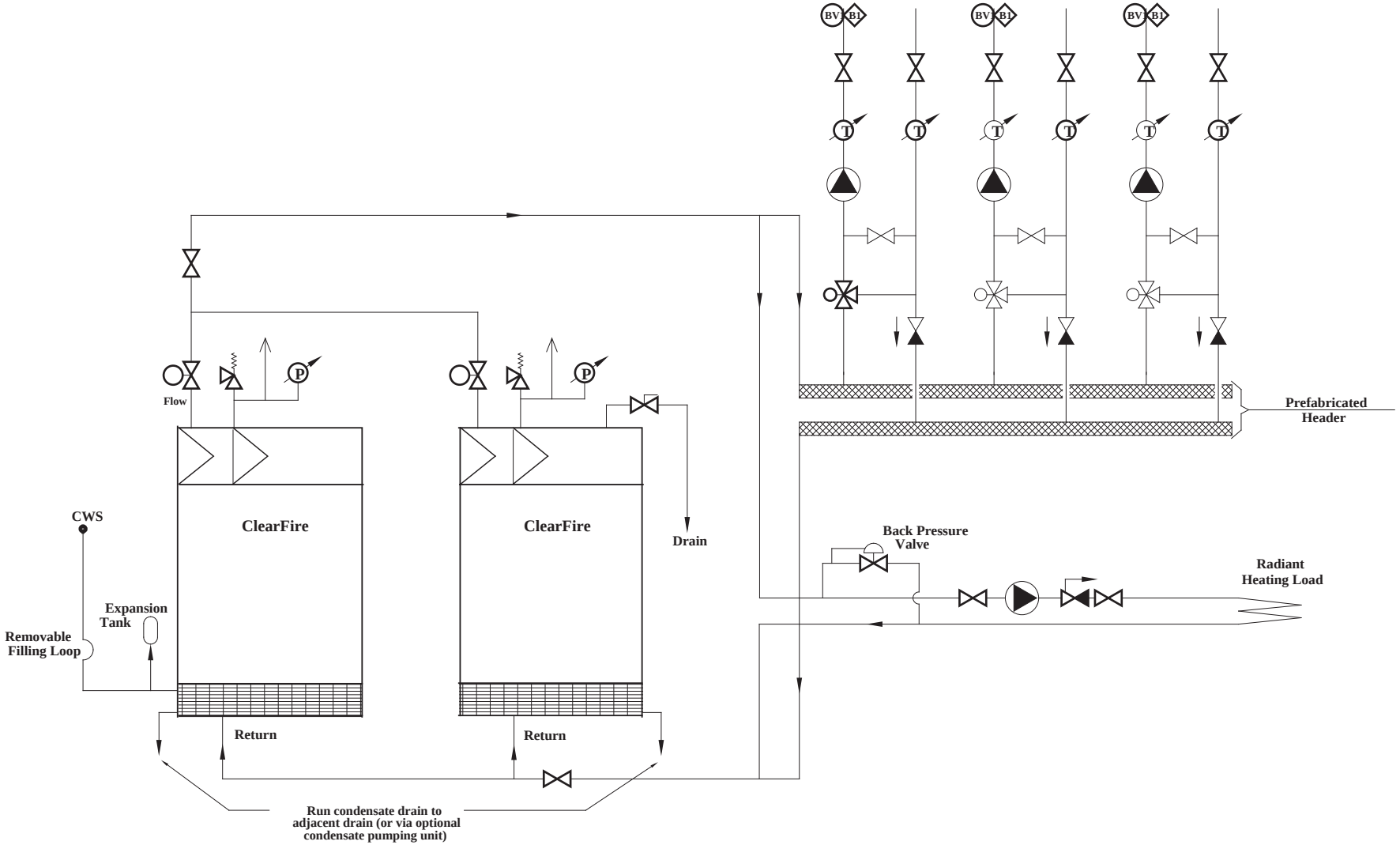


Figure B5-36. Two Boilers and Three Variable Temperature Zones (No Primary Loop)

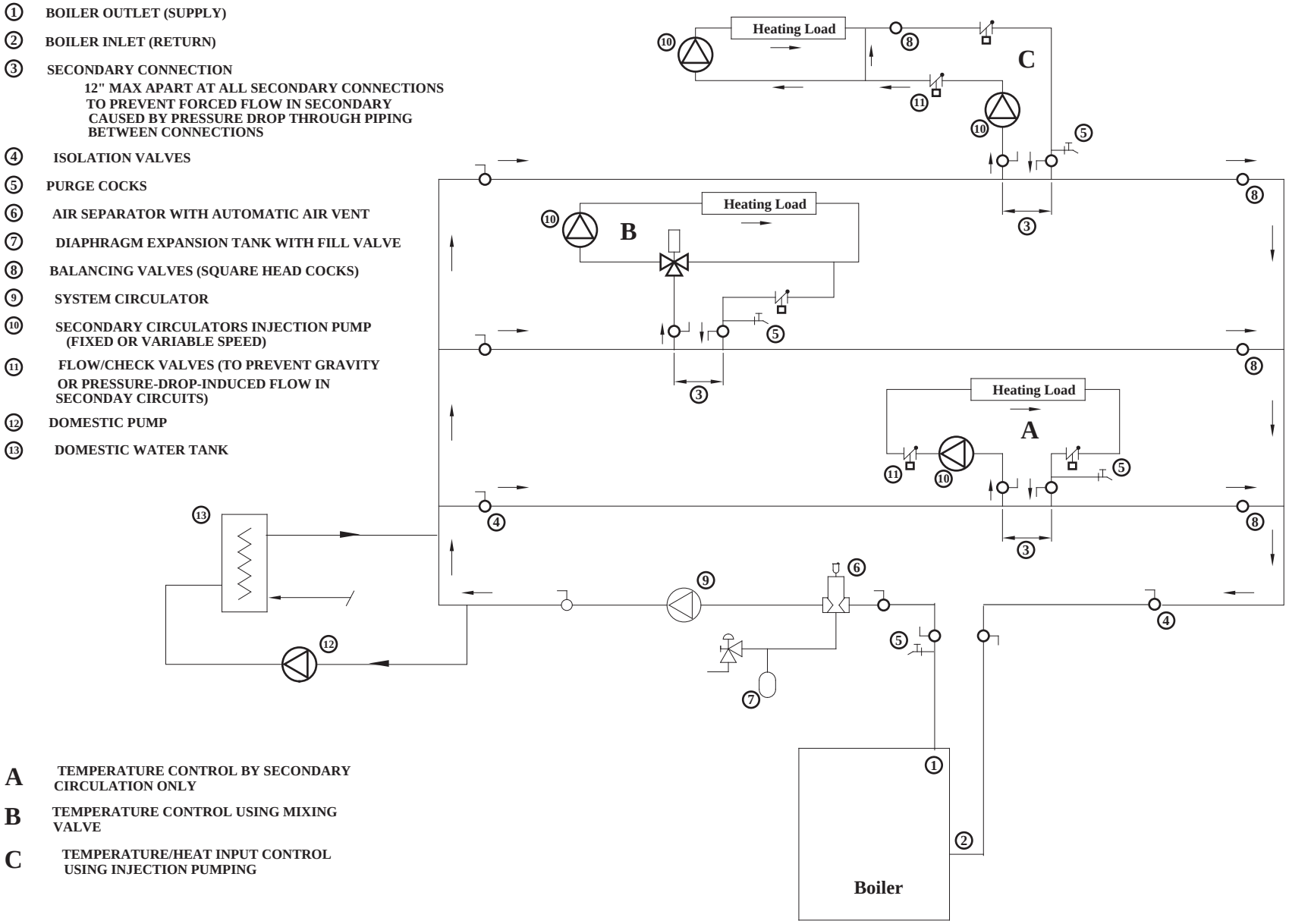


Figure B5-37. Two-Pipe Primary/Secondary Piping with Domestic Hot Water

① BOILER OUTLET (SUPPLY)

② BOILER INLET (RETURN)

③ SECONDARY CONNECTION

④ ISOLATION VALVES

⑤ PURGE COCKS

⑥ AIR SEPARATOR WITH AUTOMATIC AIR VENT

⑦ DIAPHRAGM EXPANSION TANK WITH FILL VALVE

⑧ BALANCING VALVES (SQUARE HEAD COCKS)

⑨ SYSTEM CIRCULATOR

⑩ SECONDARY CIRCULATORS INJECTION PUMP (FIXED OR VARIABLE SPEED)

⑪ FLOW/CHECK VALVES (TO PREVENT GRAVITY OR PRESSURE-DROP-INDUCED FLOW IN SECONDAY CIRCUITS)

④ 12" MAX APART AT ALL SECONDARY CONNECTIONS TO PREVENT FORCED FLOW IN SECONDARY CAUSED BY PRESSURE DROP THROUGH PIPING BETWEEN CONNECTIONS

A TEMPERATURE CONTROL BY SECONDARY CIRCULATION ONLY

B TEMPERATURE CONTROL USING MIXING VALVE

C TEMPERATURE/HEAT INPUT CONTROL USING INJECTION PUMPING

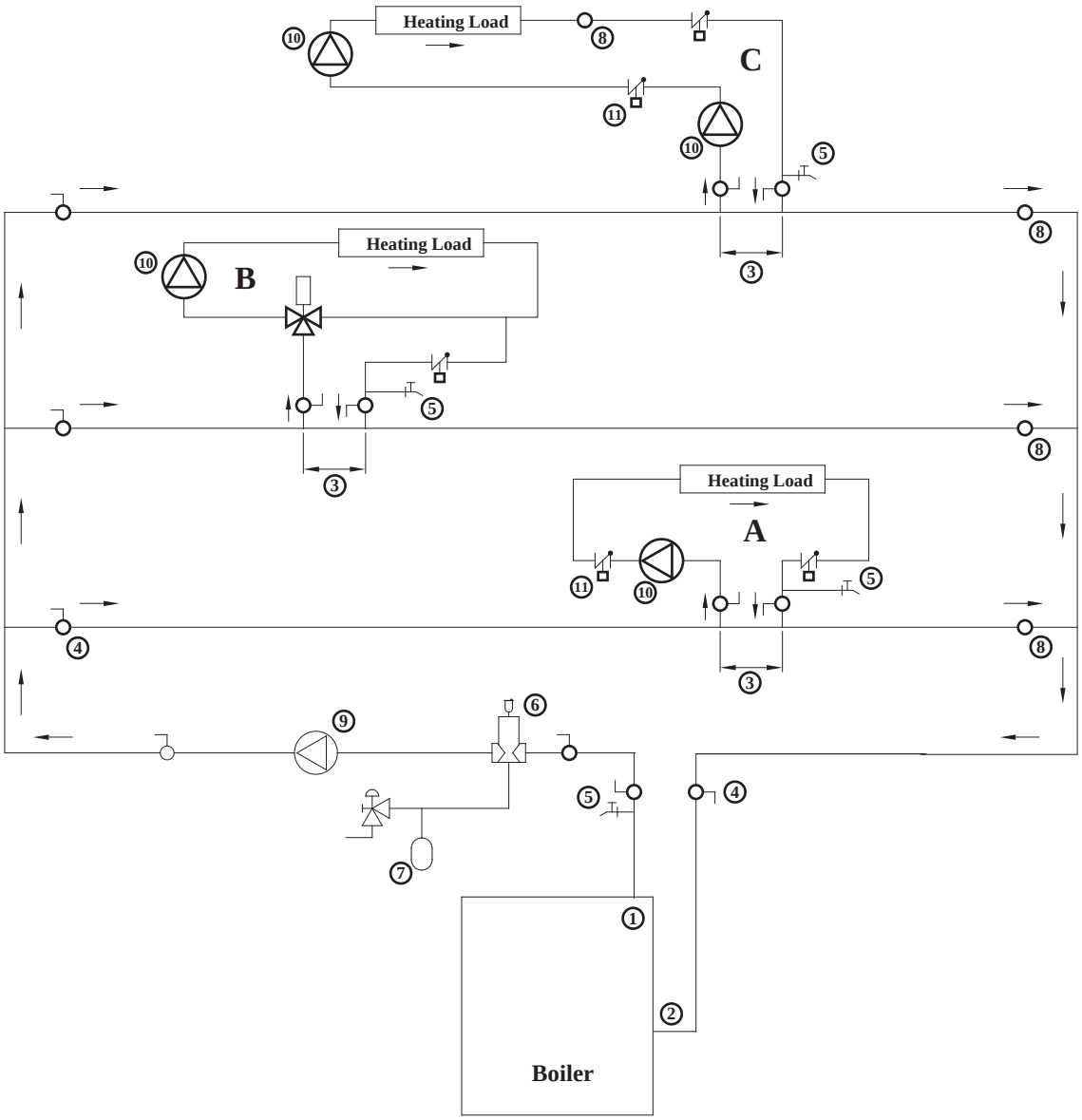


Figure B5-38. Two-Pipe Primary/Secondary Piping

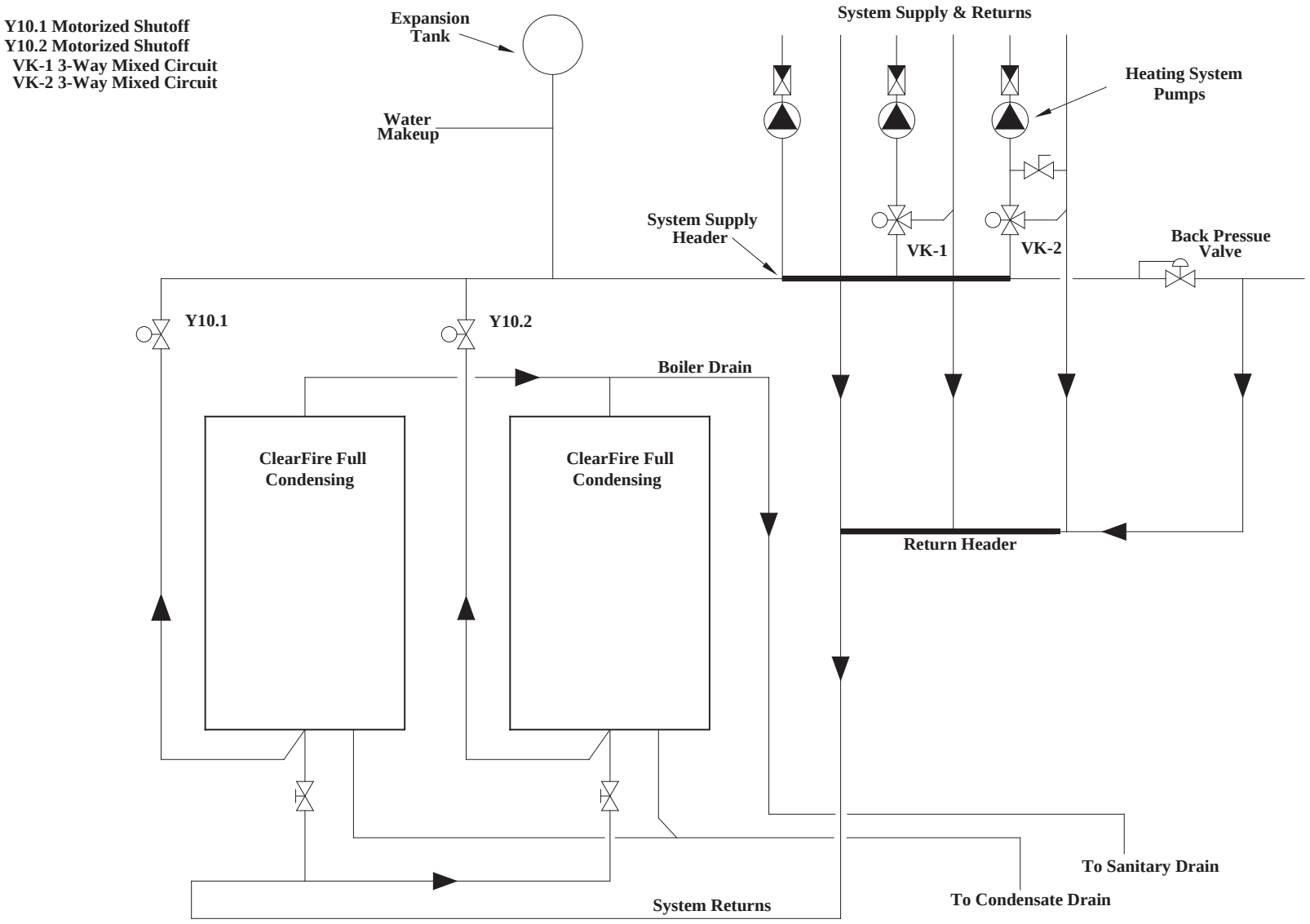


Figure B5-39. No Primary Loop

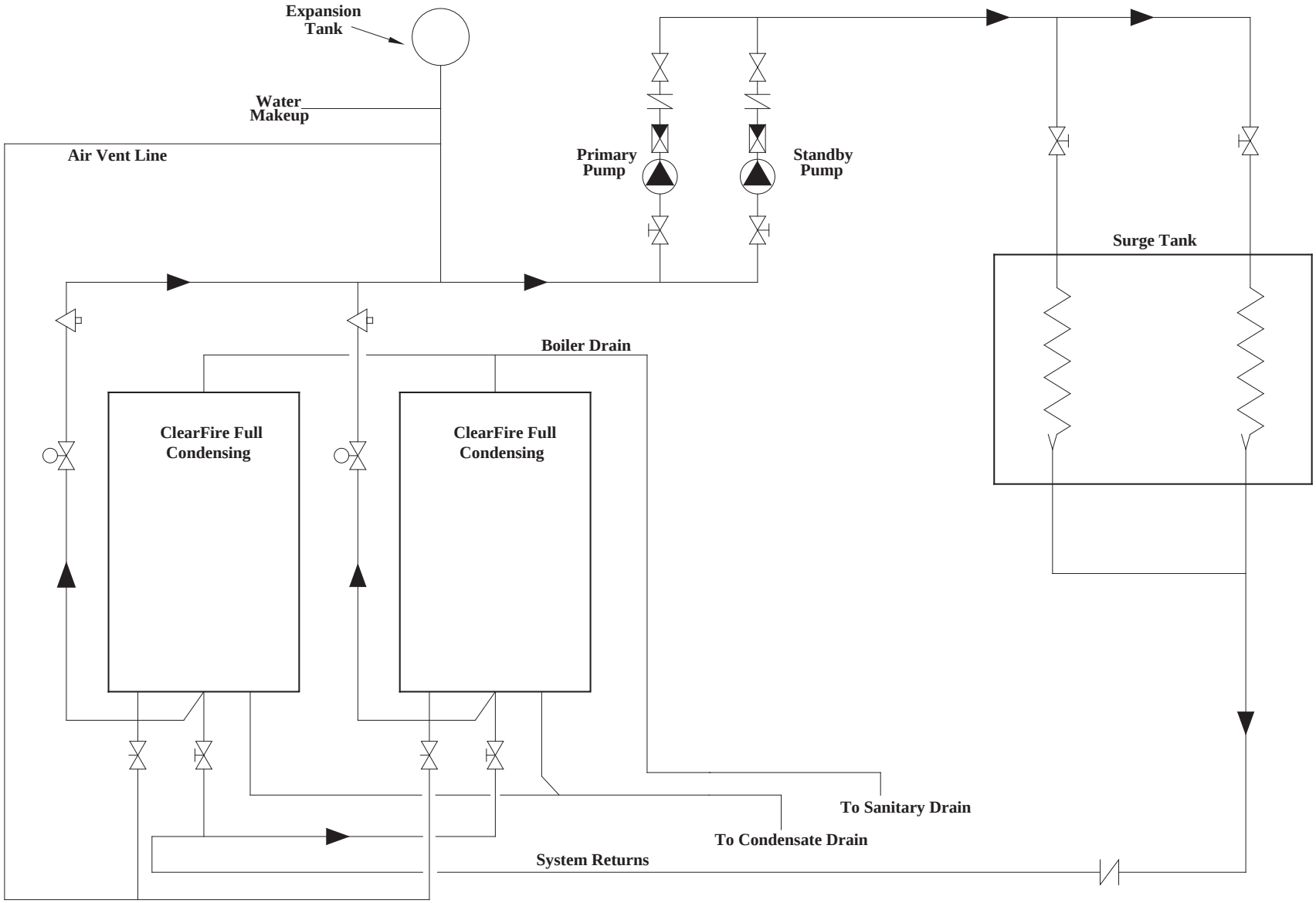


Figure B5-40. Domestic Water Heating, No Primary Loop

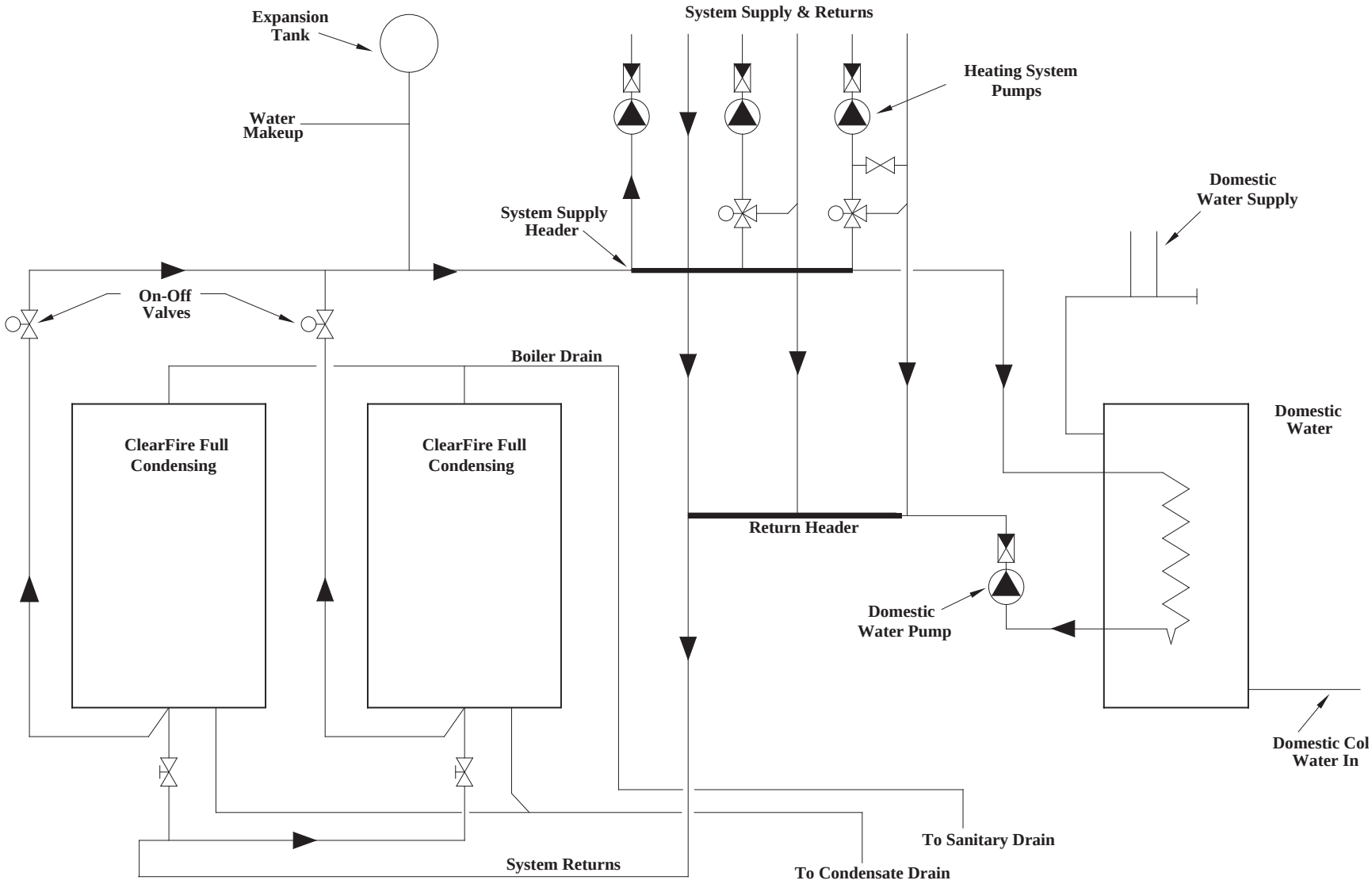


Figure B5-41. Domestic Water with On/Off and 3-Way Valves

① BOILER OUTLET (SUPPLY)
② BOILER INLET (RETURN)
③ ISOLATION VALVES
④ PURGE COCKS
⑤ AIR SEPARATOR WITH AUTOMATIC AIR VENT
⑥ DIAPHRAGM EXPANSION TANK WITH FILL VALVE
⑦ FLOW/CHECK VALVES
⑧ SYSTEM CIRCULATOR

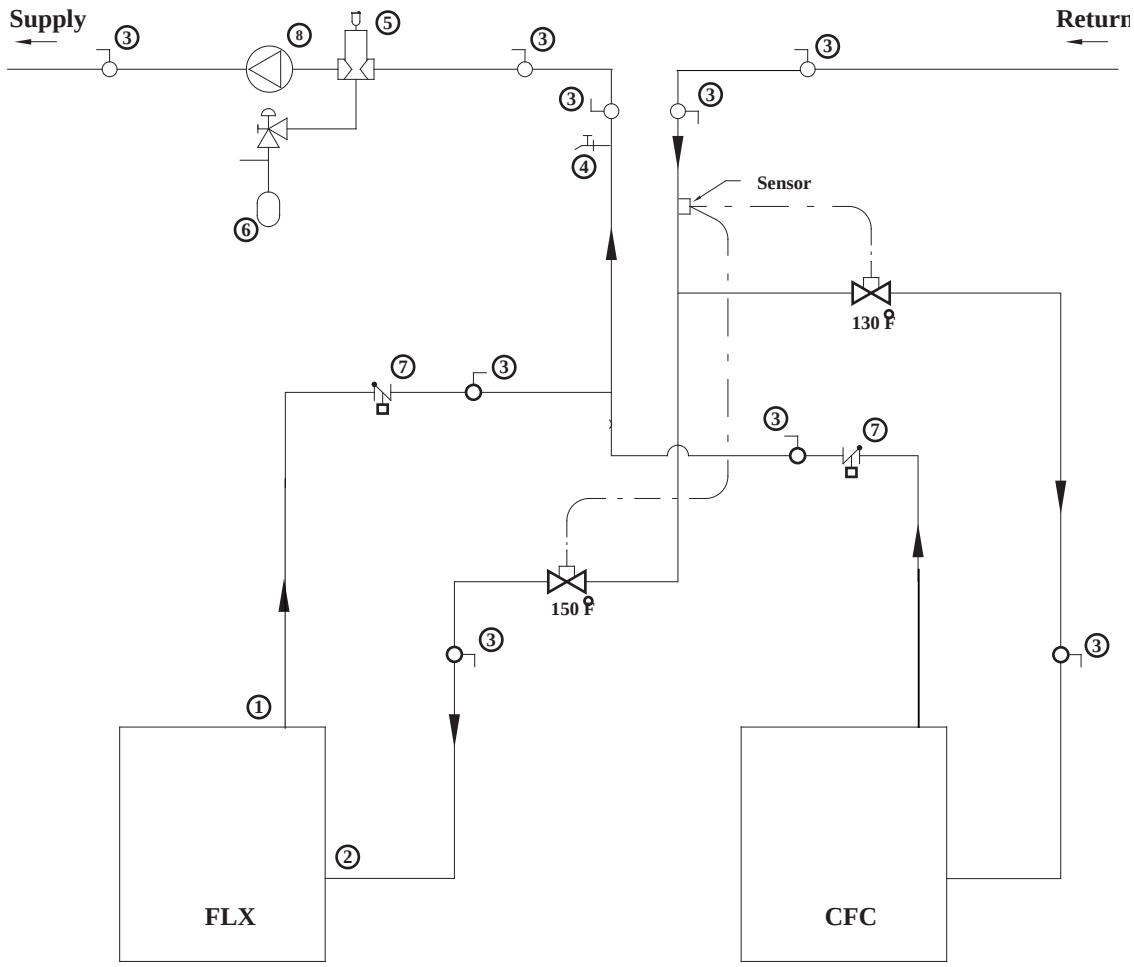


Figure B5-42. Piping 'Hybrid' Boilers

① BOILER OUTLET (SUPPLY)
② BOILER INLET (RETURN)
③ SECONDARY CONNECTION
④ ISOLATION VALVES
⑤ PURGE COCKS
⑥ AIR SEPARATOR WITH AUTOMATIC AIR VENT
⑦ DIAPHRAGM EXPANSION TANK WITH FILL VALVE
⑧ FLOW/CHECK VALVES
⑨ SYSTEM CIRCULATOR
⑩ DOMESTIC PUMP

③ 12" MAX APART AT ALL SECONDARY CONNECTIONS TO PREVENT FORCED FLOW IN SECONDARY CAUSED BY PRESSURE DROP THROUGH PIPING BETWEEN CONNECTIONS

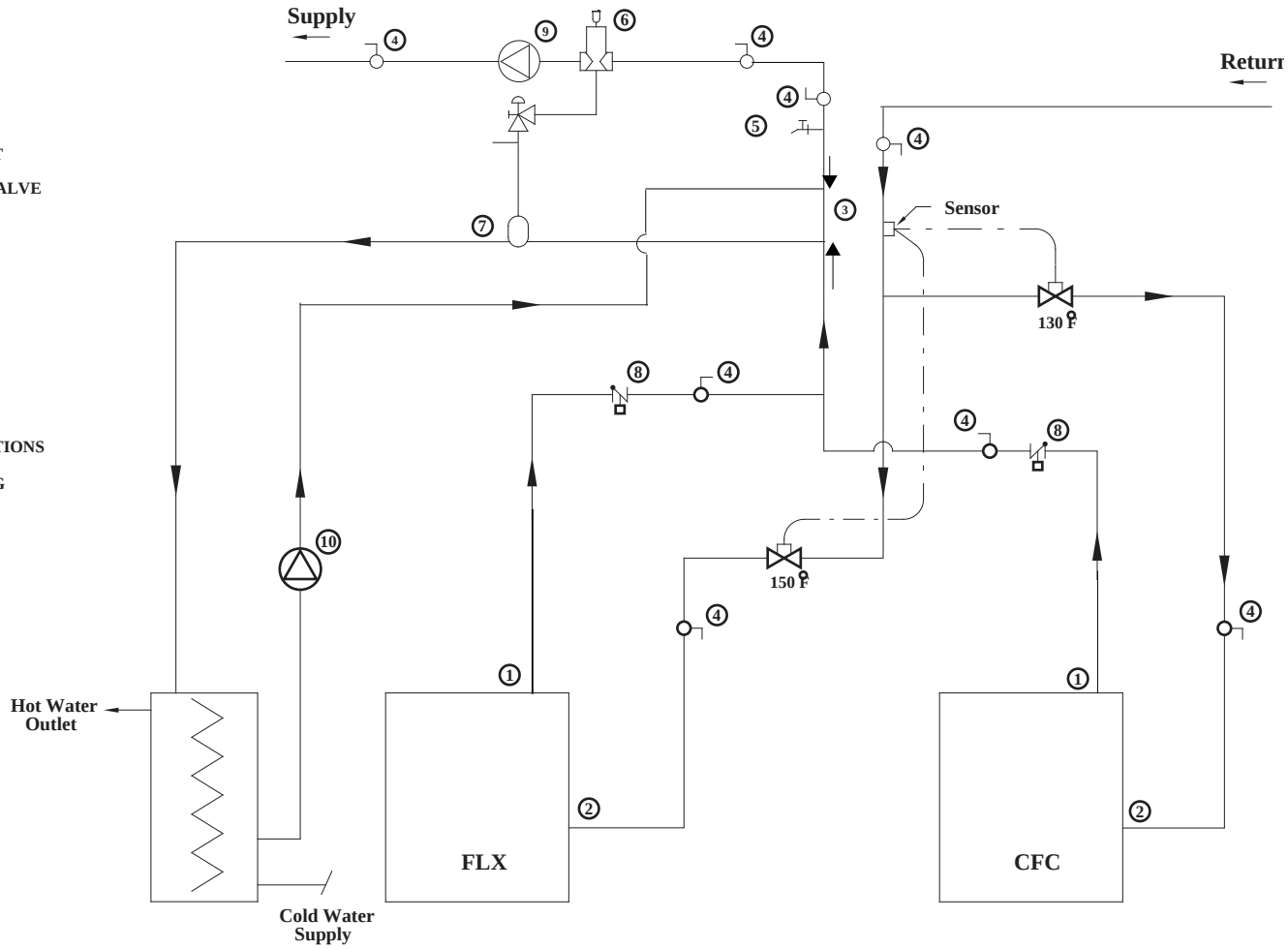
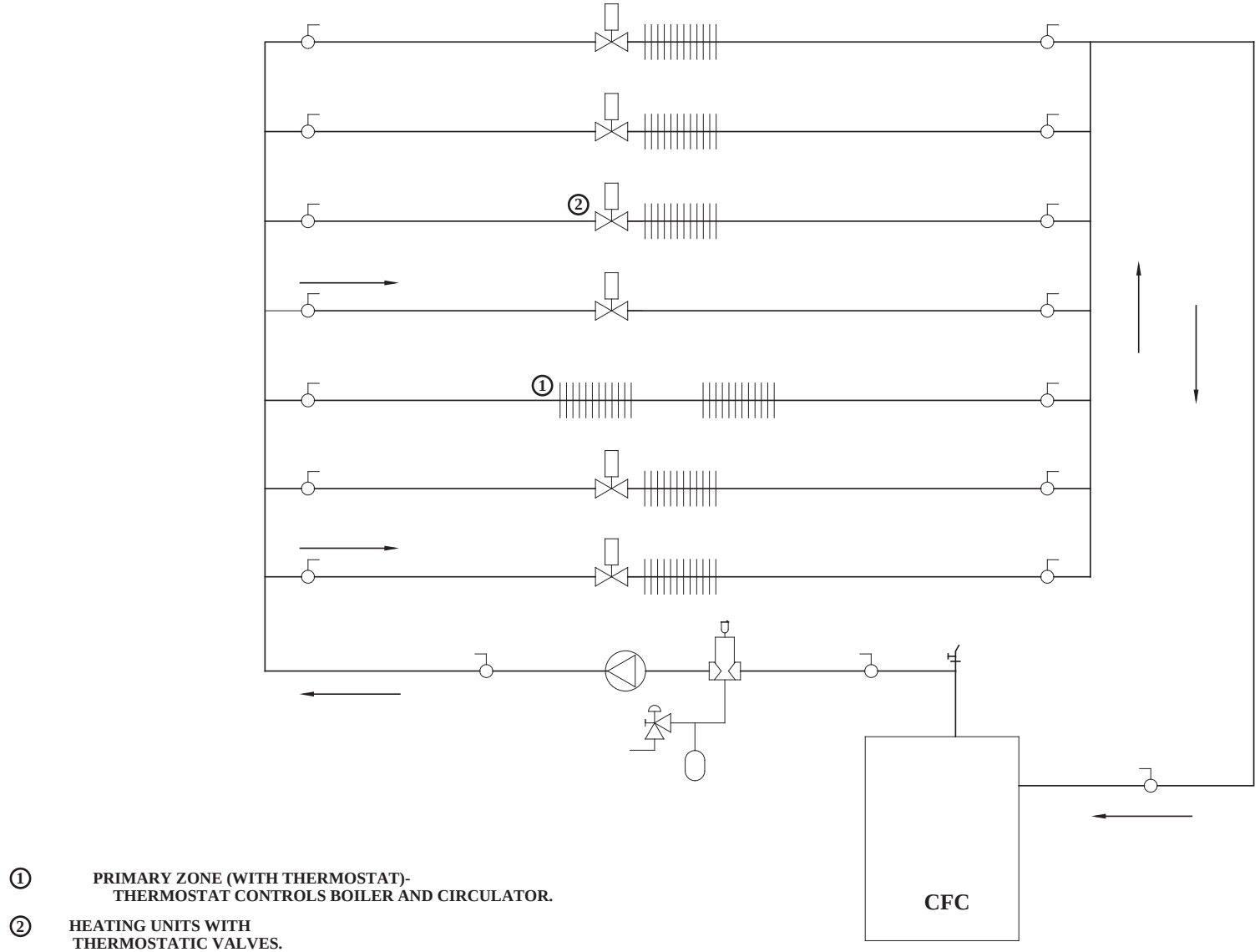


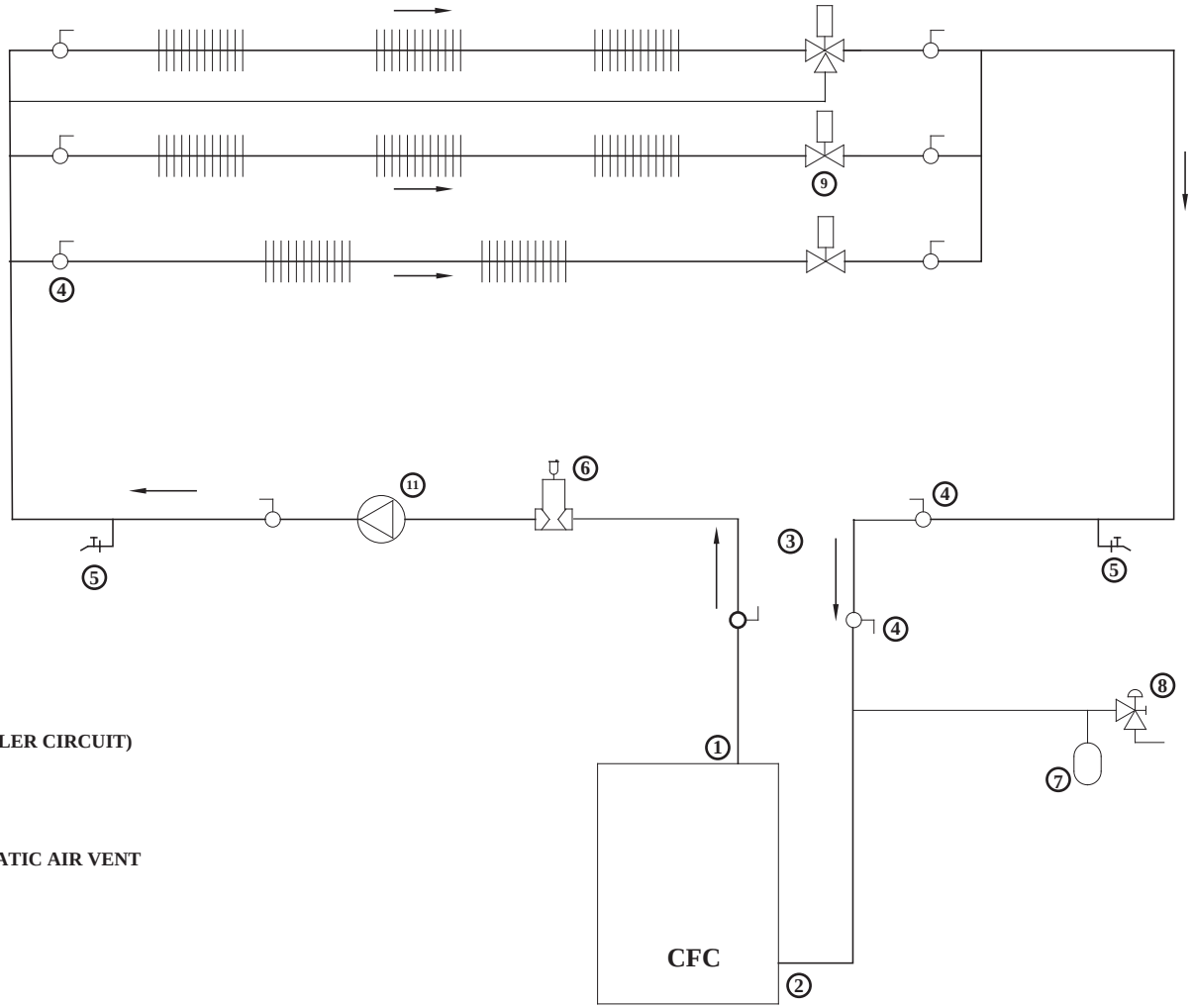
Figure B5-43. 'Hybrid' Boilers with Domestic Water



① PRIMARY ZONE (WITH THERMOSTAT)-
THERMOSTAT CONTROLS BOILER AND CIRCULATOR.

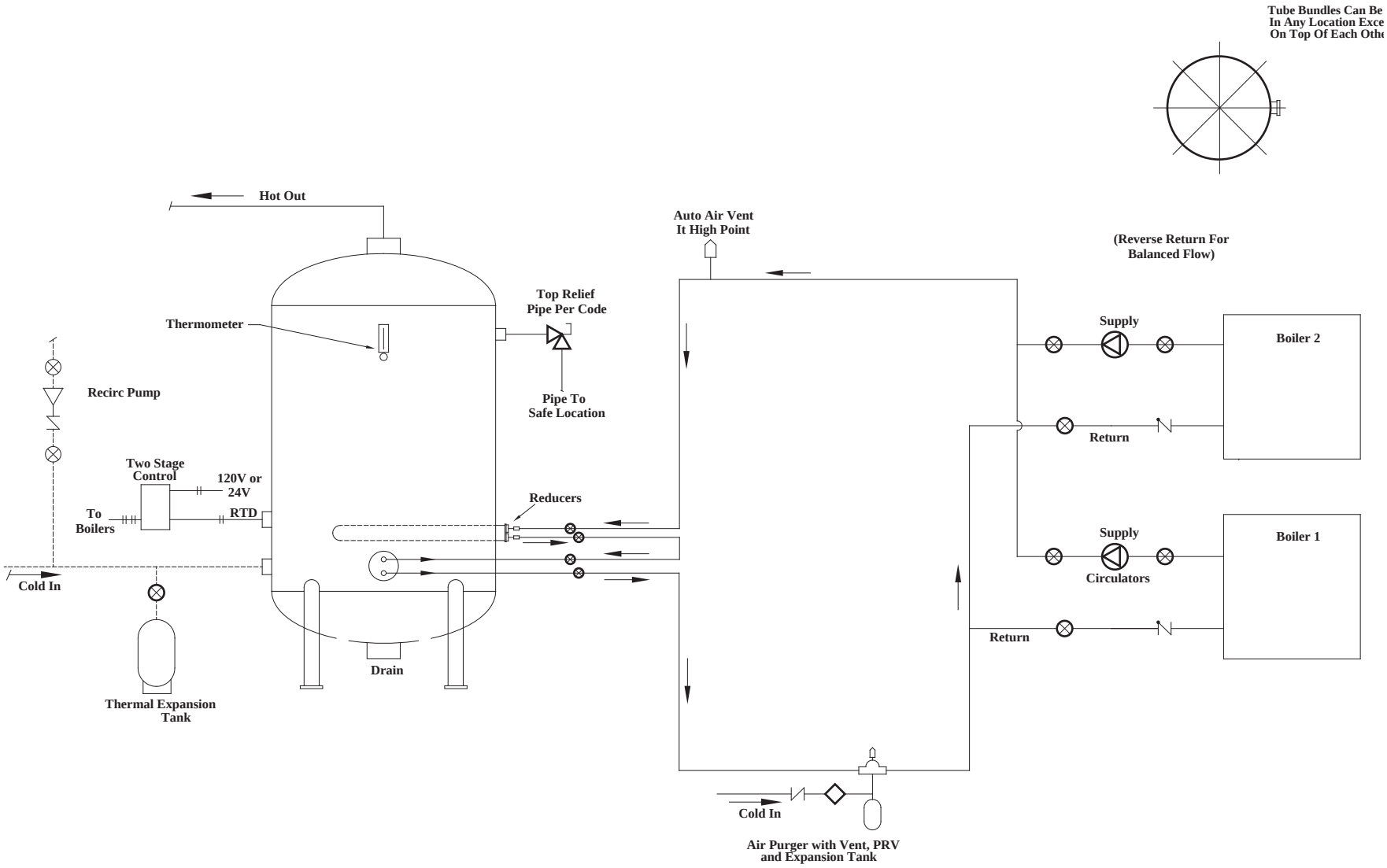
② HEATING UNITS WITH
THERMOSTATIC VALVES.

Figure B5-34. 2 Pipe System, Typical (reverse-return)



① BOILER OUTLET (SUPPLY)
② BOILER INLET (RETURN)
③ SECONDARY CONNECTION (BOILER CIRCUIT)
④ ISOLATION VALVES
⑤ PURGE COCKS (HOSE BIBB)
⑥ AIR SEPARATOR WITH AUTOMATIC AIR VENT
⑦ DIAPHRAGM EXPANSION TANK
⑧ COMBINATION FILL VALVE
⑨ ZONE VALVES
⑩ ZONE CIRCULATORS (CIRCULATOR ZONING)
⑪ SYSTEM CIRCULATOR (ZONE VALVE SYSTEM)

Figure B5-35. Zoning with Zone Valves



Heating Domestic Water with (2) Boilers and (2) Coils

Figure B5-44. Domestic Water with 2 Boilers and 2 Coils

Boiler Room Combustion and Ventilation Air

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

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

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

In accordance with NFPA54, the required volume of indoor air shall be determined in accordance with the "Standard Method" or "Known Air Infiltration Rate Method. Where the air infiltration rate is known to be less than 0.40 Air Changes per Hour, the Known Air Infiltration Rate Method shall be used. (See Section 8.3 in the NFPA54 Handbook for additional information.)

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

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

1. The mechanical equipment room must be provided with two permanent openings linked directly with additional room (s) of sufficient volume so that the combined volume of all spaces meet the criteria for an unconfined space. Note: An "unconfined space" is defined as a space whose volume is more than 50 cubic feet per 1,000 Btu per hour of aggregate input rating of all appliances installed in that space.
2. Each opening must have a minimum free area of one square inch per 1,000 Btu per hour of the total input rating of all gas utilizing equipment in the mechanical room.
3. One opening must terminate within twelve inches of the top, and one opening must terminate within twelve inches of the bottom of the room.
4. Refer to the NFGC, Section 8.3 for additional information.

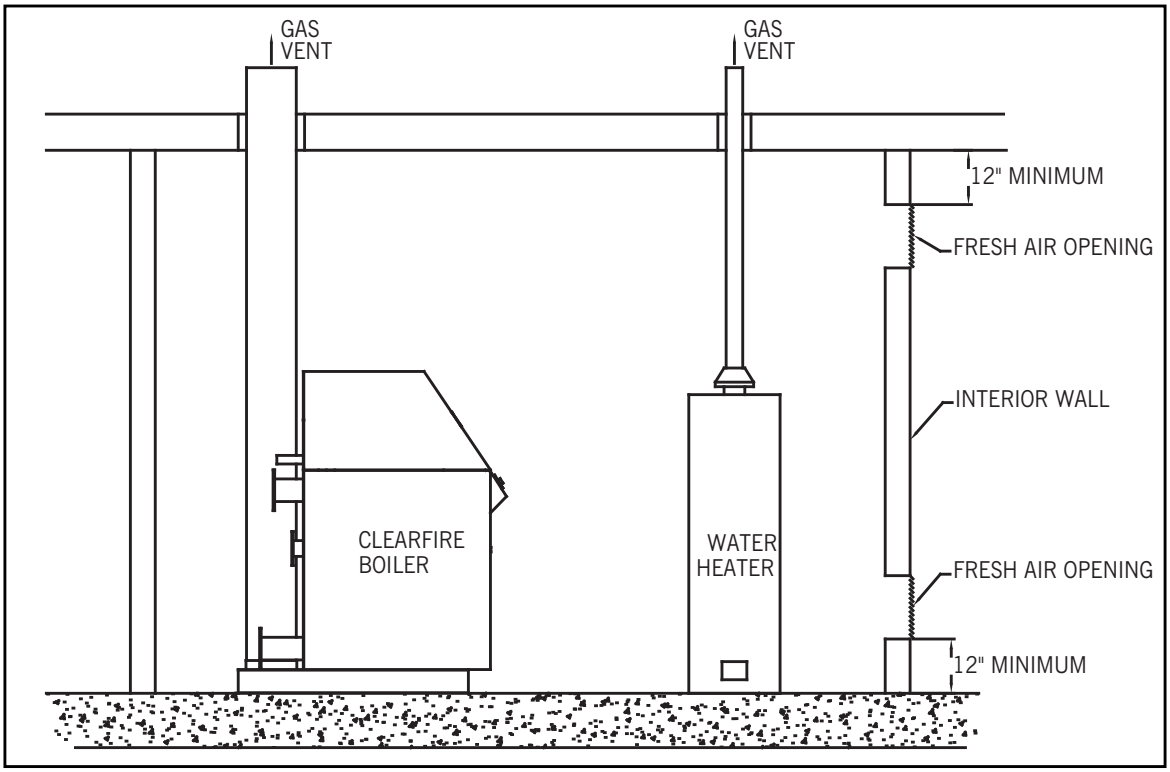


Figure B5-45. Two Opening Outside Wall Method

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

1. Two Opening Method (Figure B5-45) - The mechanical equipment room must be provided with two permanent openings, one terminating within twelve inches from the top, and one opening terminating within twelve inches of the bottom of the room.
2. The openings must be linked directly or by ducts with the outdoors.
3. Each opening must have a minimum free area of one square inch per 4,000 Btu per hour of total input rating of all equipment in the room, when the opening is directly linked to the outdoors or through vertical ducts.
4. The minimum free area required for horizontal ducts is one square inch per 2,000 Btu per hour of total input rating of all the equipment in the room.

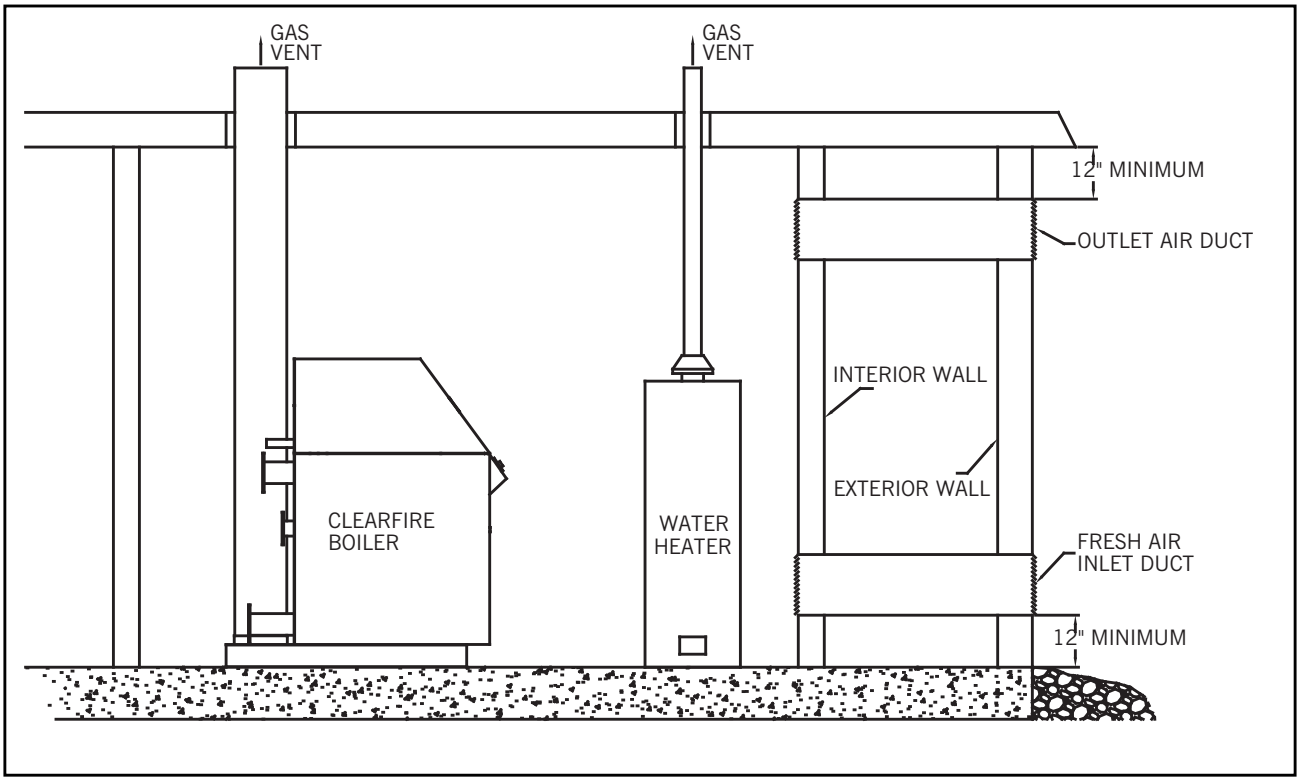


Figure B5-46. Two Opening Ducted Method

C. One Opening Method (Figure B5-47) - One permanent opening, commencing within 12 inches of the top of the enclosure, shall be provided.
   1. The equipment shall have clearances of at least 1 inch from the sides and back and 6 inches from the front of the appliance.
   2. The opening shall directly communicate with the outdoors and shall have a minimum free area of 1 square inch per 3000 BTU's per hour of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the confined space.
   3. Refer to the NFGC, Section 8.3 for additional information.

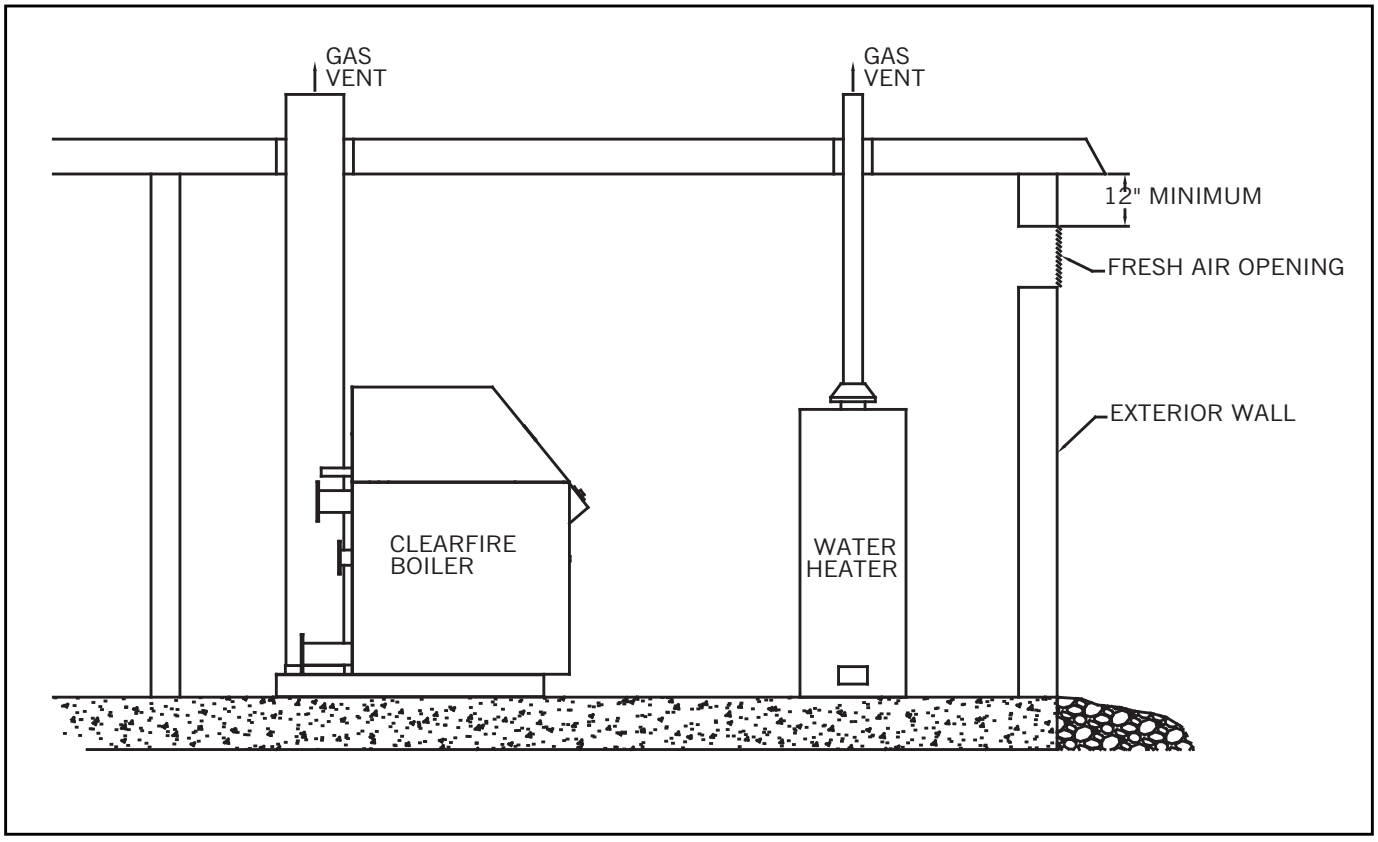


Figure B5-47. One Opening Method

Unconfined Space/ Engineered Design

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

1. Size (area) and location of air supply openings in the boiler room.
   A. Two permanent air supply openings in the outer walls of the boiler room are recommended. Locate one at each end of the boiler room, preferably below a height of 7 feet. This allows air to sweep the length of the boiler. See Figure B5-48.
   B. Air supply openings can be louvered for weather protection, but they should not be covered with fine mesh wire, as this type of covering has poor air flow qualities and is subject to clogging with dirt and dust.
   C. A vent fan in the boiler room is not recommended, as it could create a slight vacuum under certain conditions and cause variations in the quantity of combustion air. This can result in unsafe burner performance.
   D. Under no condition should the total area of the air supply openings be less than one square foot.

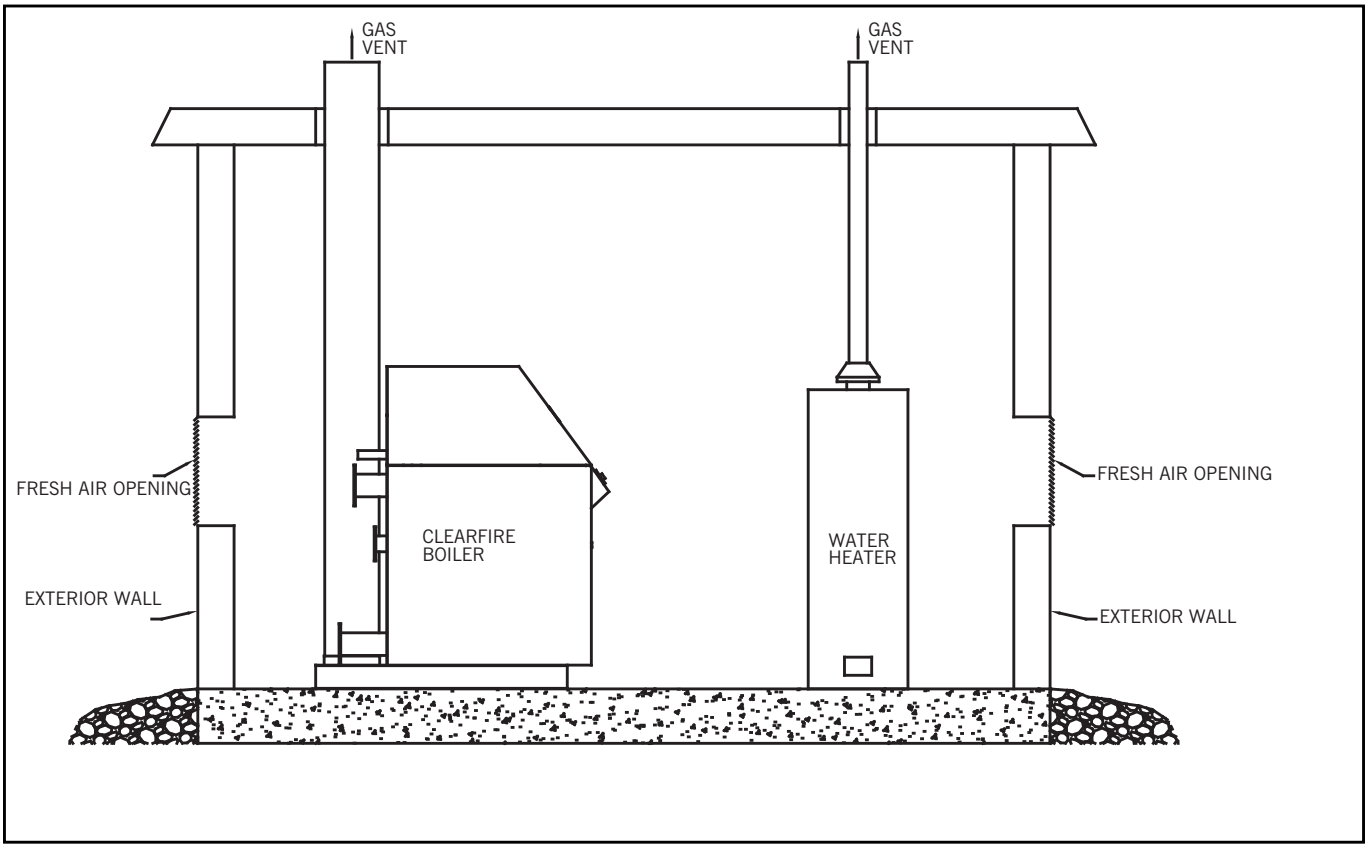


Figure B5-48. Two Opening Engineered Method

E. Size the openings by using the formula:

Area in square feet = cfm/fpm

Where cfm = cubic feet per minute of air

Where fpm = feet per minute of air

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

Example: Determine the area of the boiler room air supply openings for (2) Clearfire 1800 boilers at 750 feet elevation. The air openings to be 5 feet above floor level.

- Air required: 1800 x 2 = 3600 kBtuh. From 2C above, 3600 x 0.3 = 1,080 cfm.
- Air Velocity: Up to 7 feet = 250 fpm from 3 above.
- Area required: Area = cfm/fpm = 1,080/250 = 4.32 square feet total.
- Area/Opening: 4.32/2 = 2.16 sq-ft/opening (2 required).

Notice

Consult local codes, which may supersede these requirements.

Direct Vent Combustion

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

1. Install combustion air vent (direct vent combustion) in accordance with the boiler's Operating and Maintenance manual.
2. Provide for adequate ventilation of the boiler room or mechanical equipment room.
3. In cold climates, and to mitigate potential freeze-up of the intake pipe, it is highly recommended that a motorized sealed damper be used to prevent the circulation of cold air through the boiler during non-operating hours.
4. Figure B5-49 shows the optional direct vent combustion kit providing easy adaptation of the contractor supplied air duct to boiler connection. Refer to Table B5-26 for sizing the direct vent combustion air pipe.

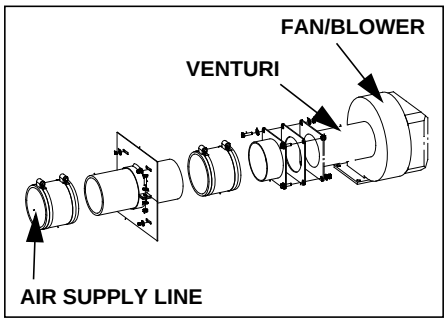


Figure B5-49. Optional Direct Vent Combustion Kit

STACK/BREECHING SIZE 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.

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

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

In some cases, PVC/CPVC material meeting ULC Type BH Class IIB specifications may be used. Use of PVC/CPVC depends on operating conditions, specific vent

suppliers, and any local codes having jurisdiction. Refer to vent manufacturer's specifications for applicability.

Proper installation of flue gas exhaust venting is critical to efficient and safe operation of the Clearfire Boiler. The vent should be supported to maintain proper clearances from combustible materials. Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

The design of the stack and breeching must provide the required draft at each boiler flue gas connection; proper draft is critical to 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 variation. Consideration of the draft must be given whenever direct vent combustion is utilized and lengthy runs of breeching are employed. Please note: The allowable pressure range for design of the stack, breeching and if used, direct vent combustion pipe, is negative 0.25" W.C. (- 62 Pa) to positive 0.25" W.C. (+62 Pa) for proper combustion and light offs.

Whenever two or more boilers are connected to a common breeching/stack, a draft control system may be required to ensure proper draft.

Vent Termination

To avoid the possibility of property damage or personal injury, special attention to the location of the vent termination must be considered.

1. Combustion gases can form a white vapor plume in the winter. The plume could obstruct a window view if the termination is installed in close proximity to windows.
2. Prevailing winds could cause freezing of Condensate and water/ice buildup on building, plants, or roof.
3. The bottom of the vent termination and the air intake shall be located at least 12 inches above grade, including the normal snow line.
4. Non-insulated single-wall metal vent pipe shall not be used outside in cold climates for venting combustion gases.
5. Through the wall vents for Category II and Category IV appliances shall not terminate over public walkways or over an area where Condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of other equipment.
6. To prevent accidental contact by people or pets, the vent termination shall be guarded.
7. DO NOT terminate vent in window well, alcove, stairwell or other recessed area, unless approved by local authority.
8. DO NOT terminate above any door, window, or gravity air intake as Condensate can freeze causing ice formation.
9. Locate or guard vent to prevent Condensate from damaging exterior finishes. Use a 2' x 2' rust resistant sheet metal backing plate against brick or masonry surfaces.
10. Multiple direct stack installations require four feet clearance between the stack caps, center to center.

U.S. Installations

Refer to the latest edition of the National Fuel Gas Code/NFPA 54. Vent termination requirements are:

1. Vent must terminate at least four feet below and four feet horizontally or one foot above any door, window or gravity air inlet to the building.

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

Canadian Installations

Refer to the latest edition of CAN/CSA-B149.1 and B149.2. Vent shall not terminate:

1. Directly above a paved sidewalk or driveway which is located between two single-family dwellings and serves both dwellings.
2. Less than 7 feet (2.31m) above a paved sidewalk or paved driveway located on public property.
3. Within 6 feet (1.8m) of a mechanical air supply inlet to any building.
4. Above a meter/regulator assembly with 3 feet (900mm) horizontally of the vertical centerline of the regulator.
5. Within 6 feet (1.8m) of any gas service regulator vent outlet.
6. Less than 1 foot (300mm) above grade level.
7. Within 3 feet (1m) of a window or door which can be opened in any building, any non-mechanical air supply inlet to any building or to the combustion air inlet of any other appliance.
8. Underneath a Verandah, porch, or deck unless:
   A. The Verandah, porch, or deck is fully open on a minimum of two sides beneath the floor.
   B. The distance between the top of the vent termination and the underside of the Verandah, porch, or deck is greater than one foot (300mm).

Horizontal Through the Wall Venting

Venting configurations using inside air for combustion (See Figure B5-50)

These installations utilize the boiler-mounted blower to vent the combustion products to the outside. Combustion air is obtained from inside the room and the exhaust vent is installed horizontally through the wall to the exterior of the building. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the NFGC/NFPA 54 for the U.S. and in Canada, the latest edition of CAN/CSA-B149.1 and.2 Installation Code for Gas Burning Appliances and Equipment.

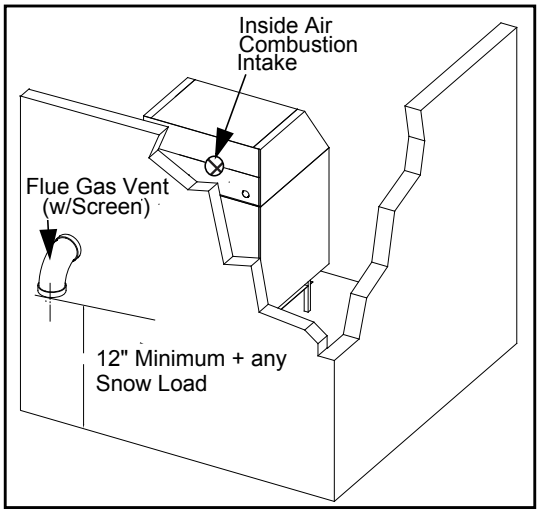


Figure B5-50. Horizontal Through the wall venting using inside air for combustion

The vent must be installed to prevent the potential accumulation of stack condensate in the horizontal run of vent pipe. Therefore, it is recommended that:

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

Note: For installations in cold/freezing climates, it is recommended that:

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

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

Notice

The stainless steel direct vent cap must be furnished in accordance with AGA/CGA requirements.

Refer to Table B5-25 for the recommended sizes of horizontal vent pipe.

Horizontal Through the Wall Stack Venting

Direct Vent Combustion. See Figure B5-51.

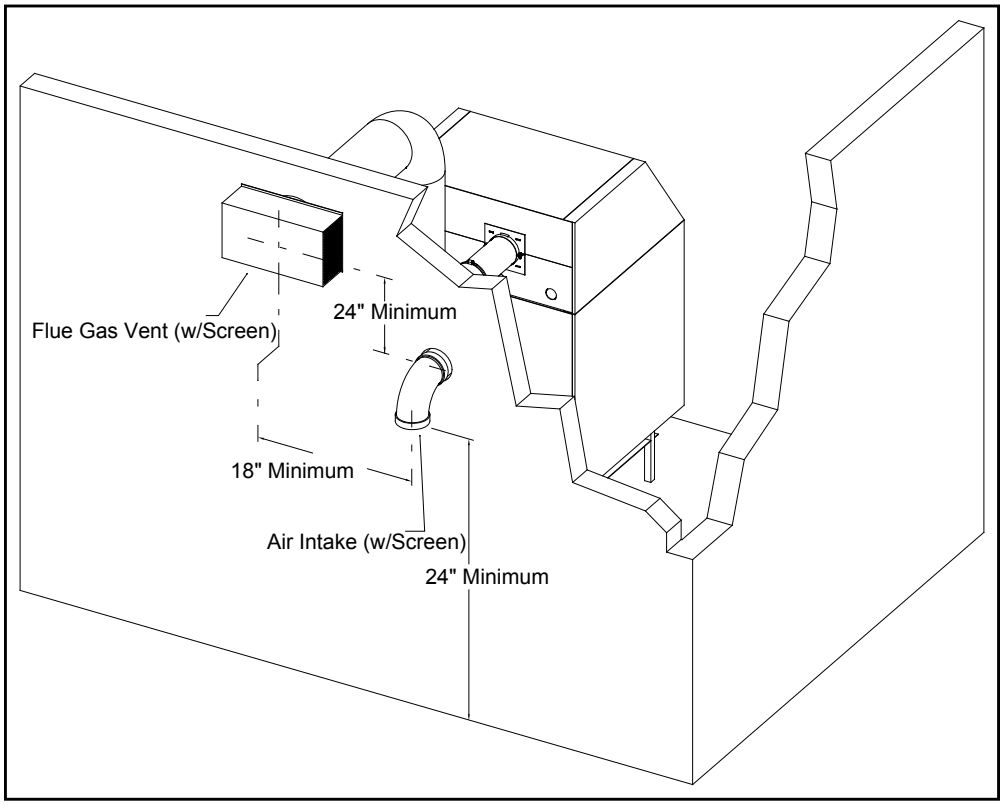


Figure B5-51. Horizontal Flue through-wall with direct vent combustion intake

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

The direct vent combustion air vent cap is not considered in the overall length of the venting 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 shall be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the stack termination.
2. The stack vent is to be insulated through the length of the horizontal run.

Note: For installations in freezing climates, it is recommended that:

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

Note: For Horizontal Stack Vent Termination:

1. The stack vent cap must be mounted on the exterior of the building. The stack vent cap cannot be installed in a well or below grade. The stack vent cap must be installed at least one foot above ground level and above normal snow levels.
2. Multiple stack vent caps should be installed in the same horizontal plane with three feet clearance from side of one stack cap to the side of the adjacent vent cap.

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

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

Table B5-25. STACK DESIGN (SINGLE BOILER) USING ROOM AIR

ROOM COMBUSTION AIR -- MAXIMUM ALLOWABLE VENTING LENGTH

Boiler	Boiler Stack/Flue Connection	Boiler Flue/Stack Size	Maximum length of Flue Gas Vent in Feet*	Flue Connection Part No.	Room Combustion Air Required (CFM)	Air Filter Kit No. (optional)
CFC 500	**6" Standard**	**6"**	**80**	**039-01704**	125	880-01858
CFC 750	**6" Standard**	**6"**	**60**	**039-01704**	190	880-01858
CFC1000	6" Option	6"	80	039-01646	250	880-01858
CFC1000	**8" Standard**	**8"**	**140**	**039-01647**	250	880-01858
CFC1000	10" Option	10"	200	039-01705	250	880-01858
CFC1500	8" Option	8"	60	039-01645	375	880-02005
CFC1500	**10" Standard**	**10"**	**80**	**039-01644**	375	880-02005
CFC1500	12" Option	12"	120	039-01688	375	880-02005
CFC1800	10" Option	10"	60	039-01644	450	880-02005
CFC1800	**12" Standard**	**12"**	**100**	**039-01688**	450	880-02005
CFC 2500	**12" Standard**	**12"**	**110**	**039-01688**	625	880-02005
CFC3300	**12" Standard**	**12"**	**60**	**039-01761**	800	880-02502
CFC3300	14" Option	14"	110	039-01762	800	880-02502

* Each additional 90 elbow equals 5 equivalent feet of ductwork. Flue terminations may add 5-10 feet to the equivalent length and should also be included in the equivalent length calculation.
** Increasing the diameter of the air intake will reduce the overall pressure drop and thereby allow longer total vent lengths.

Draft tolerance at boiler flue connection during operation is +/- 0.25" WC.

Table B5-26. STACK SIZING USING OUTSIDE AIR FOR COMBUSTION (DIRECT VENT COMBUSTION)

DIRECT VENT COMBUSTION AIR -- MAXIMUM ALLOWABLE VENTING LENGTH

Boiler	Boiler Stack/Flue Connection	Combustion Air Intake Duct & Connection	Boiler Flue/Stack Size	Maximum length of Flue Gas Vent in Feet*	Maximum length of Air Intake Duct in Feet**	Direct Vent Combustion Air Kit	Flue Connection Part No.
CFC 500	**6" Standard**	**4"**	**6"**	**75**	**75**	**880-01312**	**039-01704**
CFC 500	6" Standard	6"	6"	80	80	880-03736	039-01704
CFC750	6" Standard	4"	6"	40	40	880-01312	039-01704
CFC 750	**6" Standard**	**6"**	**6"**	**50**	**50**	**880-03736**	**039-01704**
CFC1000	6" Option	4"	6"	30	30	880-01312	039-01646
CFC1000	6" Option	6"	6"	40	40	880-03736	039-01646
CFC1000	8" Standard	4"	8"	50	50	880-01312	039-01647
CFC1000	**8" Standard**	**6"**	**8"**	**60**	**60**	**880-03736**	**039-01647**
CFC1000	10" Option	4"	10"	70	70	880-01312	039-01705
CFC1000	10" Option	6"	10"	80	80	880-03736	039-01705
CFC1500	8" Option	6"	8"	30	30	880-01313	039-01645
CFC1500	8" Option	8"	8"	40	40	880-02451	039-01645
CFC1500	**10" Standard**	**6"**	**10"**	**40**	**40**	**880-01313**	**039-01644**
CFC1500	10" Standard	8"	10"	60	60	880-02451	039-01644
CFC1500	12" Option	6"	12"	60	60	880-01313	039-01688
CFC1500	12" Option	8"	12"	80	80	880-02451	039-01688
CFC1800	10" Option	6"	10"	40	40	880-01313	039-01644
CFC1800	10" Option	8"	10"	55	55	880-02451	039-01644
CFC1800	**12" Standard**	**6"**	**12"**	**50**	**50**	**880-01313**	**039-01688**
CFC1800	12" Standard	8"	12"	80	80	880-02451	039-01688
CFC 2500	**12" Standard**	**8"**	**12"**	**100**	**100**	**880-02451**	**039-01688**
CFC3300	**12" Standard**	**8"**	**12"**	**55**	**55**	**880-02501**	**039-01761**
CFC3300	14" Option	8"	14"	100	100	880-02501	039-01762

* Each additional 90 elbow equals 5 equivalent feet of ductwork. Flue terminations may add 5-10 feet to the equivalent length and should also be included in the equivalent length calculation.
** Increasing the diameter of the air intake will reduce the overall pressure drop and thereby allow longer total vent lengths.

Draft tolerance at boiler flue connection during operation is +/- 0.25" WC.

Vertical Venting Inside Combustion Air

See Figure B5-52.

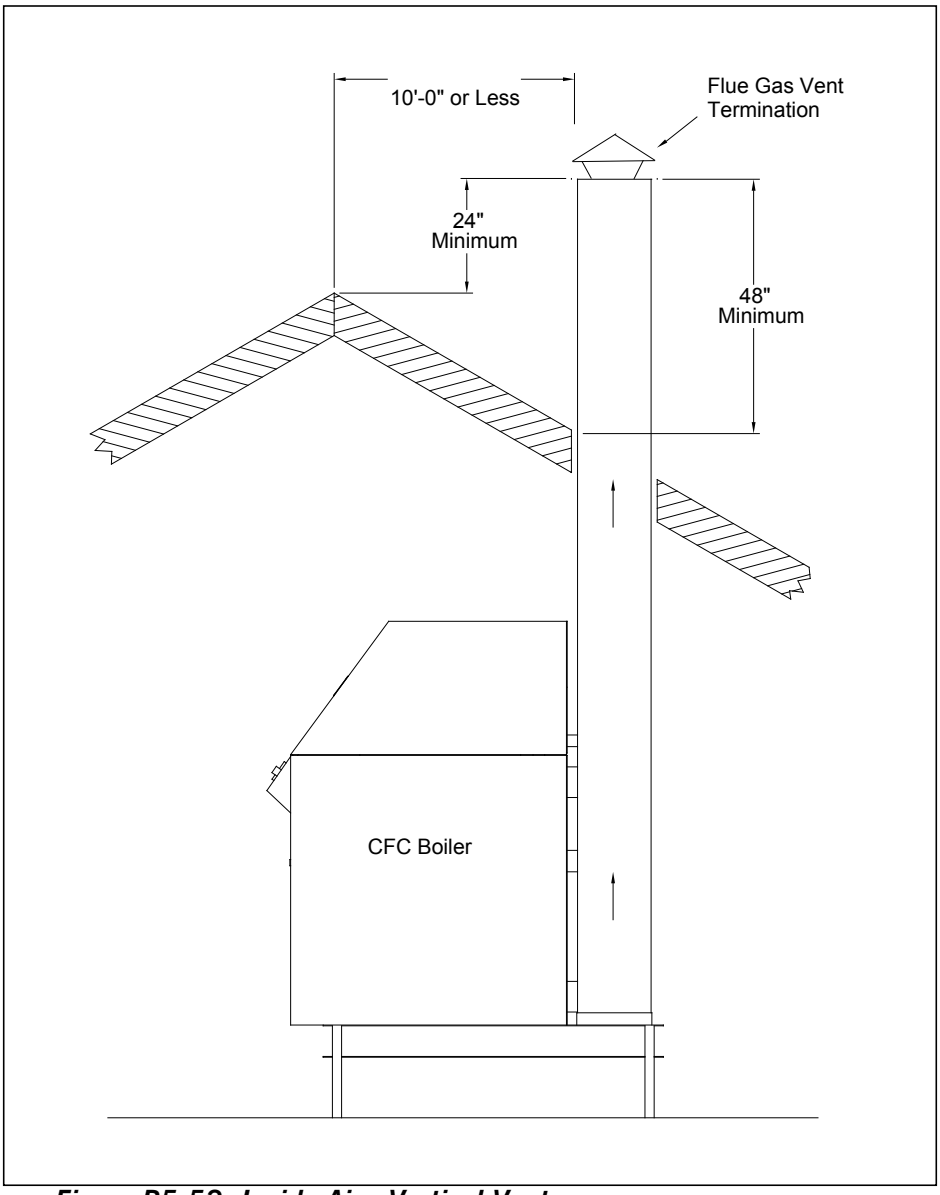


Figure B5-52. Inside Air - Vertical Vent

As noted in Paragraph A above, these installations use air from within the boiler room for combustion. The same recommendations apply as noted in Paragraph A above and also, the recommendations on flue vent sizing according to Table B5-25.

Vertical Venting Direct Vent Combustion

See Figure B5-53.

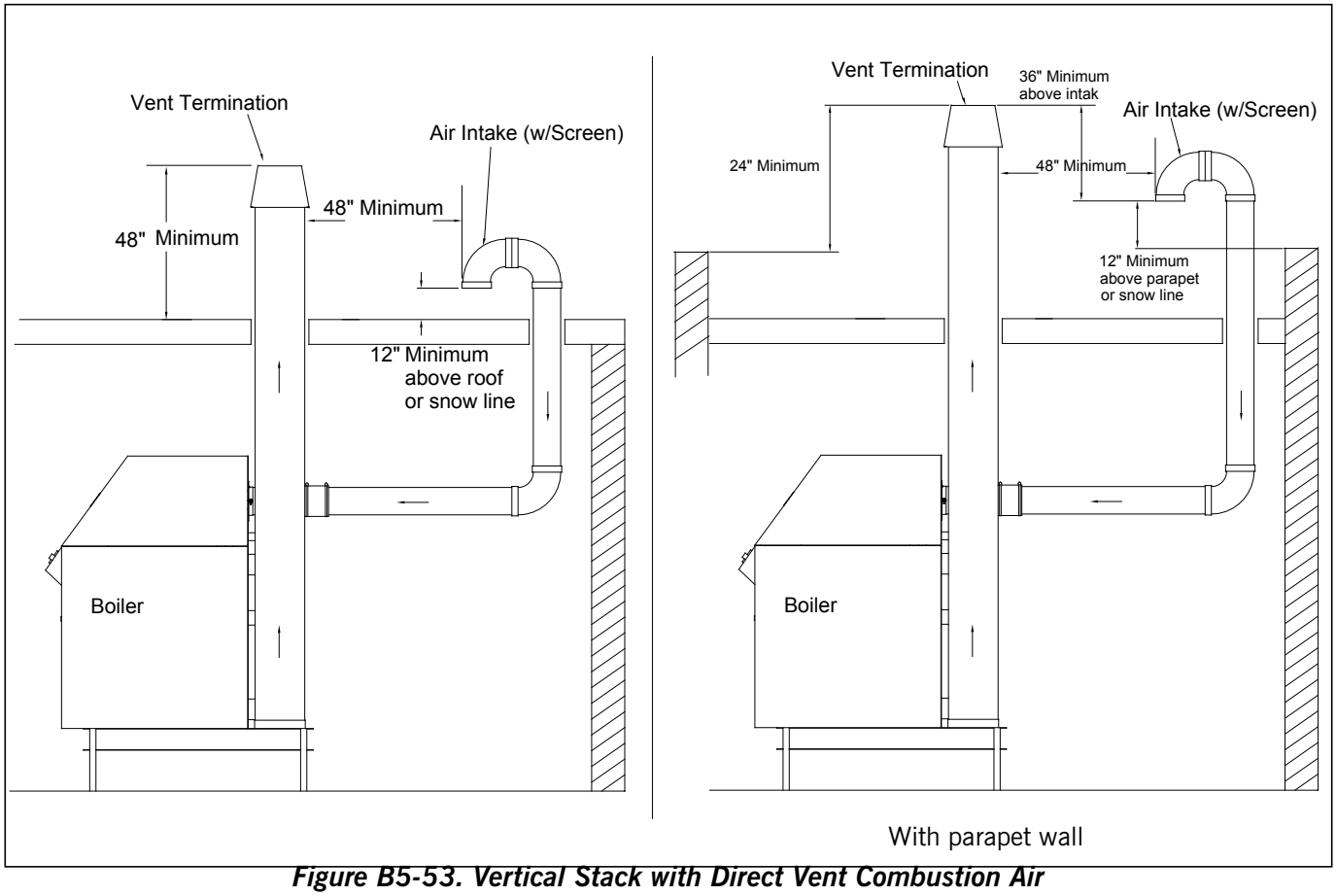


Figure B5-53. Vertical Stack with Direct Vent Combustion Air

As noted in Paragraph B above, these installations use air from outside the building for combustion. The same recommendations apply as noted in B and also, the recommendations on flue vent sizing according to Table B5-26.

ELECTRICAL

Voltage requirements for the Fan Motor are 115 - 120/1/60. Control Circuit voltage is 120/1/60 for all boiler sizes. Refer to Table B5-3 "Ratings" for ampacity requirements.

Refer to Figure B5-54 through Figure B5-56 for wiring connections and control locations.

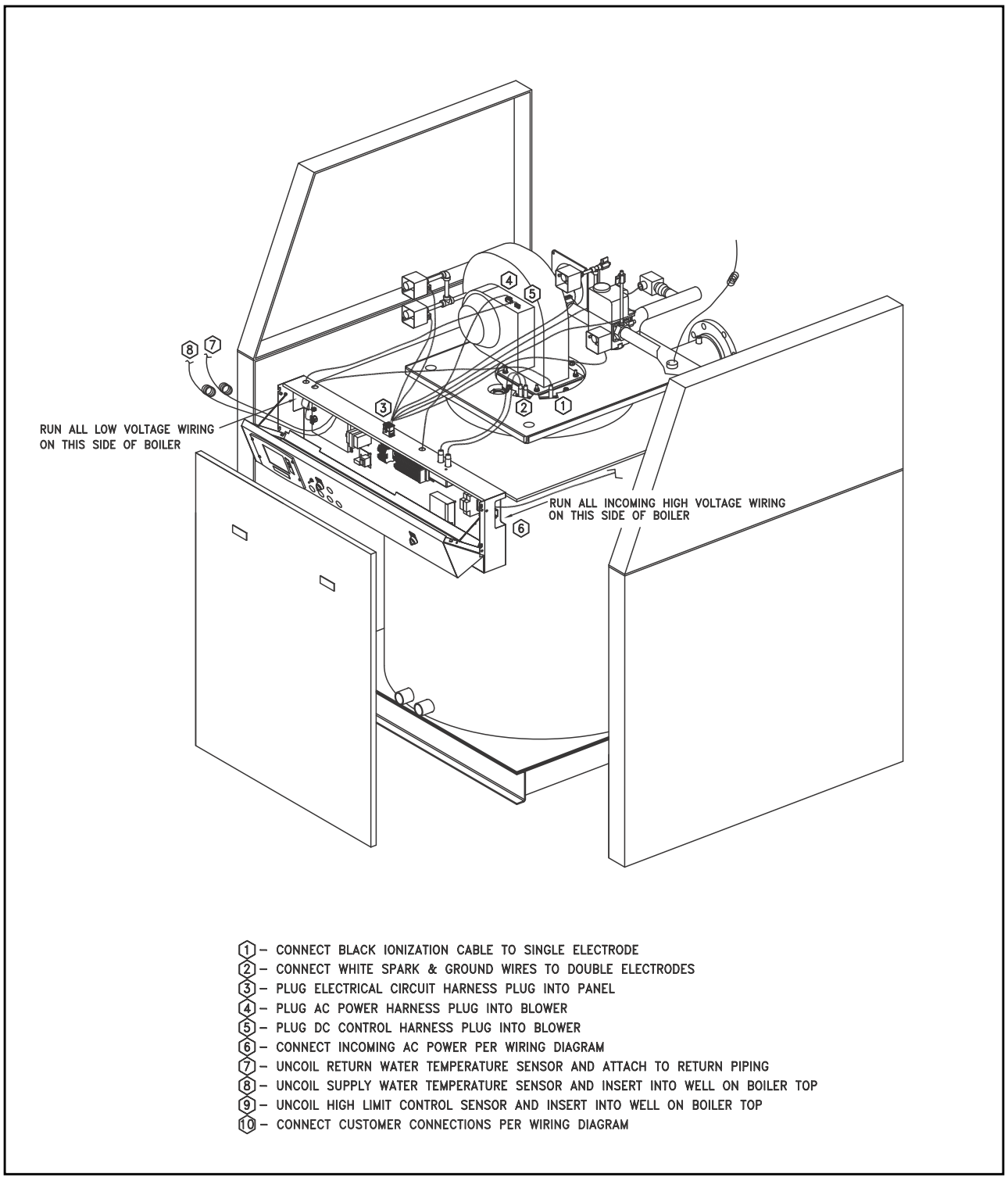


Figure B5-54. Electrical Connections CFC 500-2500

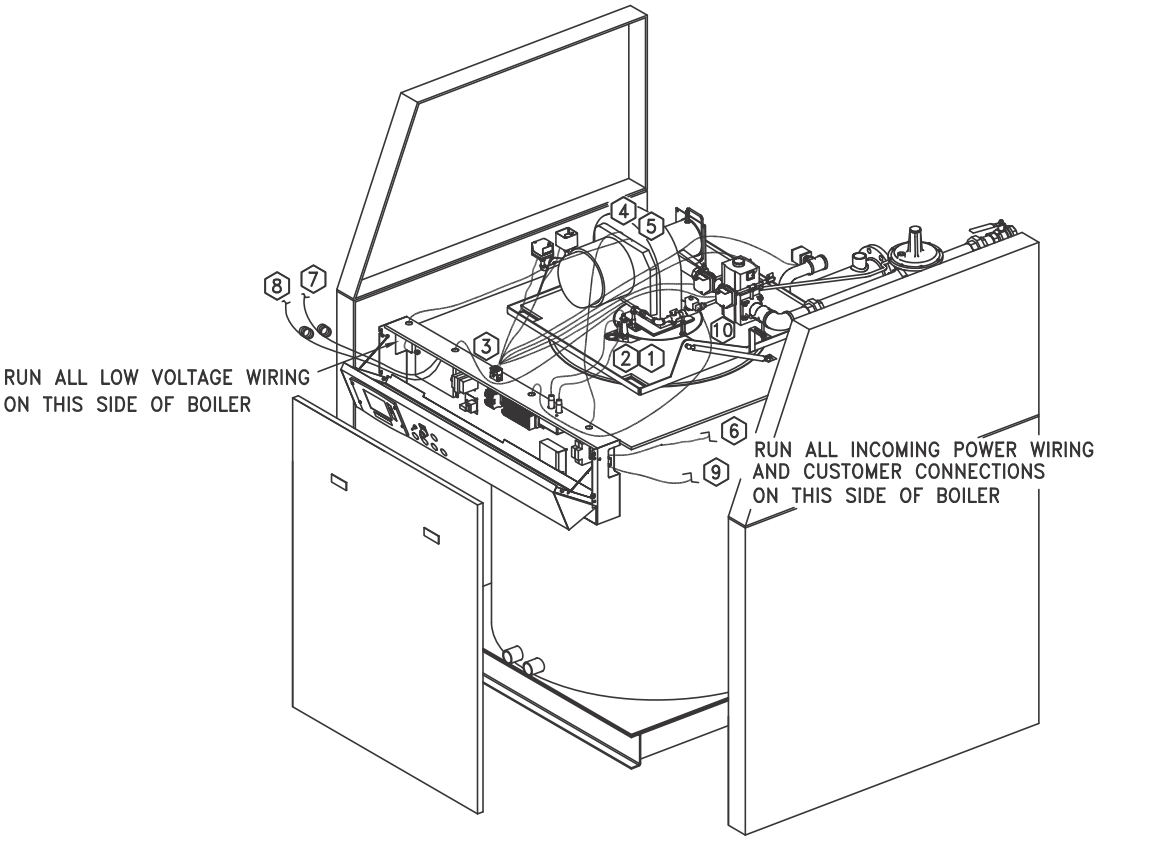


Figure B5-55. Electrical Connections CFC 3300

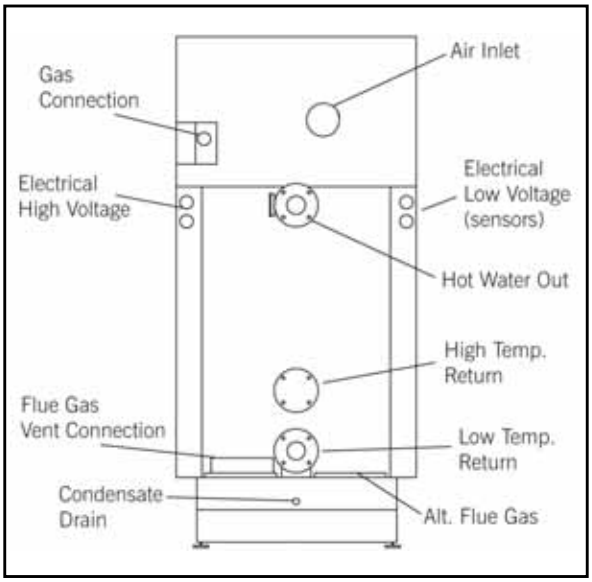


Figure B5-56. CFC Rear Connections

CB FALCON CONTROLLER

1. Control Description - The CB Falcon hydronic control is an integrated burner management and modulation control with a touch-screen display/operator interface.
2. Functionality - The controller is capable of the following functions:

- Flame supervision
- Burner sequencing
- Heating/modulation control
- Hot water system pump control
- High Limit temperature control
- Thermowell-mounted NTC temperature sensors to provide measured process variable signals to the controller.
- User-friendly touchscreen interface
- Modbus communication capability
- Alarm/lockout messaging with history (last 15 messages)
- Annunciation
- Outdoor reset
- Central Heating and Domestic Hot Water loop control
- Password protection of configurable parameters
- High Stack Temperature limit
- Remote reset
- Lead/Lag sequencing
- (3) configurable pump relays
- Remote modulation/remote setpoint
- Frost protection
- Time of Day (dual setpoint) control
- Three levels of access to control configuration:
    - End-user
    - Installer/Service Engineer (password protected)
    - OEM Manufacturer (password protected)

Table B5-27. Operating Conditions - Controller

Temperature Range	Operating	-4 F to 150 F (-20 C to 66 C)
	Storage	-40 F to 150 F (-40 C to 66 C)
Humidity	85% max. relative humidity, non-condensing	

Table B5-28. Operating Conditions - Display/Interface

Temperature Range	Operating	32 F to 122 F (0 C to 50 C)
	Storage	-40 F to 150 F (-40 C to 66 C)
Humidity	85% max. relative humidity	

Table B5-29. CB Falcon burner sequence (Central Heat)

1. Heat request detected (CH demand)
2. CH pump switched on
3. Safe Start Check, dynamic ILK input test (if enabled), blower switched on
4. If ILK input and CAPS switch closed and purge rate fan speed achieved, begin 15 second prepurge
5. When purge complete, blower RPM changed to lightoff speed
6. Trial for Ignition - 4 seconds*
7. Ignition and gas valve switched on*
8. Ignition turned off at the end of direct ignition period; 5 sec. stabilization time*
9. Release to modulation (Run)
10. At the end of CH heat request, burner is switched off and blower stays on for 15 sec. post purge period. Boiler enters standby mode.

*CFC 3300 uses pilot ignition - lightoff sequence will vary accordingly

3. Main Voltage Connection - 115V/single phase/60Hz
4. Local/Remote demand switch
5. Combustion Air Proving Switch - This input is used for proving airflow sufficient for proper combustion throughout the burner run sequence.
6. High Air Pressure Switch - prevents boiler operation in the event of high stack back pressure (blocked flue or condensate drain).
7. 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.
8. NTC (Negative Temperature Coefficient) Thermistor Inputs (10kΩ @ 25 ºC)
   A. Flow Temperature (Outlet water temperature)
   B. Return Temperature (Inlet water temperature)
   C. Optional Domestic Water Temperature
   D. Optional Outdoor Temperature
   E. Optional Stack Temperature
   F. Optional Header Temperature
9. System Configuration - CB Falcon configuration is arranged into the following functional groups:

System Identification and Accesss	Statistics Configuration
CH - Central Heat	High Limit
Outdoor Reset	Stack Limit
DHW - Domestic Hot Water	Delta T Limits
DHW Storage	T-Rise Limit
DHW Plate	Heat Exchanger High Limit
Warm Weather Shutdown	Anti-condensation
Demand Priority	Frost Protection Configuration
Modulation Configuration	Annunciation Configuration
Pump Configuration	Burner Control Interlocks

10. CB Falcon 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 CFC manual 750-263 or to the CB Falcon manual 750-265.

Figure B5-57. CB Falcon pinout