CFC-E

ClearFire Condensing Boiler

Boiler Book
09/2017

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FEATURES AND BENEFITS

Compact Firetube Design

The Model CFC-E boiler is a high mass, vertical down fired robust firetube boiler. The internal extended-heating surface tubes provide very high levels of performance in a compact space. The large water volume makes the CFC-E ideal for variable flow primary pumping systems.

Large Water Volume

The large water volume makes the CFC-E ideal for variable flow primary pumping systems.

Advanced Technology

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

Advanced Fireside 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 heating surface profile on the flue gas side.

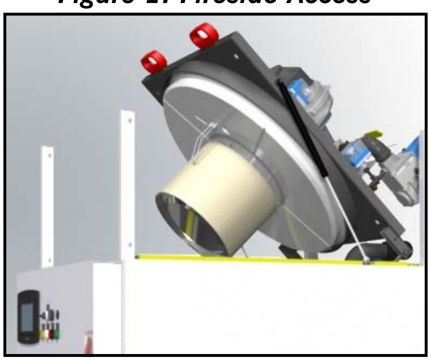
High Efficiency

With the extended heating surface tubes the CFC-E boiler will provide fuel to water efficiency of up to 99% at low fire and 95% 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 1, 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 combustion chamber.

Figure 1. Fireside Access



Quality Construction

ASME Code construction ensures high quality design, safety, third party inspection, and reliability, and accordingly bears the ASME Section IV “H” stamp.

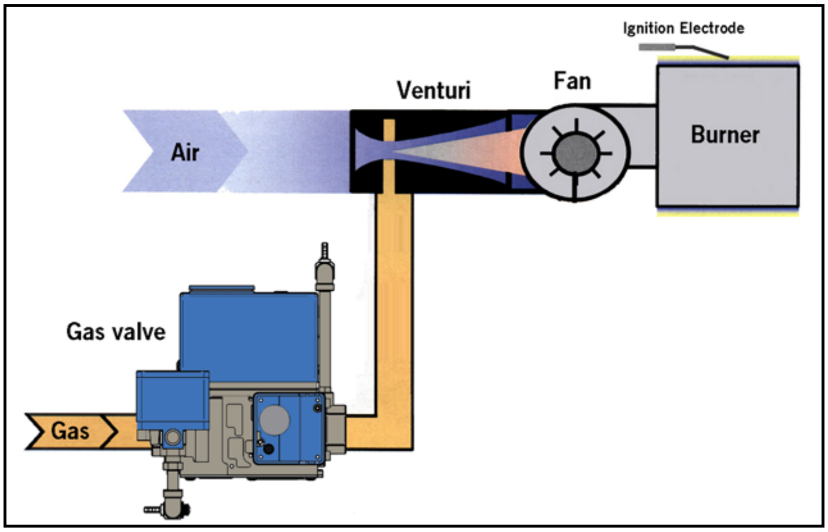
Premix Technology

The burner utilizes “Premix” technology to mix both gas fuel and combustion air prior to entering the burner canister, with air leading the fuel during burner firing transitions. Combined with the surface combustion burner and self-regulating gas valve-venturi fuel-air ratio control, this technology provides very low emission levels, exceptionally safe operation, and nearly 100% combustion efficiency.

Full Modulation

The variable speed combustion air blower with ECM technology provides modulated firing for precise linear load tracking, reduced on-off cycling, and reduced electrical consumption.

Figure 2. Premix Burner Technology



Designed For Heating Applications

The pressure vessel is designed for 125 psig MAWP (Maximum Allowable Working Pressure) and is constructed of durable ASTM Grade Steel and Stainless Steel materials. The true counter flow heat exchanger design equates to 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-E 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 lower 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 onboard controls permit domestic water programming. Therefore, the Model CFC-E can service both hydronic heating and domestic water source heating.

Dual Return

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

SCAQMD Certified

The CFC-E is certified by the South Coast Air Quality Management District.

PRODUCT OFFERING

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 pressure vessel is mounted on a base and a powder coated steel casing is 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.
   - High 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) (Optional SRV set points available.)
   - Combination Temperature/Pressure Gauge.
3. Burner Control
   A. The Falcon controller is an integrated burner management and modulation control with a color 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, 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

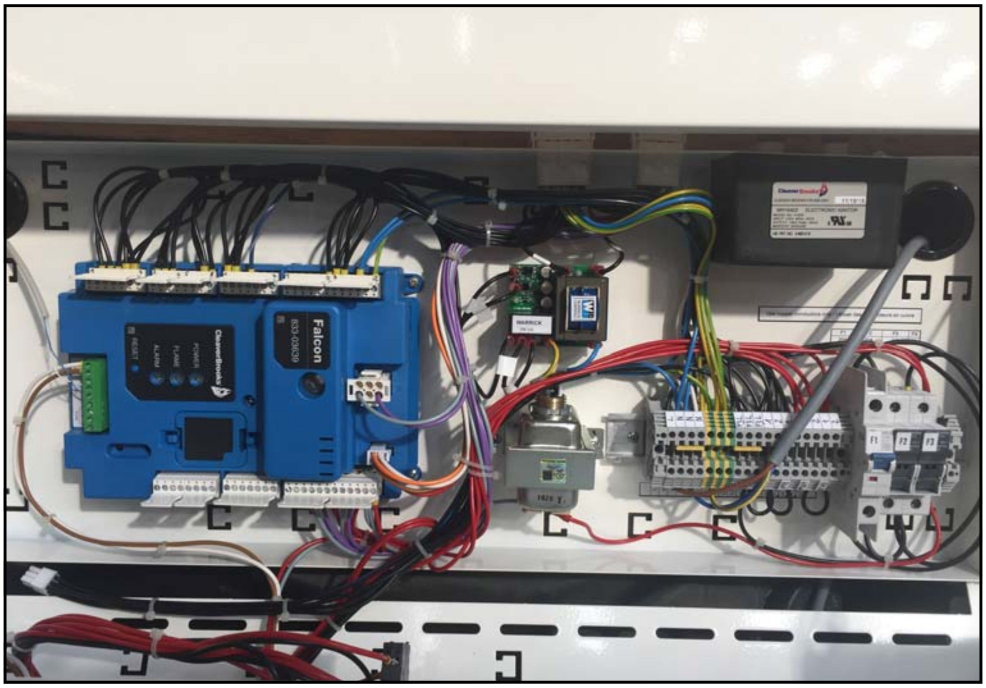


Figure 3. ClearFire CE Control Panel

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. Consistent fuel-air ratio is maintained with a self-regulating gas valve-venturi system which automatically compensates for changes in air density.
   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.
   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 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. This provides full access to the burner and electrodes, as well, to the tube sheet and tubes.
   K. Supports direct vent combustion air.
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 valve.
- 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. Reusable air filter.
B. Condensate neutralization tank assembly - consists of neutralizing media, filter, and PVC condensate holding tank with integral drain trap.
C. Outside air intake for direct vent combustion.
D. Outdoor temperature sensor for indoor/outdoor control.
E. Header temperature sensor for multiple boiler Lead/Lag operation.
F. Auxiliary Low Water Control (shipped loose) for field piping by others into the system piping.
G. Alarm Horn for safety shutdown.
H. Relays for output signal for burner on, fuel valve open.
I. Stack Thermometer.
J. Stack temperature limit-sensor.
K. Auto air vent.
L. Boiler drain valve.
M. Adjustable feet.
N. Seismic anchoring brackets.
O. Protocol translator for communications

DIMENSIONS AND RATINGS

For layout purposes, the overall dimensions for the Model CFC-E are shown in Table 1 (US Dimensions) and Table 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 3.

Altitude

See Table 4 for input capacity ratings at various altitude levels.

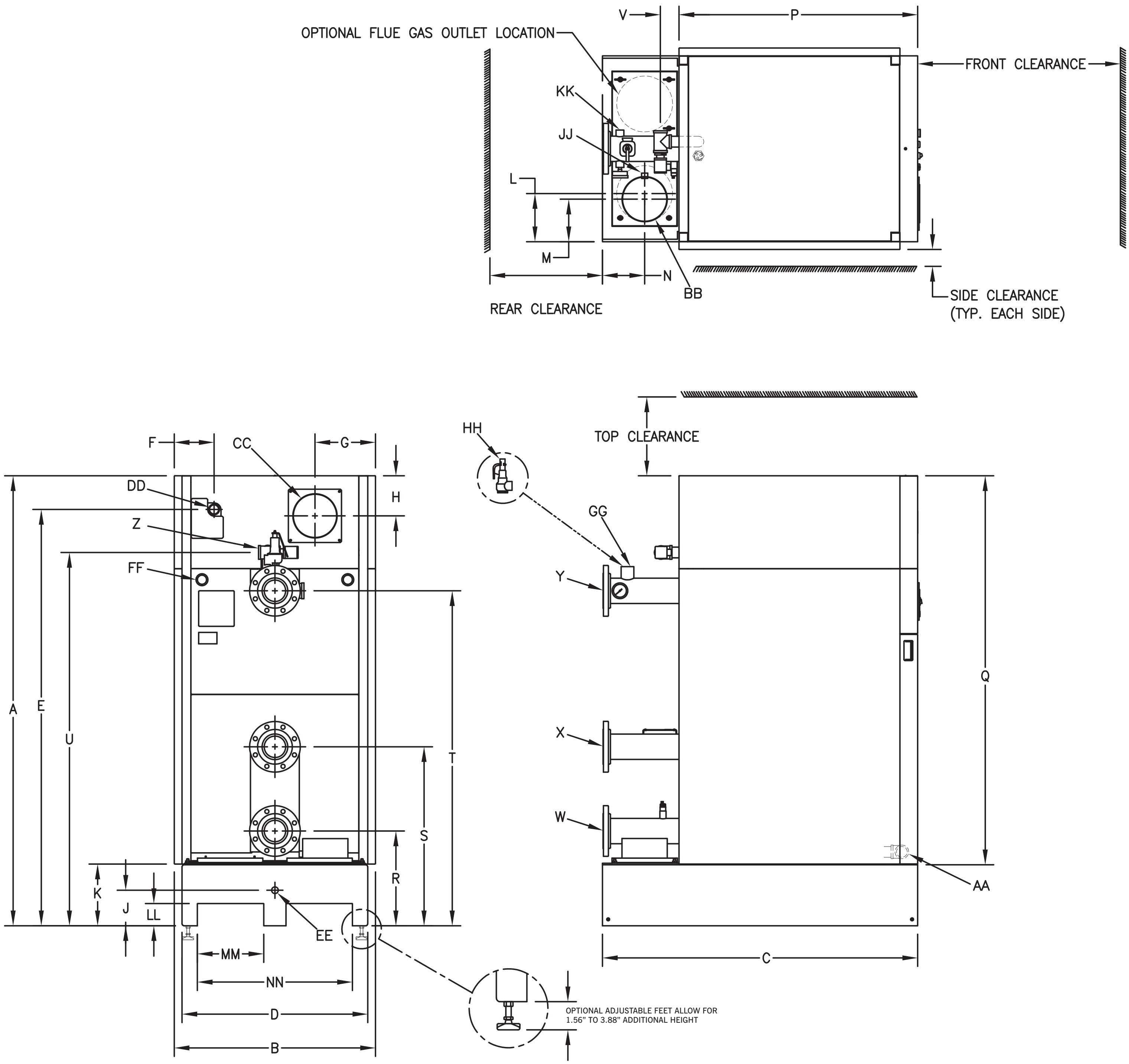


Figure 4. Model CFC-E Dimensional Views

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

ITEM	DIMENSIONS (inches)	750	1000	1500	2000
A	Overall Height	78.0	78.0	79.9	79.9
B	Overall Width	34.9	34.9	35.8	35.8
C	Overall Depth	49.4	49.4	56	56
D	Width Less Casing	32.1	32.1	33.0	33.0
E	Gas Connection to Floor	70.3	70.3	73.9	73.9
F	Side of Casing to Gas Connection	3.7	3.7	7.1	7.1
G	Side of Casing to Air Inlet	10.8	10.8	10.8	10.8
H	Top of Casing to Air Inlet	7.7	7.7	7.1	7.1
J	Floor to Condensate Drain	6.3	6.3	6.3	6.3
K	Floor to Bottom of Casing	11.0	11.0	11.0	11.0
L	Side of Base to Flue Outlet (Centered)	7.4	7.4	8.5	8.5
M	Side of Base to Flue Outlet (Offset)	6.4	6.4	7.5	7.5
N	Rear of Base to Flue Outlet	6.5	6.5	7.5	7.5
P	Casing Depth	36.3	36.3	42.4	42.4
Q	Casing Height	67.0	67.0	68.9	68.9
R	Floor to Lower Return Connection	16.8	16.8	16.8	16.8
S	Floor to Upper Return Connection	31.8	31.8	31.8	31.8
T	Floor to Supply Connection	59.5	59.5	59.5	59.5
U	Floor to Air vent Connection	66.3	66.3	66.3	66.3
V	Air Vent Line Projection From Rear of Casing	3.2	3.2	3.3	3.3

CONNECTIONS

W	Water Low Temp. Return, Class150 RF Flange	2-1/2"	2-1/2"	4"	4"
X	Water High Temp. Return, Class150 RF Flange	2-1/2"	2-1/2"	4"	4"
Y	Water Outlet, Class150 RF Flange	2-1/2"	2-1/2"	4"	4"
Z	Air Vent, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"
AA	Vessel Drain, NPT	1-1/2"	1-1/2"	1-1/2"	1-1/2"
BB	Flue Gas Outlet				
	(Standard) - Nominal	6"	8"	8"	8"
	(Option) - Nominal	8"	6"	10"	10"
CC	Combustion Air - Nominal	6"	6"	8"	8"
DD	Gas, NPT	1"	1"	1-1/2"	1-1/2"
EE	Condensate Drain, NPT	1"	1"	1"	1"
FF	Electrical Opening, Left or Right	1.6"	1.6"	1.6"	1.6"
GG	Safety Relief Valve Vessel Connection, NPT	1-1/4"	1-1/4"	1-1/4"	1-1/4"
HH	Safety Relief Valve				
	30 psig Inlet x Outlet, NPT	1" x 1-1/4"	1" x 1-1/4"	1" x 1-1/4"	1-1/4" x 1-1/2"
	50 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	1" x 1-1/4"
	60 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	1" x 1-1/4"
	75 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	3/4" x 1"
	80 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	3/4" x 1"
	100 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	3/4" x 1"
	125 psig Inlet x Outlet, NPT	3/4" x 1"	3/4" x 1"	3/4" x 1"	3/4" x 1"
JJ	Flue Coupling, NPT	3/4"	3/4"	3/4"	3/4"
KK	Water Outlet Coupling, NPT	1-1/4"	1-1/4"	1-1/4"	1-1/4"

FORK POCKETS (inches)

LL	Pocket Height	3.9	3.9	3.9	3.9
MM	Pocket Width	11.8	11.8	11.8	11.8
NN	Overall Pocket Width	27.6	27.6	27.6	27.6

WEIGHTS

	Dry Weight (lb)	1298	1396	1861	2041
	Shipping Weight (lb)	1413	1511	1986	2166
	Operating Weight (lb)	2065	2113	2778	2858
	Water Volume (gallon)	92	86	110	98

CLEARANCES

Top	14"
Side	3"
Rear	20"
Front	36"

Notes:

- Boiler rear must be accessible for servicing.
- Side clearance to wall or between boilers.
- Side clearance typical each side.

Table 2. Dimensions (Metric) Model CFC-E

ITEM	DIMENSIONS (mm)	750	1000	1500	2000
A	Overall Height	1982	1982	2028	2028
B	Overall Width	886	886	908	908
C	Overall Depth	1255	1255	1422	1422
D	Width Less Casing	816	816	838	838
E	Gas Connection to Floor	1786	1786	1877	1877
F	Side of Casing to Gas Connection	95	95	180	180
G	Side of Casing to Air Inlet	275	275	273	273
H	Top of Casing to Air Inlet	196	196	180	180
J	Floor to Condensate Drain	160	160	160	160
K	Floor to Bottom of Casing	279	279	279	279
L	Side of Base to Flue Outlet	189	189	217	217
M	Side of Base to Flue Outlet (Offset)	164	164	192	192
N	Rear of Base to Flue Outlet	165	165	190	190
P	Casing Depth	921	921	1077	1077
Q	Casing Height	1703	1703	1749	1749
R	Floor to Lower Return Connection	428	428	428	428
S	Floor to Upper Return Connection	808	808	808	808
T	Floor to Supply Connection	1511	1511	1511	1511
U	Floor to Air vent Connection	1683	1683	1683	1683
V	Air Vent Line Projection From Rear of Casing	81	81	84	84

FORK POCKETS (mm)

LL	Pocket Height	100	100	100	100
MM	Pocket Width	300	300	300	300
NN	Overall Pocket Width	700	700	700	700

WEIGHTS

	Dry Weight (kg)	589	633	844	926
	Shipping Weight (kg)	641	686	901	983
	Operating Weight (kg)	939	969	1260	1280
	Water Volume (liter)	350	324	416	370

CLEARANCES (mm)

Top	356
Side	76
Rear	508
Front	914

Notes:
- Boiler rear must be accessible for servicing.
- Side clearance to wall or between boilers.
- Side clearance typical each side.

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

		Boiler Size			
Description	**Units**	**750**	**1000**	**1500**	**2000**
Input Max.	Btu/Hr	750,000	1,000,000	1,500,000	2,000,000
	KCal/Hr	189,000	252,000	378,000	504,000
Natural Gas	Ft^3/Hr	750	1000	1500	2000
Propane	Ft^3/Hr	300	400	600	800
Natural Gas	M^3/Hr	21	28	42	57
Propane	M^3/Hr	8.5	11	17	23
Output at 120/80 F [49/27 C] 100% Firing	Btu/Hr	705,000	940,000	1,410,000	1,880,000
	KCal/Hr	177,660	236,880	355,320	473,760
	BHP	21	28	42	56
	KW	207	275	413	551
Output at 180/140 F [82/60 C] 100% Firing	Btu/Hr	660,000	880,000	1,320,000	1,760,000
	KCal/Hr	166,320	221,760	332,640	443,520
	BHP	20	26	39	53
	KW	193	258	387	516
MAWP	psi	125	125	125	125
	Bar	8.6	8.6	8.6	8.6
MAWT	°F	210	210	210	210
	°C	99	99	99	99
Maximum Operating Setpoint	°F	194	194	194	194
	°C	90	90	90	90
Water Content	Gallons	92	86	110	98
	Liters	350	324	416	370
Weight w/o Water	Pounds	1,298	1,396	1,861	2,041
	Kg	589	633	844	926
Standby Heat Loss	Btu/Hr	1500	2000	3000	4000
	Watts	440	586	879	1172
ECM Blower Motor Size	Watts	335	335	1,700	1,700
Operating Voltage, Blower	Volts/Ph/Hz	115/1/60	115/1/60	115/1/60	115/1/60
Control Circuit	Volts/Ph/Hz	115/1/60	115/1/60	115/1/60	115/1/60
Max Current Draw, Blower	Amperes	4	4	13.5	13.5
Max Current Draw Cont. Circuit	Amperes	1.5	1.5	2	2
Max Over Current Protection	Amperes	20	20	20	20
Condensate Quantity Firing Nat. Gas & operating @ 120/80 F.	Gal/Hr	5	6.5	10	13
Flue Gas Mass Flow @ 100% Firing	lb/hr	835	1,113	1,670	2,226
	kg/hr	379	505	758	1010

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

Natural Gas MBTU/h at various altitudes

	700' ASL	2000'	4000'	6000'	8000'	10000'
CFC-E 2000	2000	2000	1883	1747	1619	1552
CFC-E 1500	1500	1500	1500	1500	1500	1472
CFC-E 1000	1000	1000	945	877	813	779
CFC-E 750	750	750	750	707	655	628

** 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 14. Altitude corrections for supply pressure should be made per Table 15
Natural gas heating value of 1000 BTU/SCF assumed.

LP Gas MBTU/h at various altitudes

	700' ASL	2000'	4000'	6000'	8000'	10000'
CFC-E 2000	2000	2000	2000	1867	1730	1659
CFC-E 1500	1500	1500	1500	1500	1500	1500
CFC-E 1000	1000	1000	1000	926	858	822
CFC-E 750	750	750	750	750	724	694

** 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 14. Altitude corrections for supply pressure should be made per Table 15
LP (propane) gas heating value of 2500 BTU/SCF assumed.

PERFORMANCE DATA

Efficiency

The Model CFC-E 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. 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 premix burner, the ClearFire’s efficiency under “traditional” hot water conditions is also outstanding. Table 5 shows 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.

ClearFire Efficiencies

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

Table 5. CFC-E Efficiencies

CFC-E 750 Efficiency

% Firing Rate	Return Water Temperature °F (°C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20%	98.5	97.4	95.6	92.1	90.3	88.8	88.0
50%	97.2	95.7	93.6	90.8	89.4	88.4	87.7
75%	96.1	94.3	92.0	89.7	88.7	88.0	87.5
100%	95.0	92.9	90.3	88.6	88.0	87.6	87.3

CFC-E 1000 Efficiency

% Firing Rate	Return Water Temperature °F (°C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20%	99.0	98.8	97.0	93.3	90.7	88.9	88.0
50%	97.8	96.9	94.7	91.5	89.8	88.5	87.7
75%	96.9	95.4	92.7	90.0	89.0	88.2	87.5
100%	95.9	93.8	90.8	88.6	88.2	87.9	87.3

CFC-E 1500 Efficiency

% Firing Rate	Return Water Temperature °F (°C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20%	98.5	97.6	95.2	91.8	90.1	88.8	88.0
50%	97.1	95.9	93.4	90.6	89.3	88.3	87.8
75%	96.0	94.4	91.9	89.6	88.6	87.9	87.5
100%	94.9	93.0	90.4	88.6	87.9	87.5	87.3

CFC-E 2000 Efficiency

% Firing Rate	Return Water Temperature °F (°C)						
	68 (20)	80 (27)	100 (38)	120 (49)	130 (55)	140 (60)	160 (72)
20%	98.0	97.1	94.5	91.4	90.0	88.9	88.0
50%	96.6	95.5	93.0	90.5	89.3	88.5	87.7
75%	95.5	94.1	91.7	89.6	88.8	88.2	87.5
100%	94.3	92.7	90.5	88.8	88.3	87.8	87.2

Conditions:
Natural Gas
40% Excess Air
Relative Humidity = 50%
ΔT = 40°F
R & C Loss = 0.2% of rated capacity

Figure 5. Efficiency 750

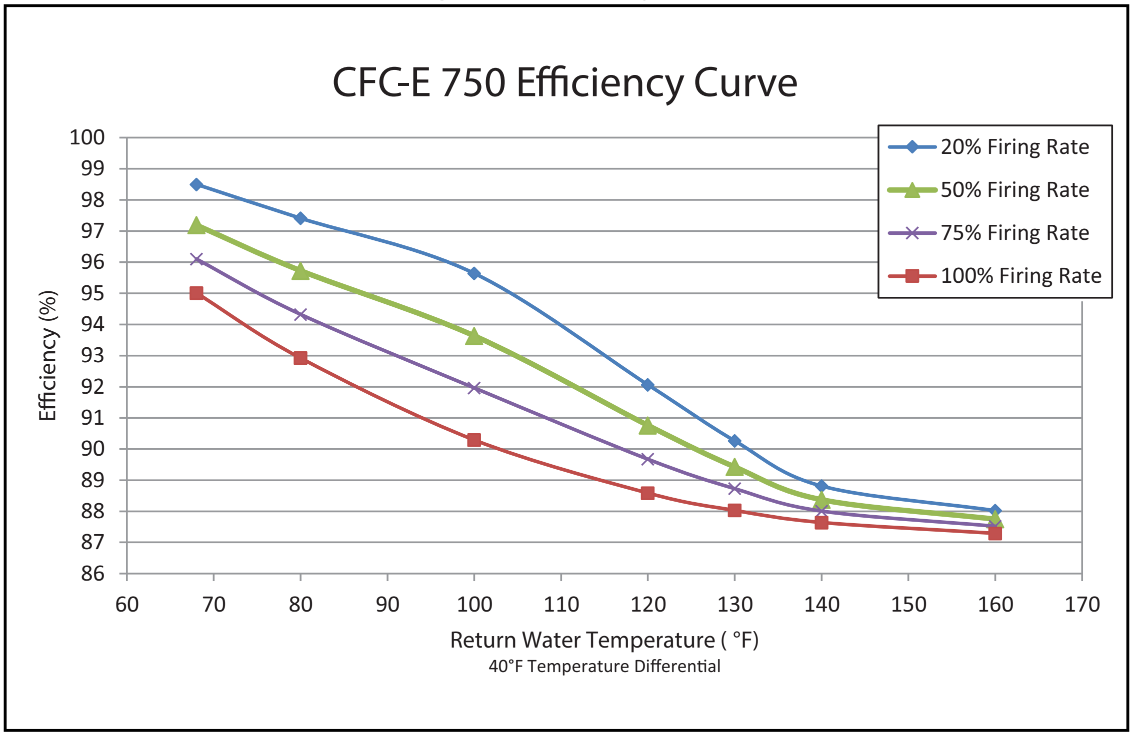


Figure 6. Efficiency 1000

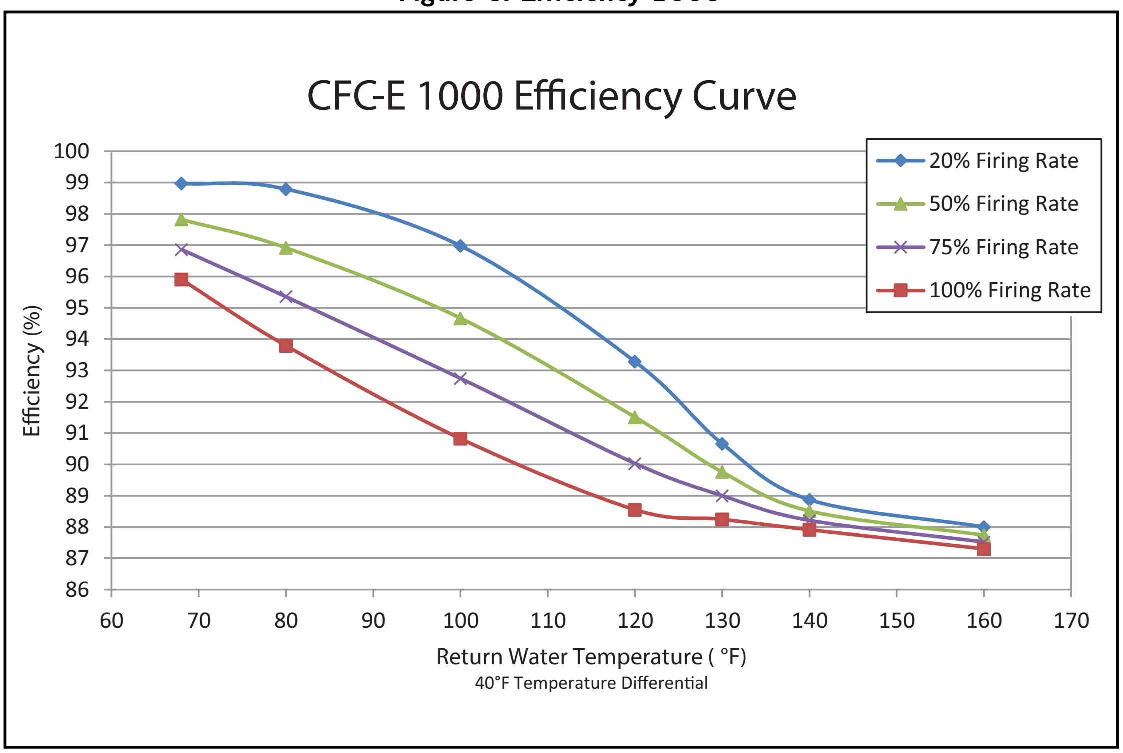


Figure 7. Efficiency 1500

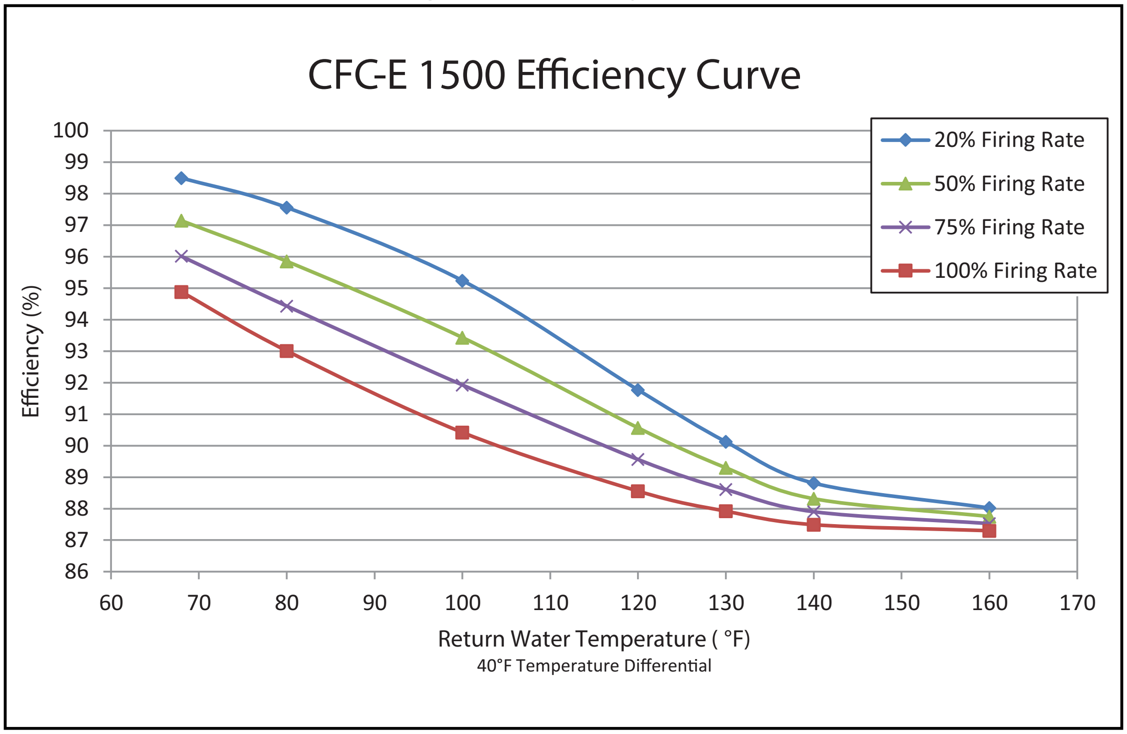
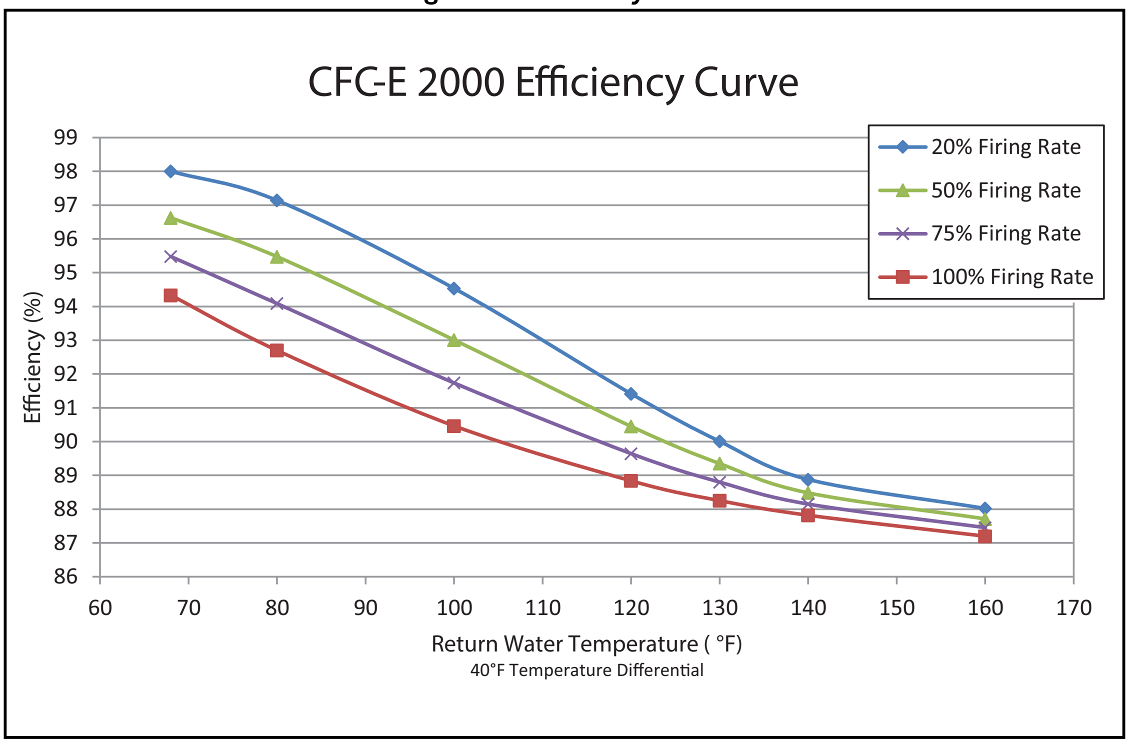


Figure 8. Efficiency 2000



Emissions

By means of the Pre-mix burner, the Clearfire boiler provides environmentally friendly emissions when firing natural gas; emission data are shown below.

Table 6. Emissions

POLLUTANT	UNITS	
CO	ppm*	<20
	lb/MMBTU	<0.014
NOx	ppm*	<20
	lb/MMBTU	<0.024
SOx	ppm*	<1
	lb/MMBTU	<0.001
HC/VOC	ppm*	<4
	lb/MMBTU	<0.0016
PM	ppm*	-
	lb/MMBTU	<0.01

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

Noise Level

The Model CFC-E 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 7. Noise level (dBA) measured 3 feet in front of boiler

	20% Input	60% Input	100% Input
CFC-E 750	41	51	60
CFC-E 1000	43	56	61
CFC-E 1500	46	56	66
CFC-E 2000	46	61	70

ENGINEERING DATA

Boiler Information

The Model CFC-E boiler is designed for service in any closed hydronic 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 194° F (90° C); ideal for systems such as ground water source heat pump applications. 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 8. Flow Rates

CFC-E Flow Rates

	Temperature Differential (°F)											
	10	20	30	40	50	60	70	80	90	100	110	120
Size	Flow Rate GPM											
750	141	71	47	35	28	24	20	18	16	14	13	12
1000	188	94	63	47	38	31	27	24	21	19	17	16
1500	283	141	94	71	57	47	40	35	31	28	26	24
2000	377	188	126	94	75	63	54	47	42	38	34	31

Recommended flow rates relative to temperature drop so as not to exceed boiler output.
Based on 94% nominal effficiency and maximum firing capacity
Based on water only

CFC-E Flow Rates [metric]

	Temperature Differential (°C)											
	6	11	17	22	28	33	39	44	50	56	61	67
Size	Flow Rate m^3/hr											
750	32.1	16.0	10.7	8.0	6.4	5.3	4.6	4.0	3.6	3.2	2.9	2.7
1000	42.8	21.4	14.3	10.7	8.6	7.1	6.1	5.3	4.8	4.3	3.9	3.6
1500	64.1	32.1	21.4	16.0	12.8	10.7	9.2	8.0	7.1	6.4	5.8	5.3
2000	85.5	42.8	28.5	21.4	17.1	14.3	12.2	10.7	9.5	8.6	7.8	7.1

Recommended flow rates relative to temperature drop so as not to exceed boiler output.
Based on 94% nominal efficiency and maximum firing capacity
Based on water only

Figure 9. Waterside Pressure Drop CFC-E 750

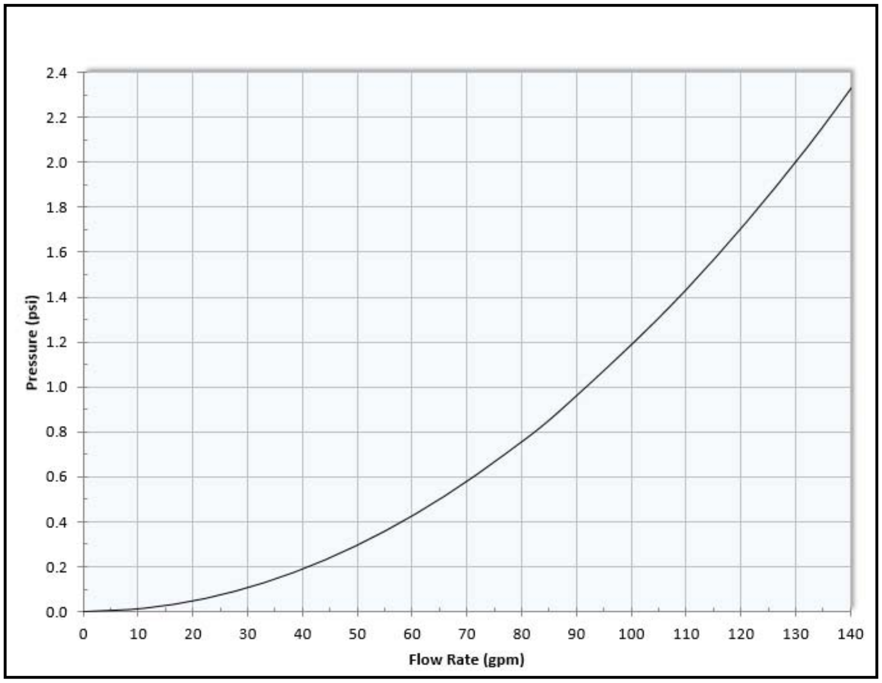


Figure 10. Waterside Pressure Drop CFC-E 1000

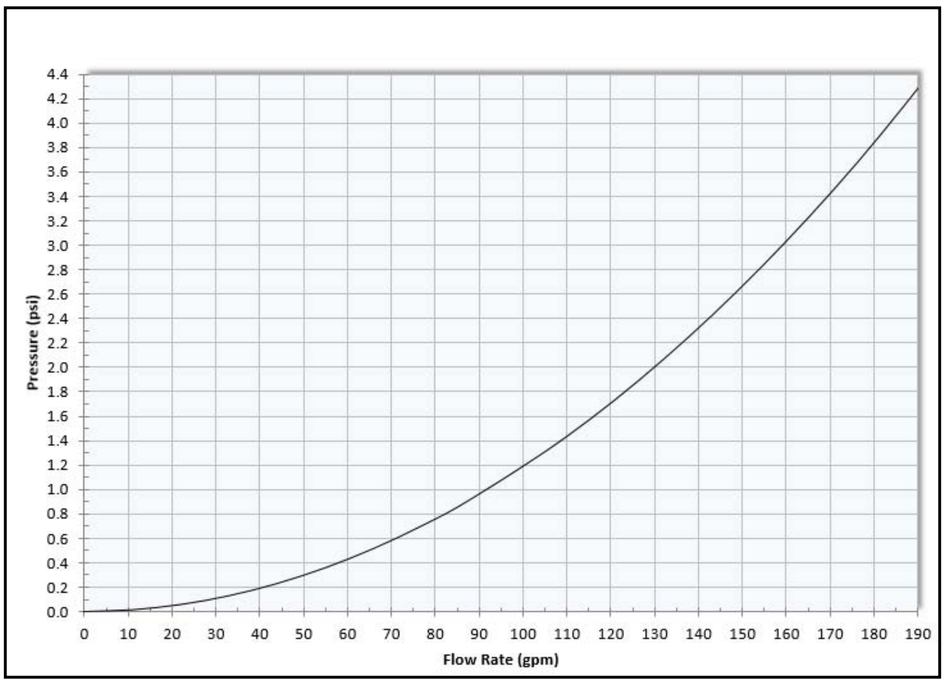


Figure 11. Waterside Pressure Drop CFC-E 1500

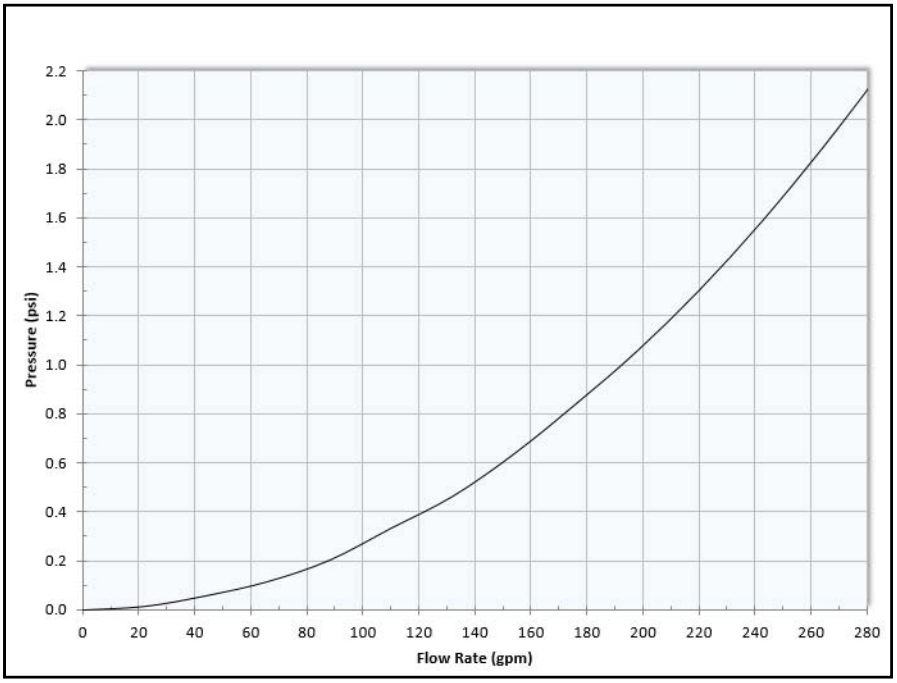
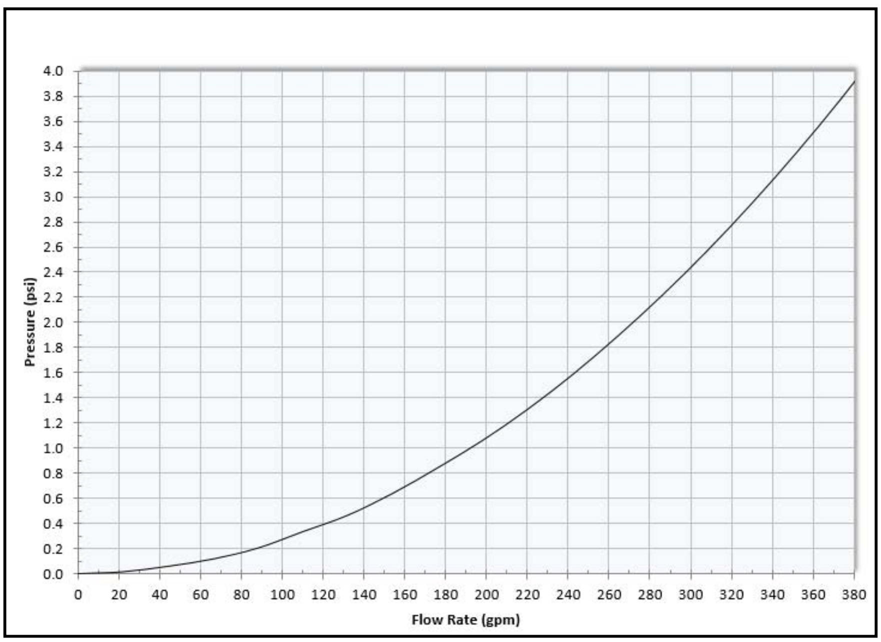


Figure 12. Waterside Pressure Drop CFC-E 2000



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 9.

Maximum Allowable Working Temperature (MAWT) is 210°F (99°C).

Maximum operating set point is 194°F (90°C)

Maximum Allowable Working Pressure is 125 PSIG (963 KPA)

Practical operating pressure limit is 112 PSIG (874 KPA)

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 10).

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 vessel as the boiler cools, or in some instances the vent can become plugged.

Table 9. Model CFC-E Minimum Over Pressure Requirements

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

Table 10. Safety Relief Valve Information

@125 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	3364
CFC-E 1000	3/4"	1"	3364
CFC-E 1500	3/4"	1"	3364
CFC-E 2000	3/4"	1"	3364
@100 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	2756
CFC-E 1000	3/4"	1"	2756
CFC-E 1500	3/4"	1"	2756
CFC-E 2000	3/4"	1"	2756
@80 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	2270
CFC-E 1000	3/4"	1"	2270
CFC-E 1500	3/4"	1"	2270
CFC-E 2000	3/4"	1"	2270
@75 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	2148
CFC-E 1000	3/4"	1"	2148
CFC-E 1500	3/4"	1"	2148
CFC-E 2000	3/4"	1"	2148
@60 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	1785
CFC-E 1000	3/4"	1"	1785
CFC-E 1500	3/4"	1"	1785
CFC-E 2000	1"	1-1/4"	2789
@50 psig			
Model	Inlet (NPT)	Outlet (NPT)	Valve Capacity (MBH)
CFC-E 750	3/4"	1"	1540
CFC-E 1000	3/4"	1"	1540
CFC-E 1500	3/4"	1"	1540
CFC-E 2000	1"	1-1/4"	2407

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.

Table 11. Model CFC-E Water Chemistry Requirements in accordance with ABMA

Parameter	Limit
Glycol	50%
pH	8.3 - 10.5
Nitrates	50 ppm
Sulfates	50 ppm
Chloride	< 250 ppm
Oxygen	< 0.1 ppm
Specific Conductivity	< 3500 μmho/cm
Total Hardness	< 10 ppm

Glycol Application Guidelines

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

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

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

The following recommendations should be adhered to in applying ClearFire model CFC-E 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 ΔT (Delta T). A ΔT Limit algorithm should be enabled in the boiler controller.

b) Independent from the hydraulics of the heating system, constant water circulation through each boiler is required while the boiler is operating (requires a dedicated boiler pump if in a primary/secondary loop arrangement). Refer to table below for minimum boiler circulation rates.

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 10.5
7) It is recommended to maintain continuous circulation in glycol systems. Where this is impractical (e.g. multiple boiler systems), a periodic pump exercise routine should be implemented to ensure proper mixture of glycol and to avoid degradation that naturally occurs with glycol mixtures. This can be as simple as opening a boiler isolation valve once a day or turning on a boiler circulating pump.

Table 12. Glycol Minimum Flow Recommendations for ClearFire Model CFC-E Boiler

(Minimum required boiler circulation rate (gpm) at maximum firing rate.)

	System ΔT (˚F)			
Model-Size	ΔT = 10˚	ΔT = 20˚	ΔT = 30˚	ΔT = 40˚
CFC-E 750	142	71	47	36
CFC-E 1000	190	95	63	47
CFC-E 1500	285	142	95	71
CFC-E 2000	380	190	127	95

Notes/Limitations:

1. Maximum firing rate determined by ClearFire CFC-E Glycol Firing Rate Limitation chart (below). Maximum high fire blower speed set according to chart.
2. Glycol concentration 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 Cleaver-Brooks 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.

Figure 13. High Fire Speed Settings vs. % Glycol

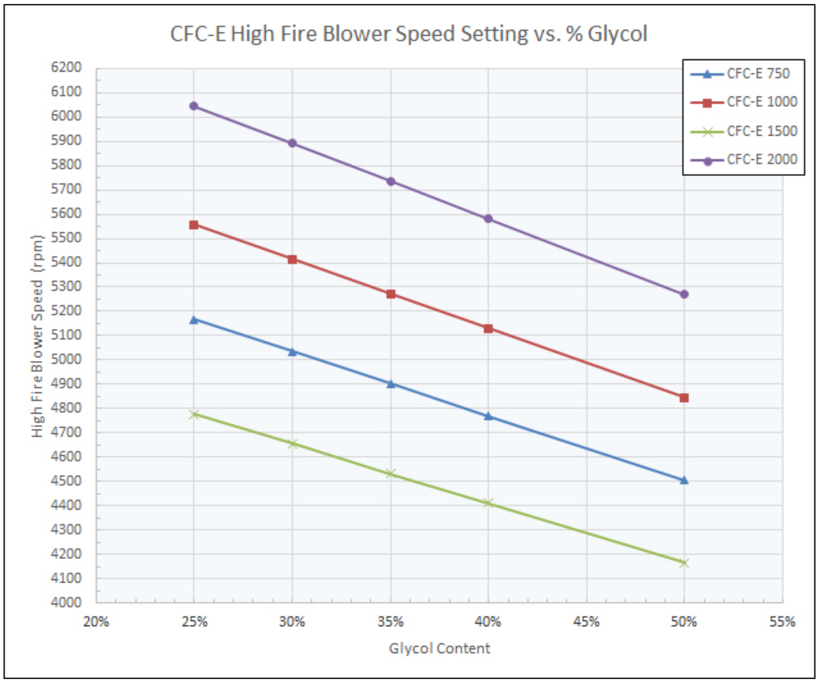
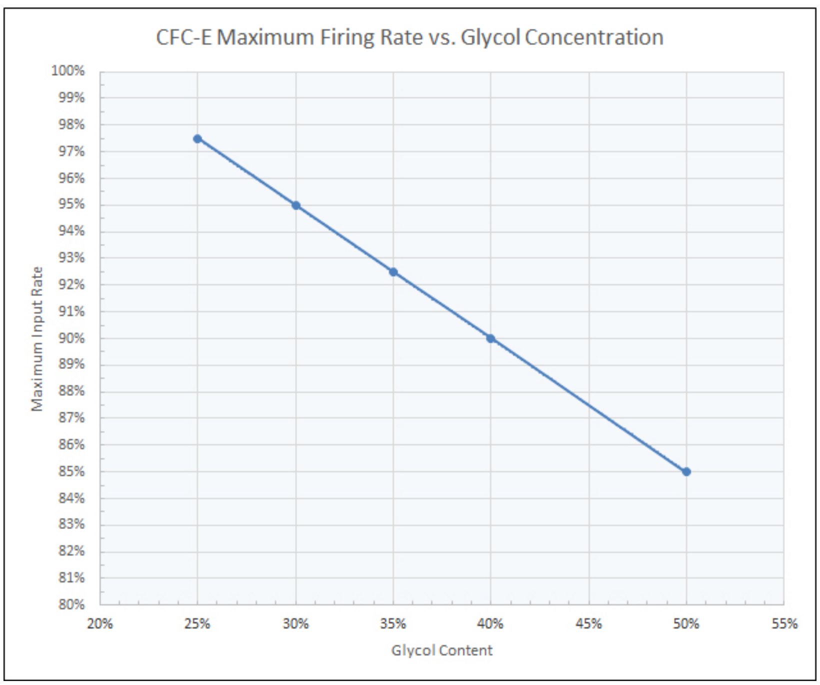


Figure 14. Maximum Firing Rate vs. % Glycol



Condensation

The CFC-E uses one of several condensate removal options, depending on the application:

(1) Condensate direct to drain - The condensate is piped directly to a drain through the piping and water trap supplied during installation (see **Figure 15**).

- Piping is to be a minimum of 3/4” NPT.
- Maximum discharge pipe height from floor to be 9”.
- Condensate water trap (5”) required.

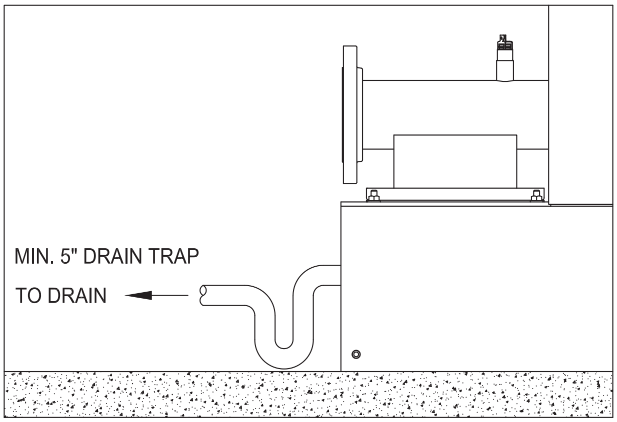


Figure 15. Condensate Piped Direct to Drain

(2) Neutralization Capsule - A compact, corrosion resistant capsule is piped to the condensate drain downstream of the water trap. Capsule is filled with a replaceable neutralizing agent.

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

Capsule is limited to individual boilers 1000 MBH and smaller.

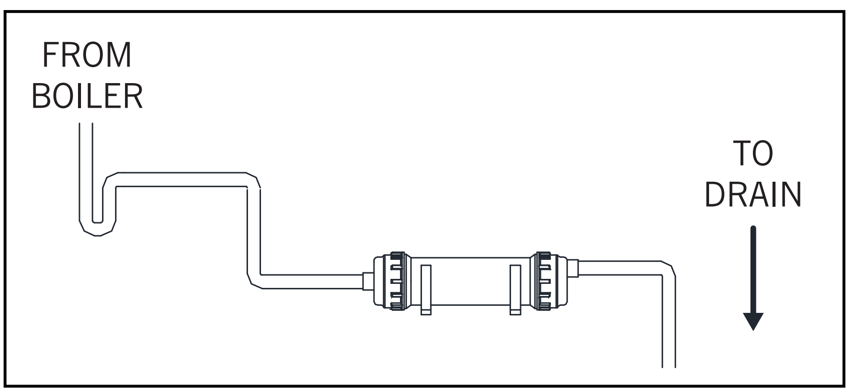


Figure 16. Neutralization Capsule

(3) Combo trap/treatment tank - The condensate is held in a condensate tank under the boiler. The condensate is neutralized as it passes through the granular bed. The neutralized condensate is then piped to the drain.

The combo tank features an integral water trap and float makeup valve.

- To install the system, assemble the tank and neutralization granulate per Figure 17**.** Two bags of neutralization media are sufficient to fill the tank.
- Install the condensate tank cover and slide the complete assembly under the boiler

Pipe to the appropriate drain.

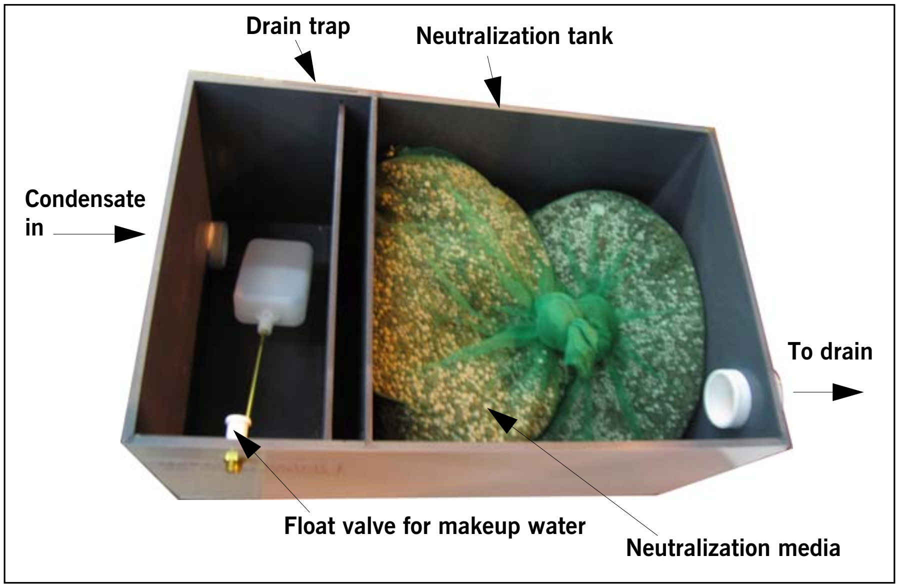


Figure 17. Combo Trap/Tank

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

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

(4) Treatment tank - The condensate is held in a condensate tank(s) under or near the boiler. The condensate is neutralized as it passes through a bed of granular material. The neutralized condensate is then piped to the drain.

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

Pipe to an appropriate drain.

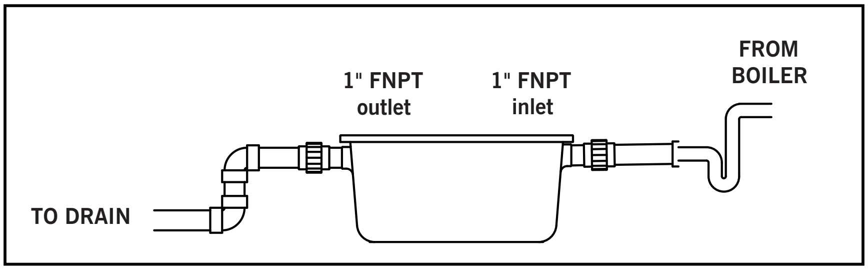


Figure 18. Treatment Tank

Condensate Piping for Multiple Boilers

Table 13. Condensate piping for multiple boilers

CFC-E Model	BTU/hr	Max. Condensation GPH	Max. Boilers per Tank
2000	2,000,000	13	4
1500	1,500,000	9	4
1000	1,000,000	7	4
750	750,000	5	4

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 a maximum of 4 boilers per tank, with total BTU per tank not to exceed 8,000,000.

See figures below for suggested piping. When using the combo tank, supply make-up water at the connection shown. An internal float in the tank activates the make-up water valve.

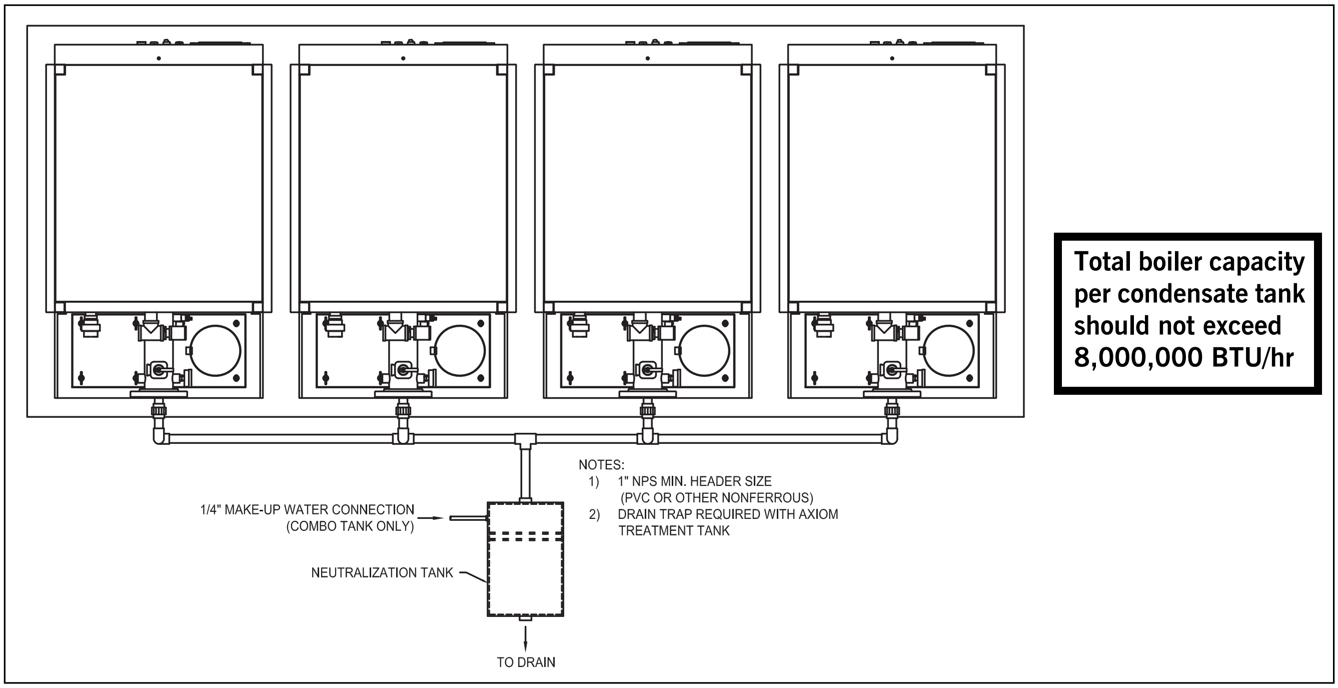


Figure 19. Condensate Piping for Multiple Boilers

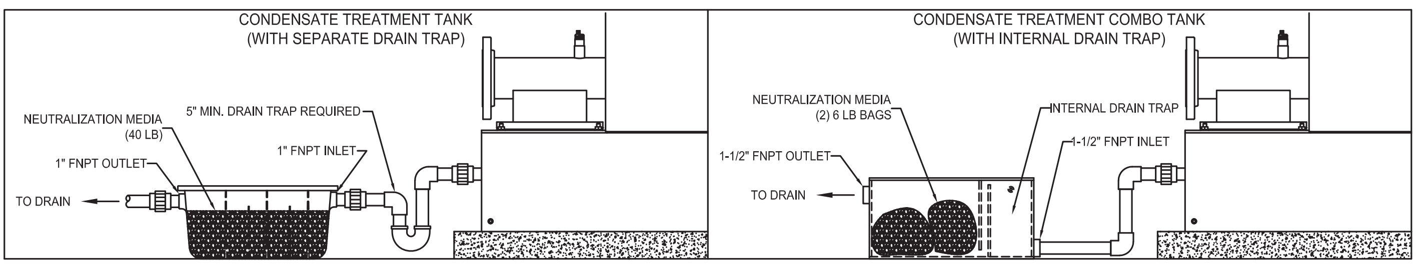


Figure 20. Tank Detail, Multiple Boilers

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 21 and Figure 22 for piping suggestions.

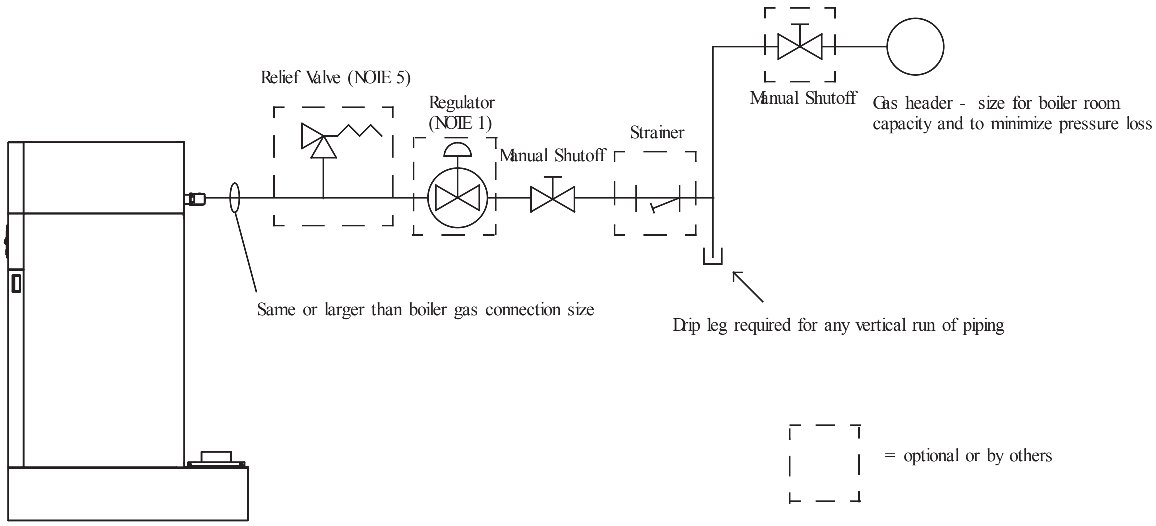
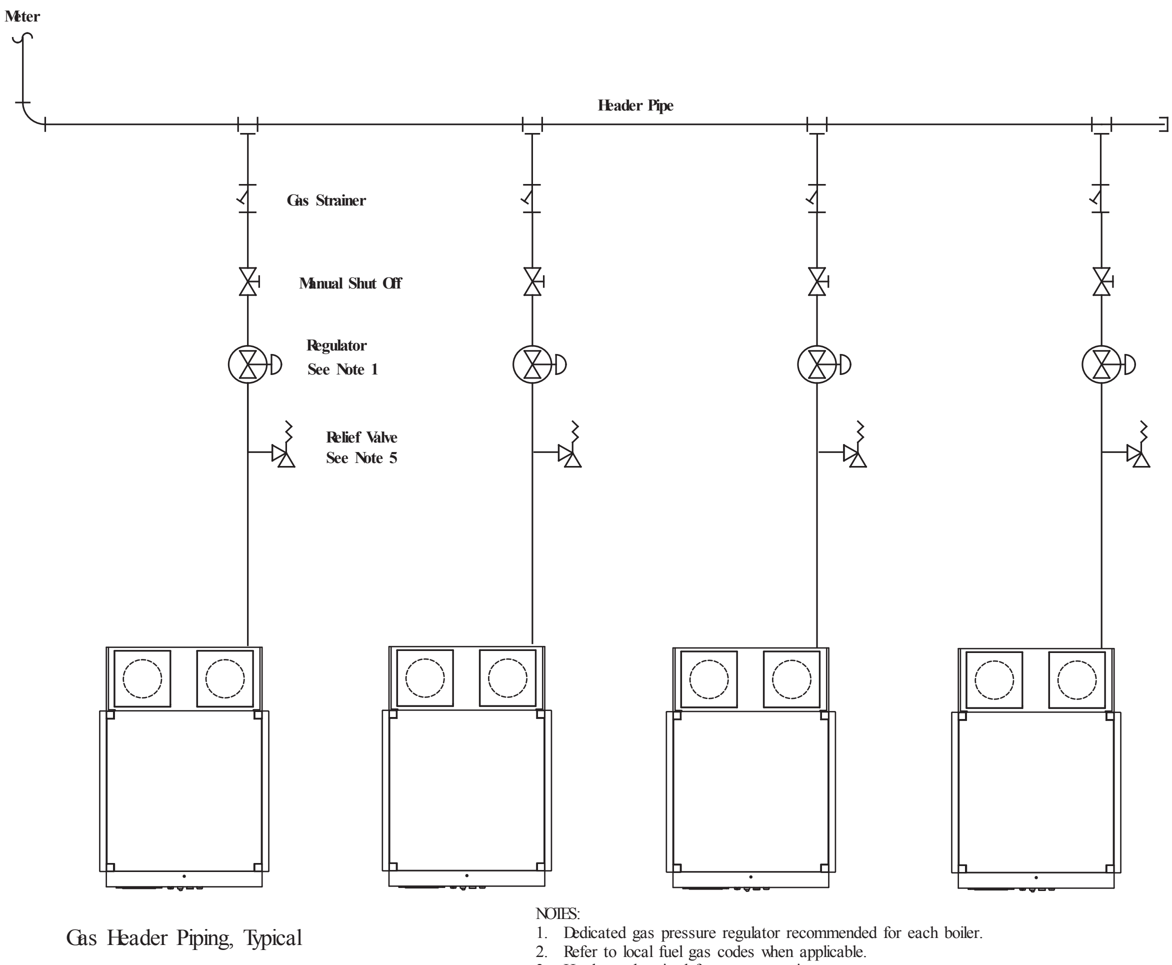


Figure 21. Gas Piping Schematic

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 14 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 required.
C. Table 15 shows the correction factors for gas pressure at elevations at 2000 feet and higher above sea level.



NOTES:
1. Dedicated gas pressure regulator recommended 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 22. Gas Header Piping

Table 14. Model CFC-E Minimum and Maximum Gas Pressure

Boiler Model	Minimum pressure required at gas train connection (inches Water Column)		Max. pressure (without step-down regulator)	Maximum gas train pressure rating*	
	Natural Gas	LP Gas		UL	cUL/CSA
750	7”	11”	14” WC (1/2 psig)	1 psig	1/2 psig
1000	7”	11”			
1500	7”	11”			
2000	7”	11”			

*Overpressure protection required when room supply gas pressure is greater than maximum gas train pressure rating.

Table 15. Model CFC-E Minimum Required Gas Pressure Altitude Correction

Altitude in Feet	Correction Factor
1000	1.04
2000	1.07
3000	1.11
4000	1.16
5000	1.21

Altitude in Feet	Correction Factor
6000	1.25
7000	1.3
8000	1.35
9000	1.4

To obtain minimum required inlet pressure, select altitude of installation and multiply the pressure shown in Table 13 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 optional adjustable feet 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 23.

Hot Water Piping

Dedicated boiler circulation pumps are not required with the Model CFC-E 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.

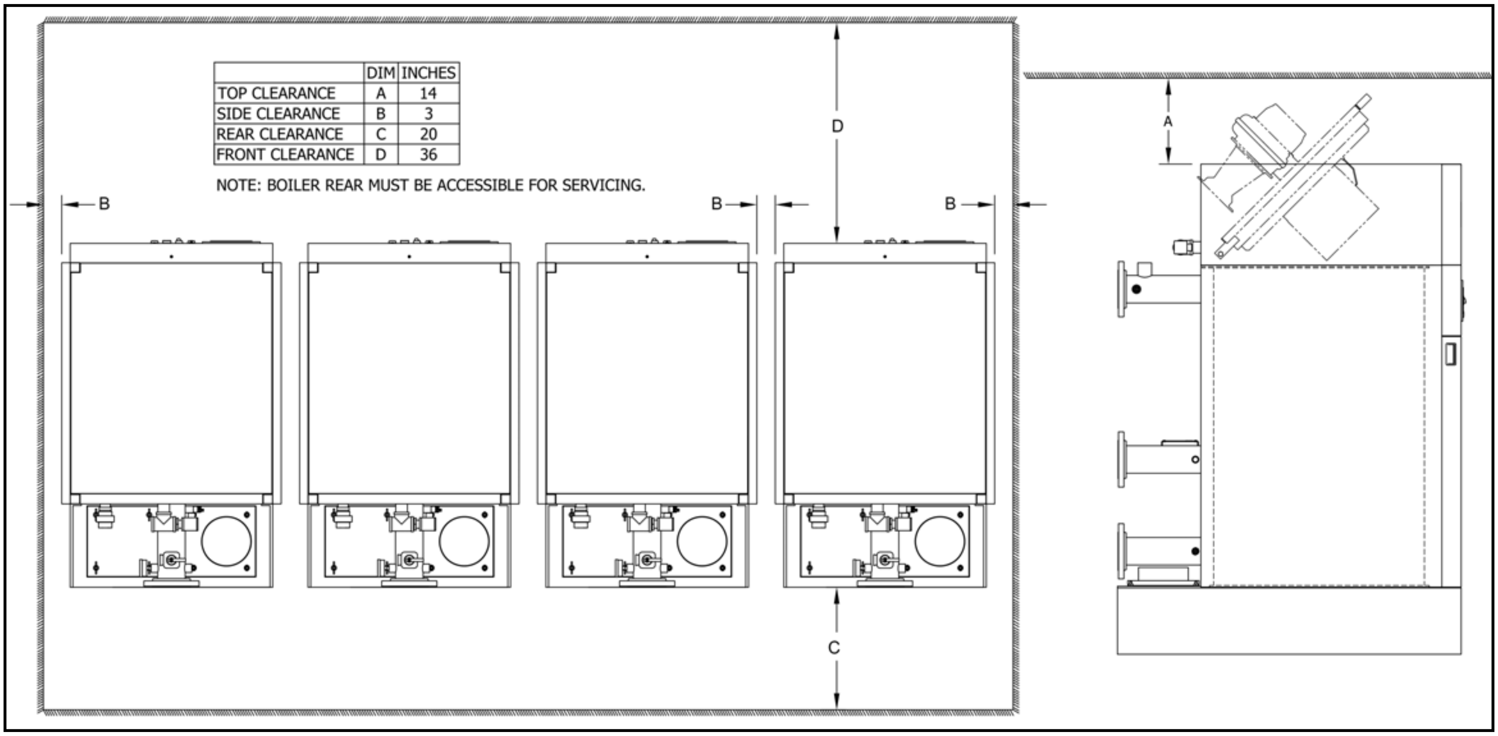


Figure 23. Model CFC-E Minimum Room Clearance Dimensions

Seismic Legs

Seismic mounting details shown below.

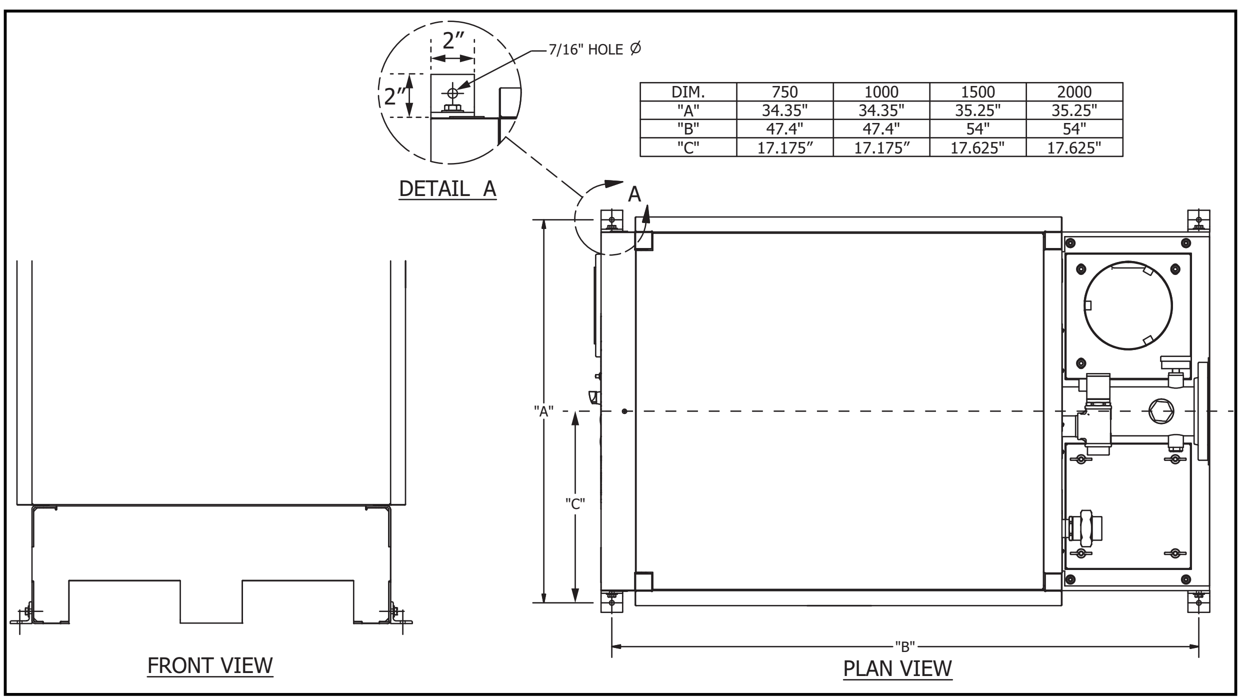


Figure 24. CFC-E Seismic Mounting

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.

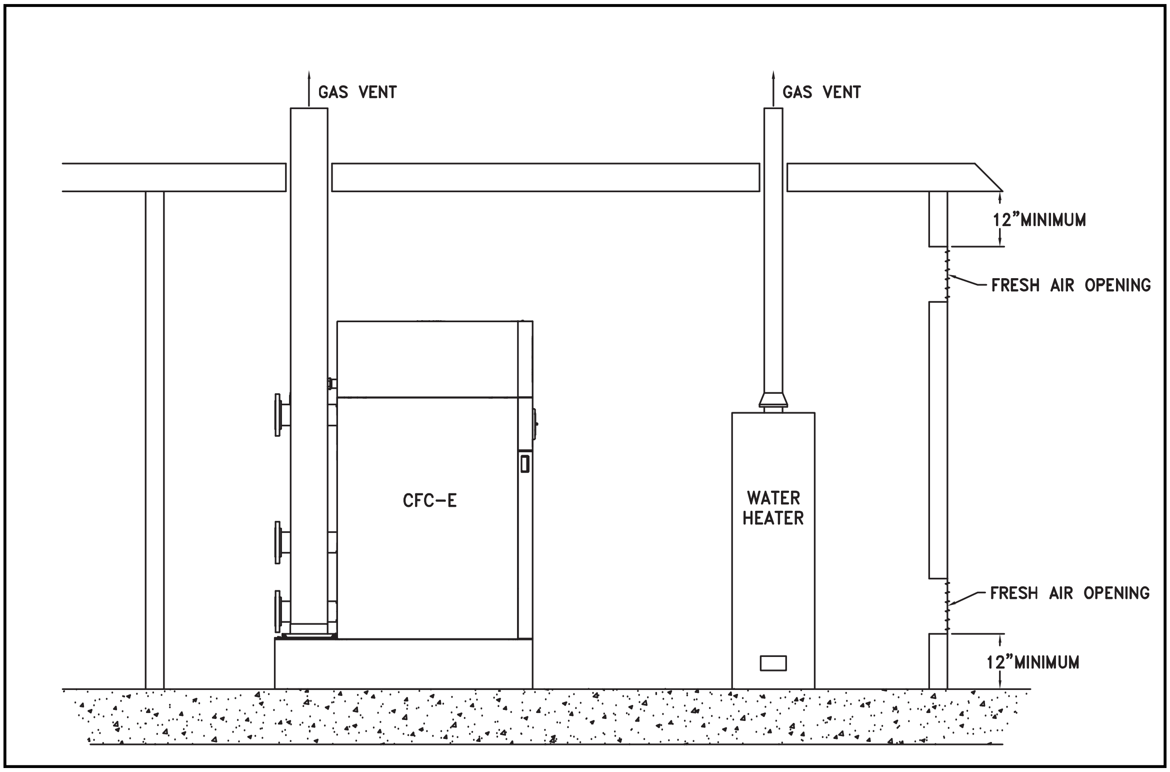


Figure 27. Two Opening Outside Wall Method

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 27) - 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.

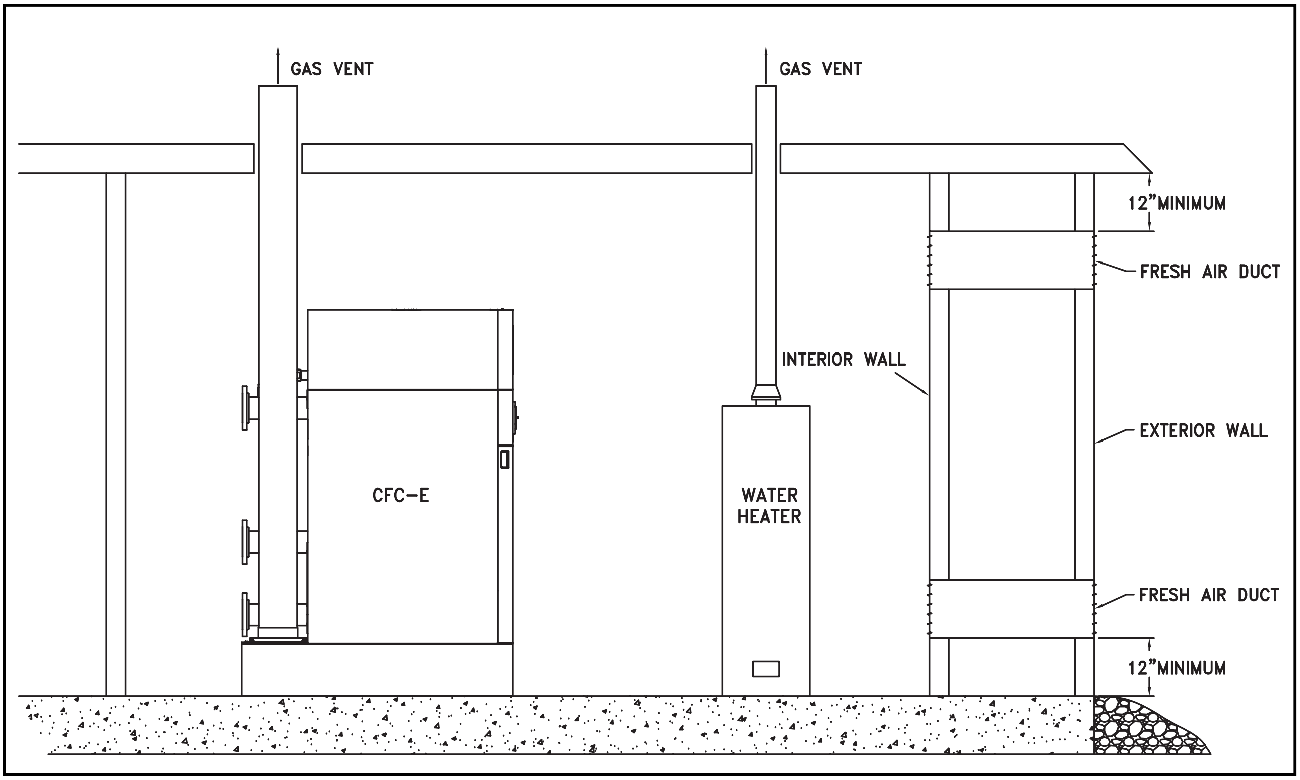


Figure 28. Two Opening Ducted Method

C. One Opening Method (Figure 29) - 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.

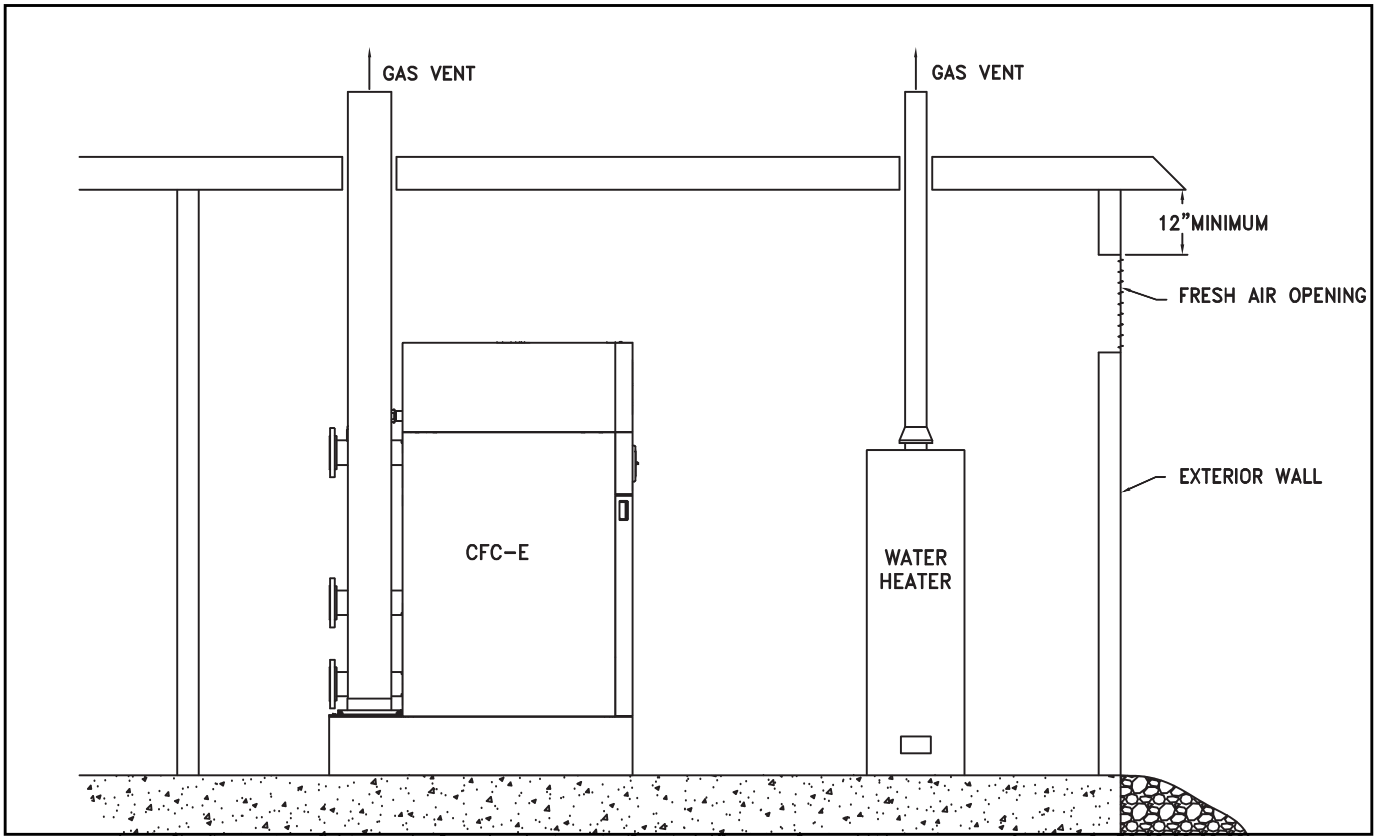


Figure 29. One Opening Method

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 30.
   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.

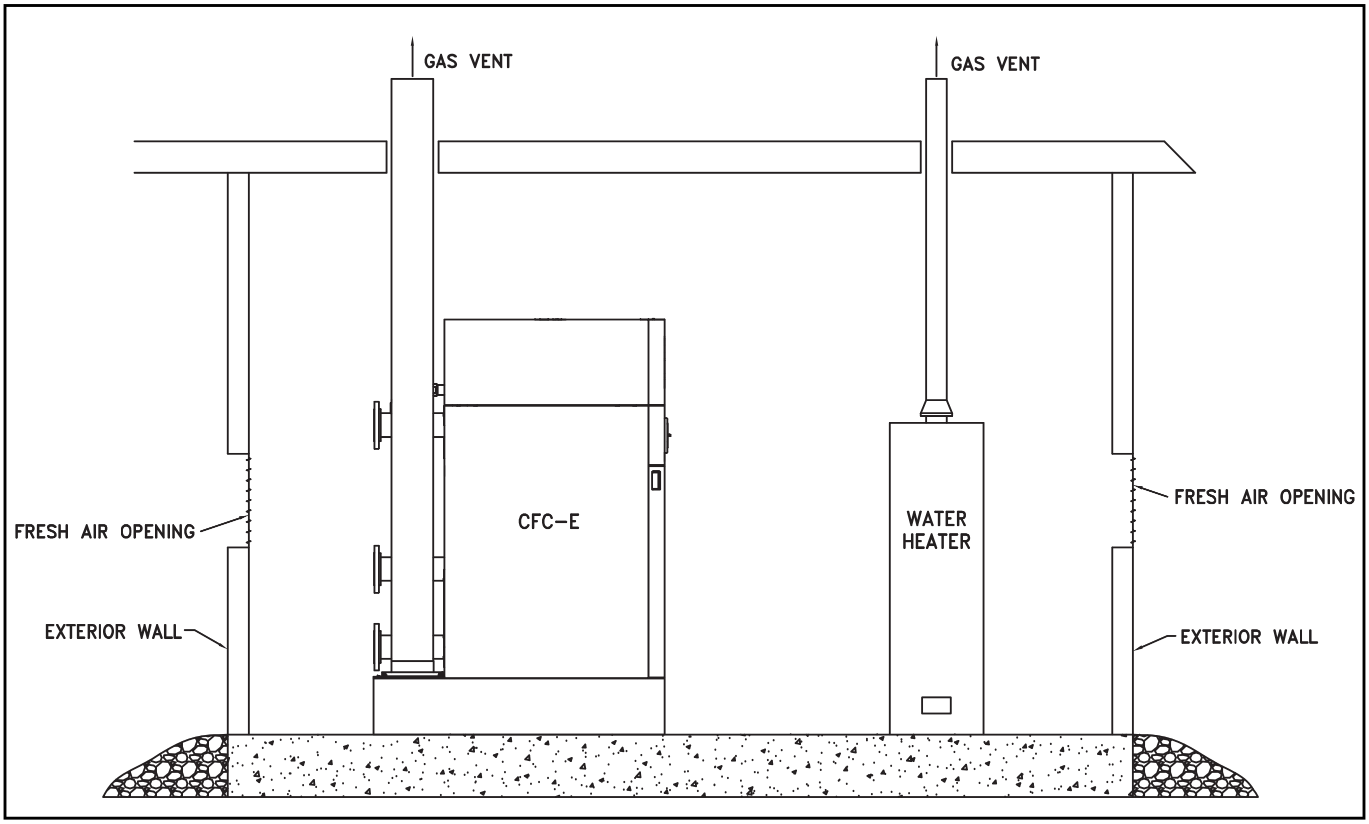


Figure 30. Two Opening Engineered Method

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).

Consult local codes, which may supersede these requirements.

Boiler Air Inlet

The boiler ships with both an air inlet screen and a direct vent collar (see illustration below). If room air will be used for combustion, install the air inlet screen; the collar may be discarded. If direct venting will be used, install the vent collar; the screen may be discarded.

Mounting hardware is provided with the boiler.

When using direct vent combustion:

1. Provide for adequate ventilation of the boiler room or mechanical equipment room.
2. 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.

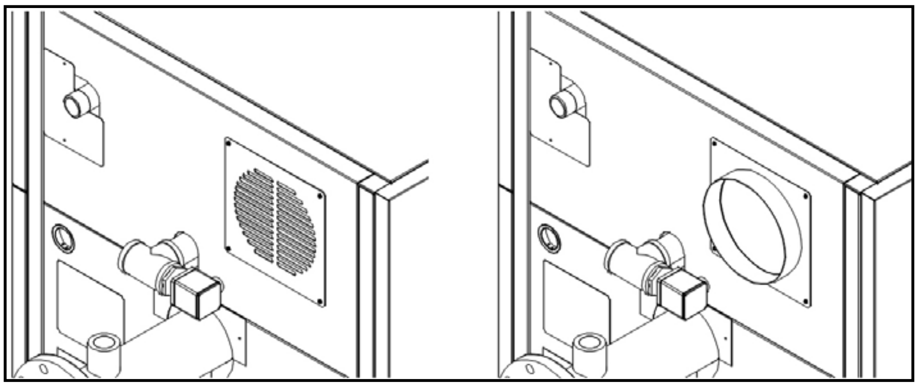


Figure 31. Boiler Air Inlet

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-E 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 veranda, porch, or deck unless:
   A. The veranda, 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 veranda, porch, or deck is greater than one foot (300mm).

Horizontal Through the Wall Venting

Venting configurations using inside air for combustion (See Figure 32)

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.

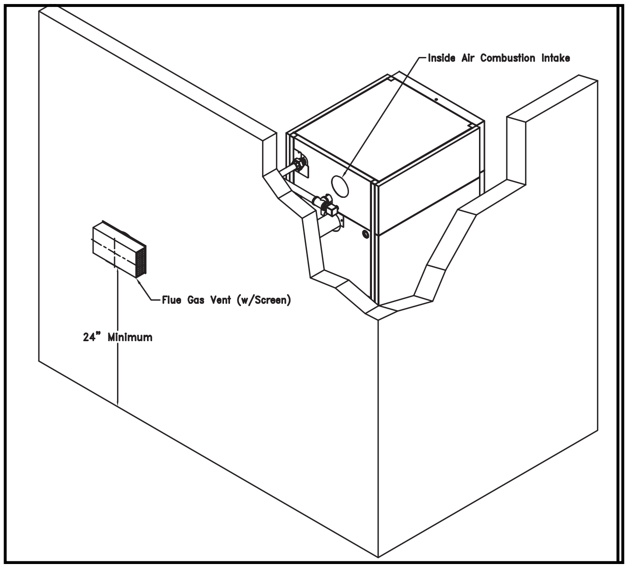


Figure 32. Horizontal through-wall venting using inside air for combustion

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.

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

Refer to table for the recommended sizes of horizontal vent pipe.

Horizontal Through the Wall Stack Venting

Direct Vent Combustion. See Figure 33.

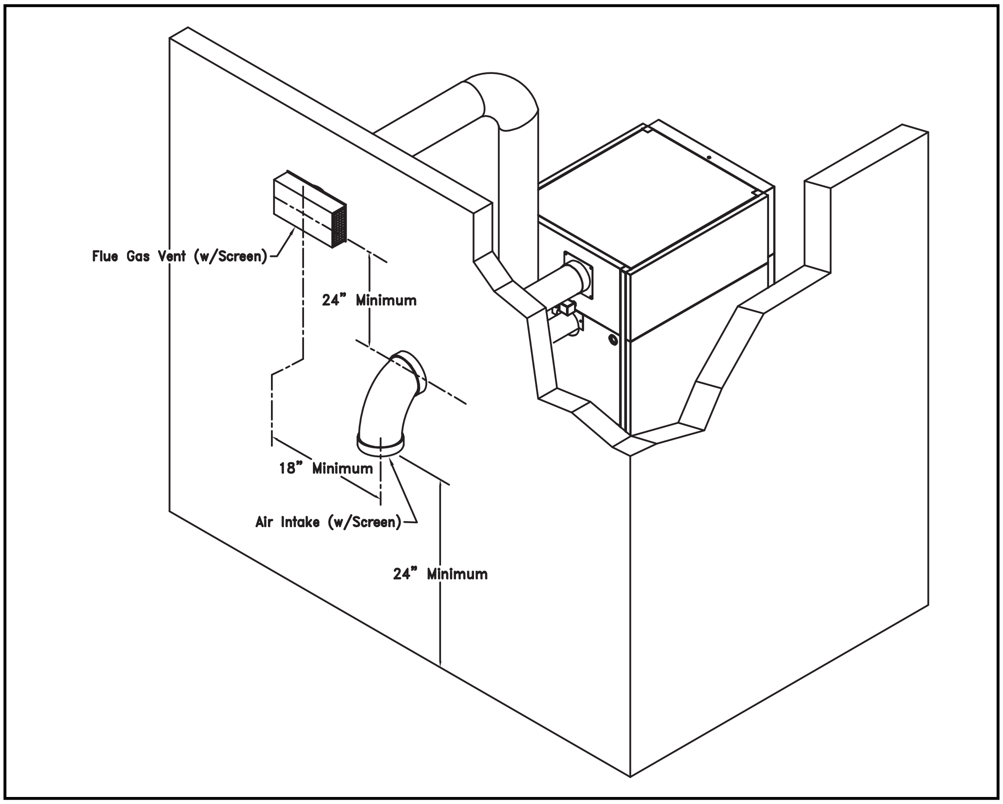


Figure 33. Horizontal flue through-wall with direct vent combustion intake

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 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.

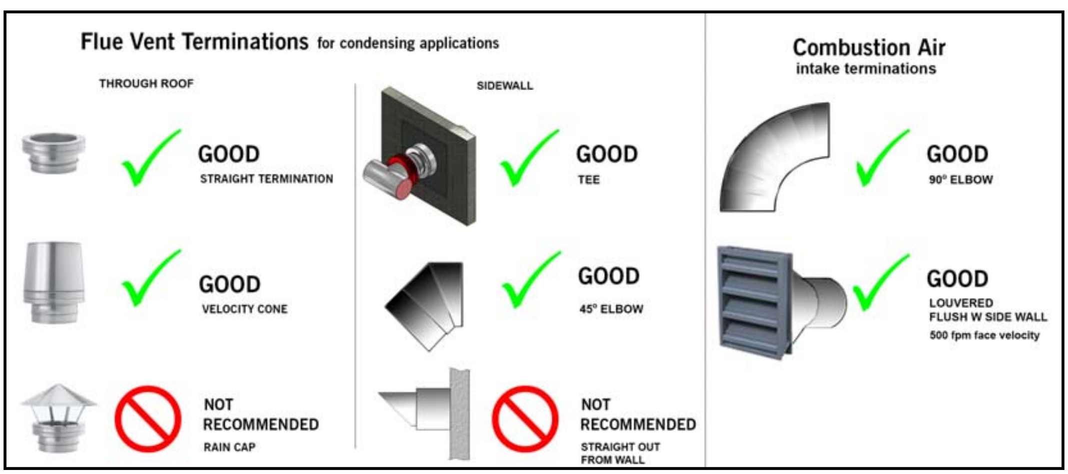
Table 15. **STACK SIZING USING OUTSIDE AIR FOR COMBUSTION (DIRECT VENT)**

Boiler	Combustion Air Duct (Inches Diameter)	Combustion Air SCFM Required	Flue Connection/Duct (Inches Diameter)	Max. Length* (Equivalent Feet)
CFC-E 750	6	188 SCFM	6 standard	100
			8 optional	120
CFC-E 1000	6	250 SCFM	8 standard	100
			6 optional	50
CFC-E 1500	8	375 SCFM	8 standard	100
			10 optional	120
CFC-E 2000	8	500 SCFM	8 standard	100
			10 optional	120

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.

Draft tolerance at boiler flue connection during operation is +/-0.25” W.C.; Use +/-0.10” when designing venting system.

*Maximum vent length assumes horizontal run and sidewall terminations. Larger diameter venting, vertical flue runs, and vertical flue termination may allow for longer vent lengths than indicated here, provided the engineered draft calculations are within the allowable operational tolerance of +/-0.25” W.C.



Vertical Venting Inside Combustion Air

See Figure 34.

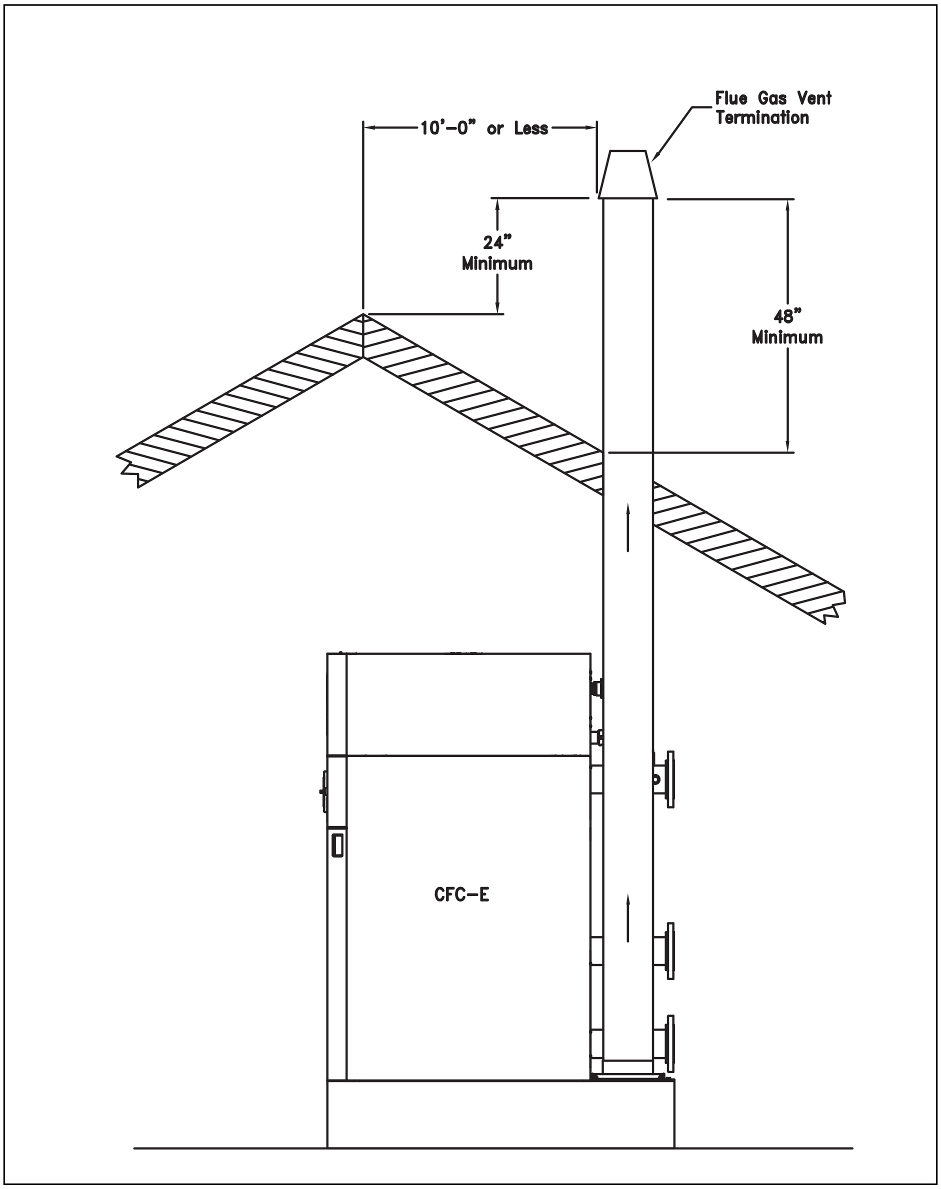


Figure 34. Inside Air - Vertical Vent

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.

Vertical Venting Direct Vent Combustion

See Figure 35.

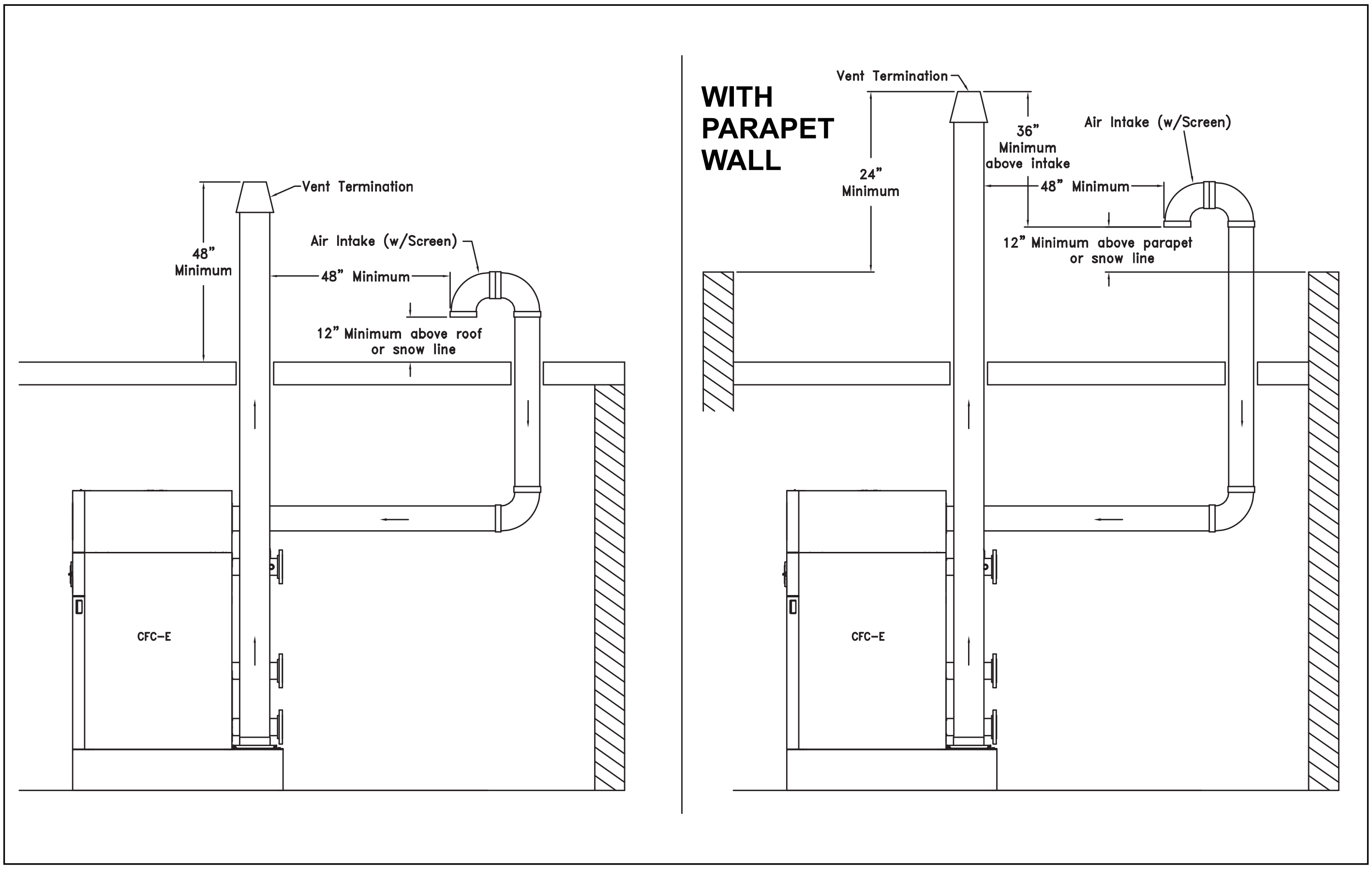


Figure 35. Vertical Stack with Direct Vent Combustion Air

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.

Boiler Rear Connections

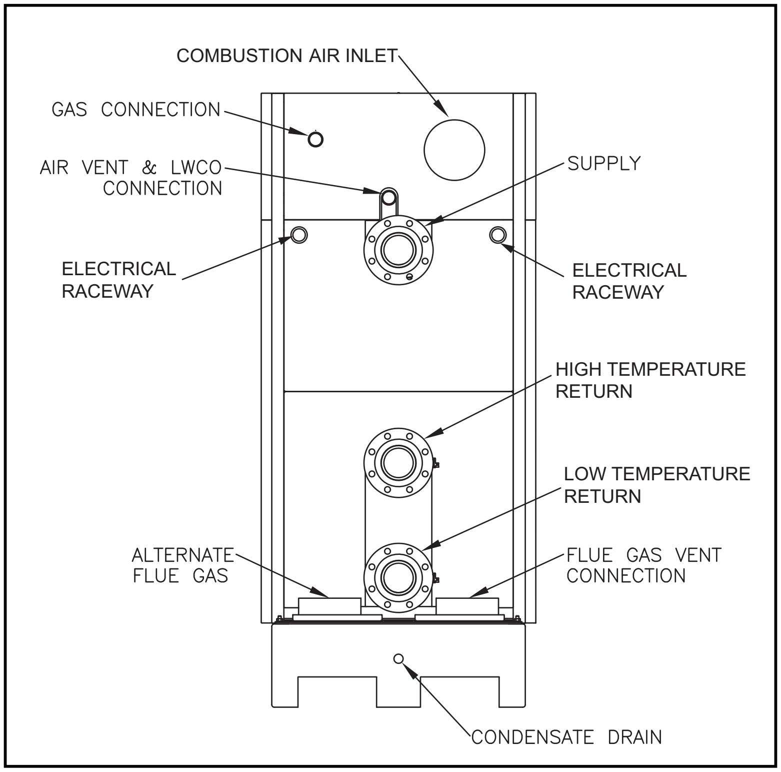


Figure 36. CFC-E Rear Connections

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 16. 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 17. 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 18. 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.

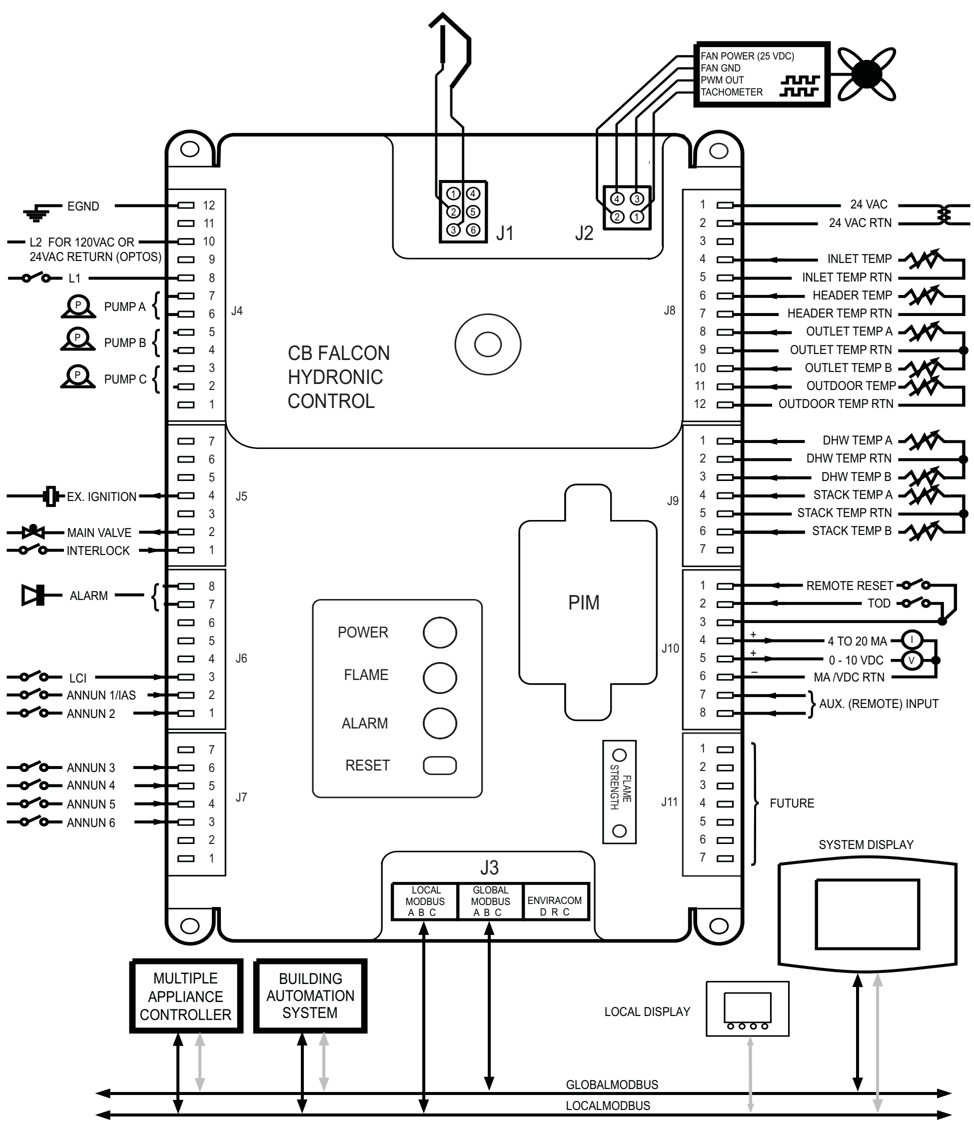
3. Main Voltage Connection - 115V/single phase/60Hz
4. Local/Remote demand switch
5. Combustion Air Proving Switch - This input is used for proving airflow sufficient for proper combustion throughout the burner run sequence.
6. High Air Pressure Switch - prevents boiler operation in the event of high 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 ^{o}C)
    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-E manual 750-263 or to the CB Falcon manual 750-265.

Figure 37. CB Falcon Pinout



EXAMPLE SYSTEM SCHEMATICS

Typical piping arrangements using the CFC-E are shown in the figures that follow.

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 38. Primary/Secondary, Single Boiler

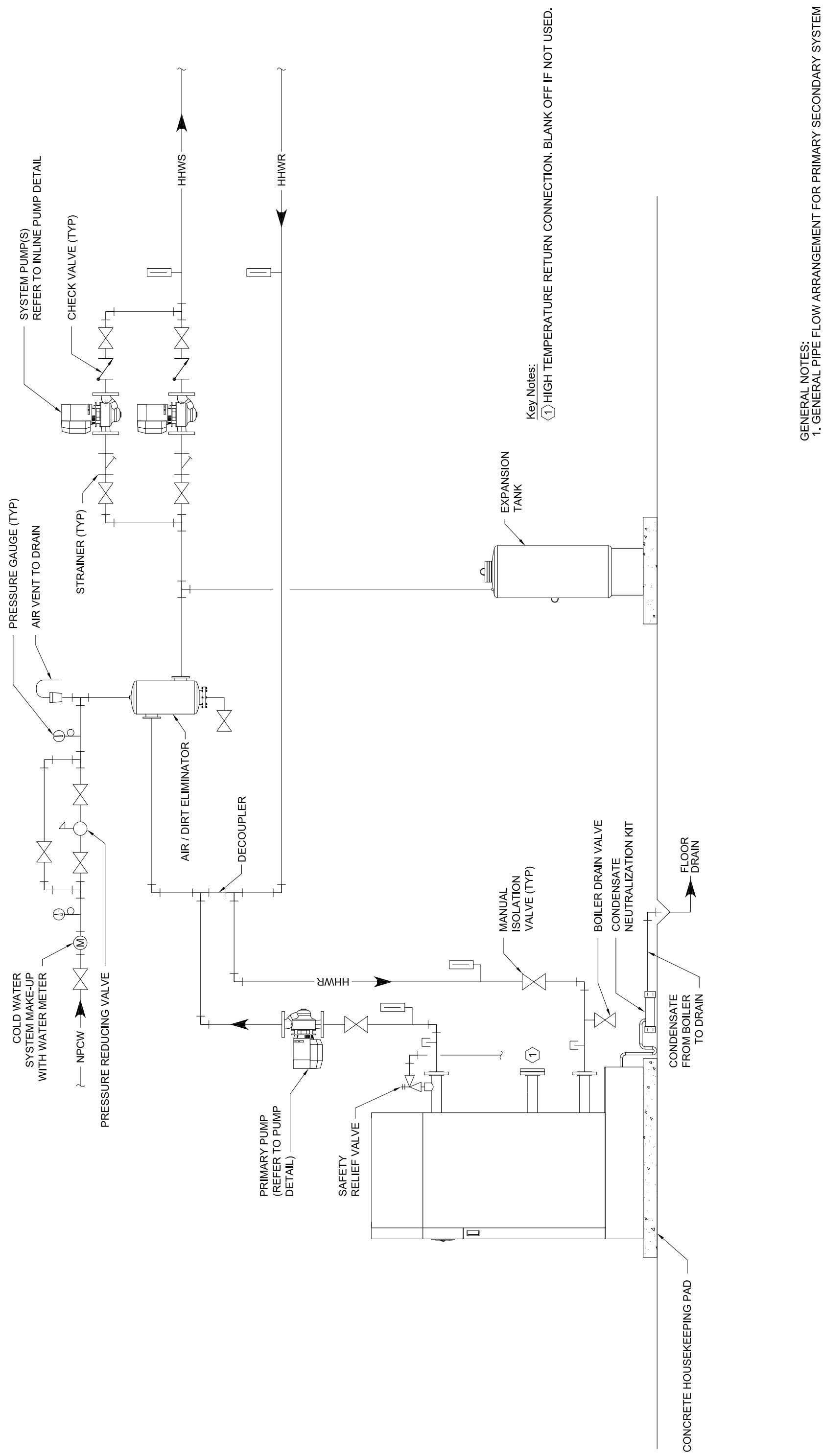


Figure 39. Primary/Secondary, Two Boilers

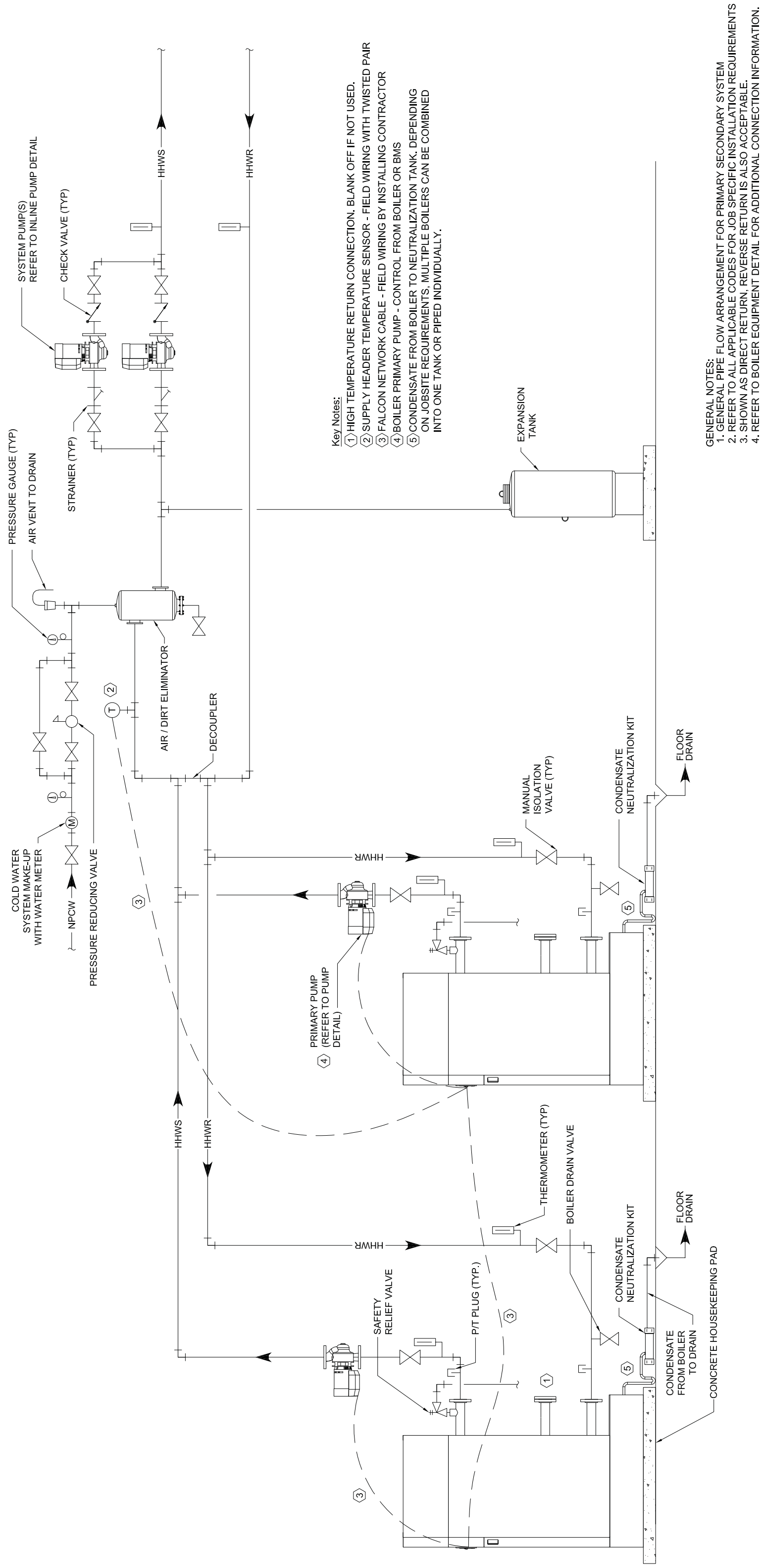


Figure 40. Primary/Secondary, Three Boilers

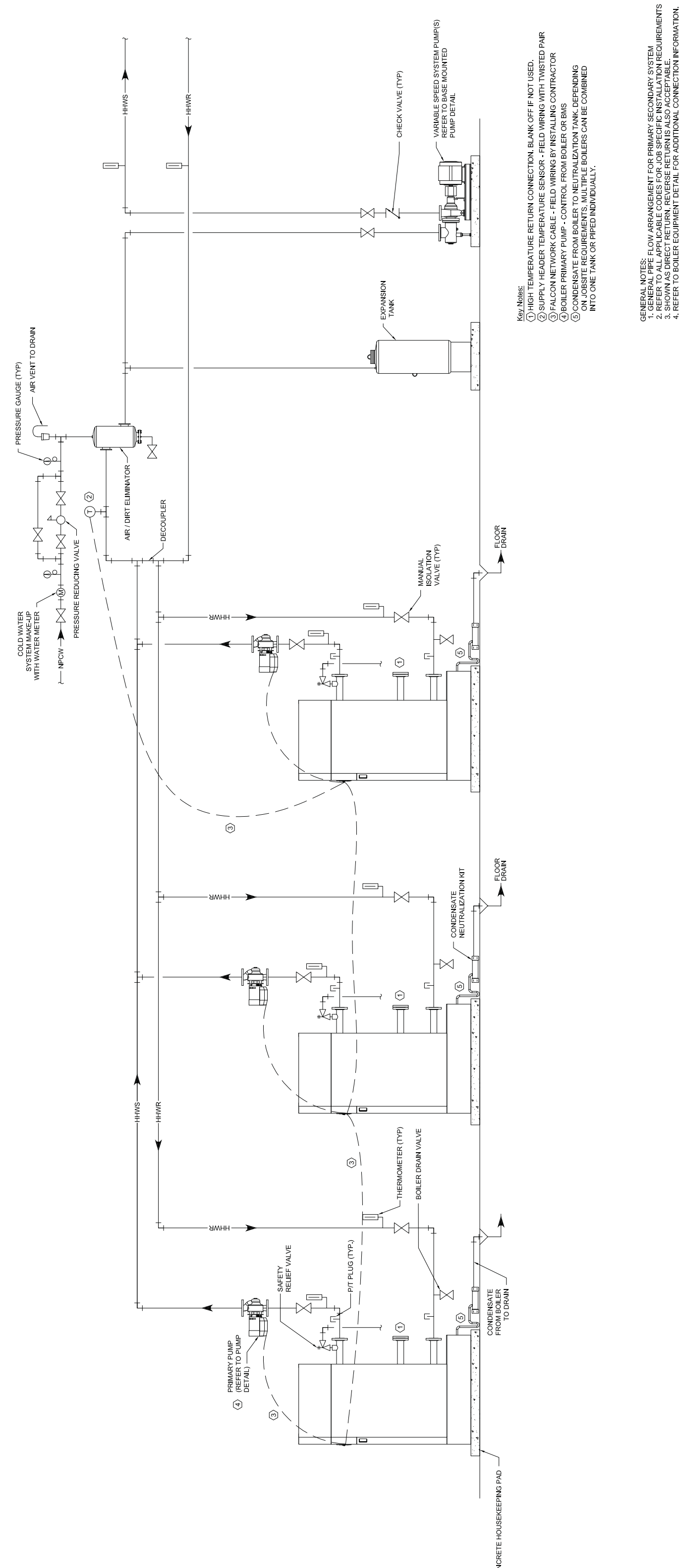


Figure 41. Primary Variable Flow, Single Boiler

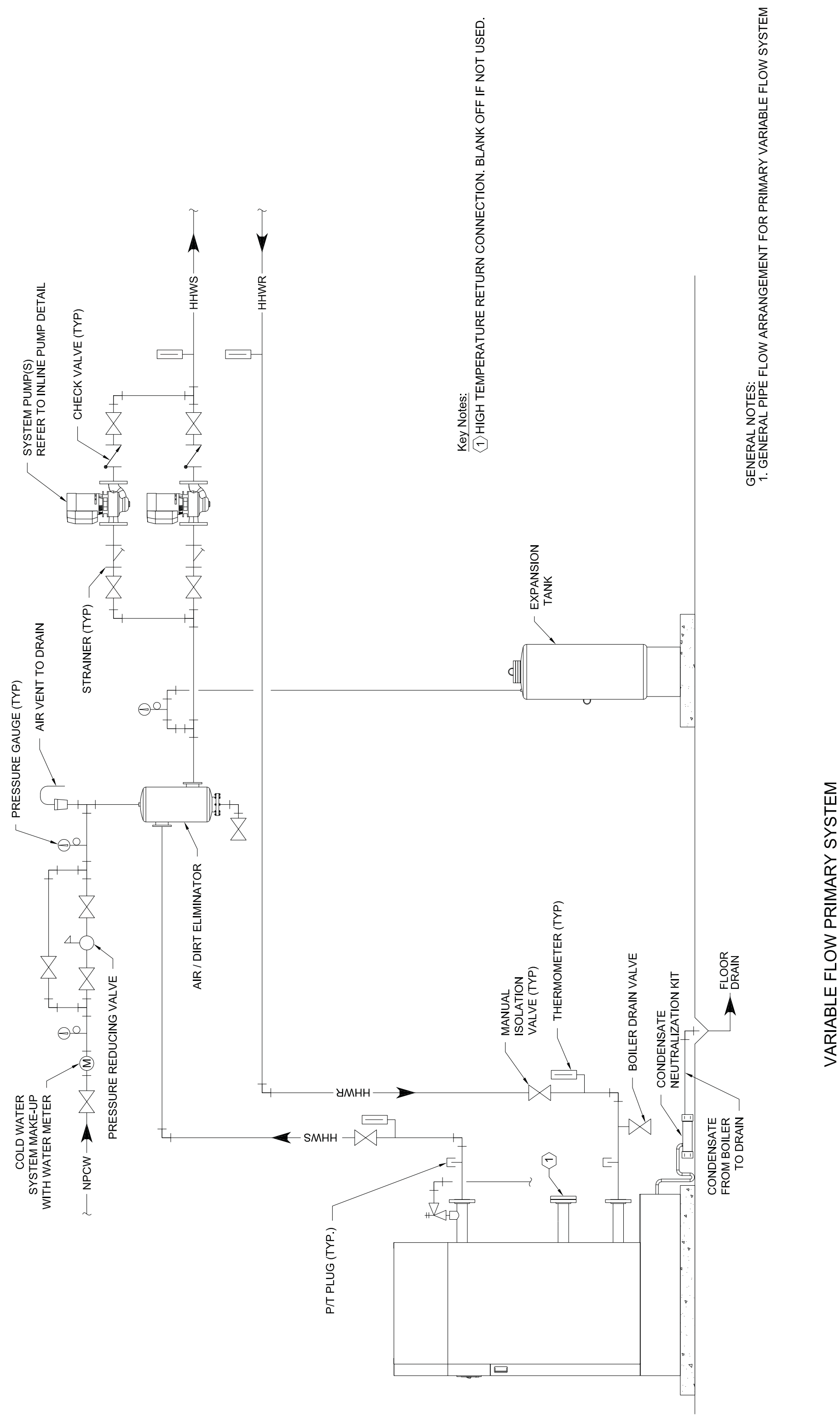


Figure 42. Primary Variable Flow, Two Boilers

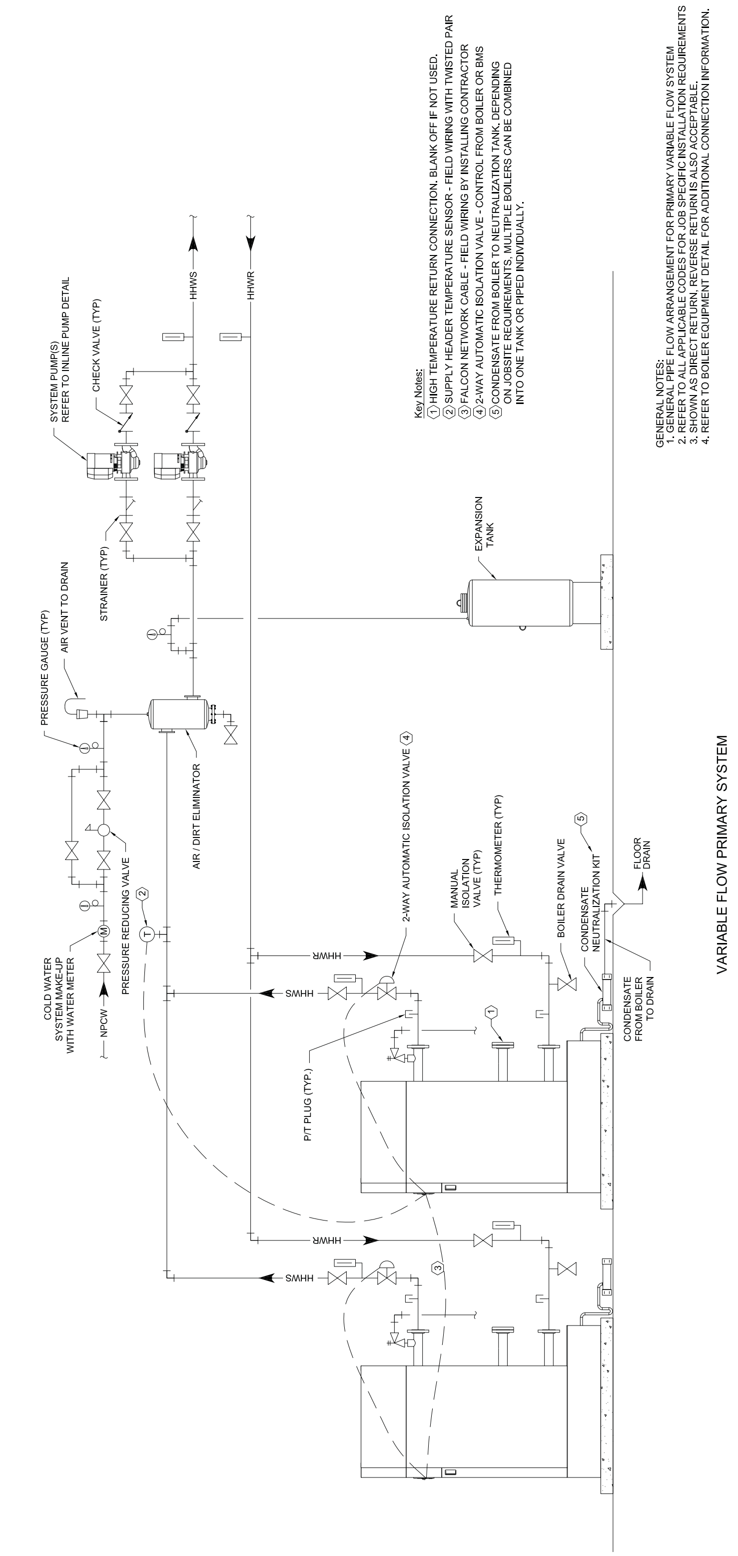


Figure 43. Primary Variable Flow, Three Boilers

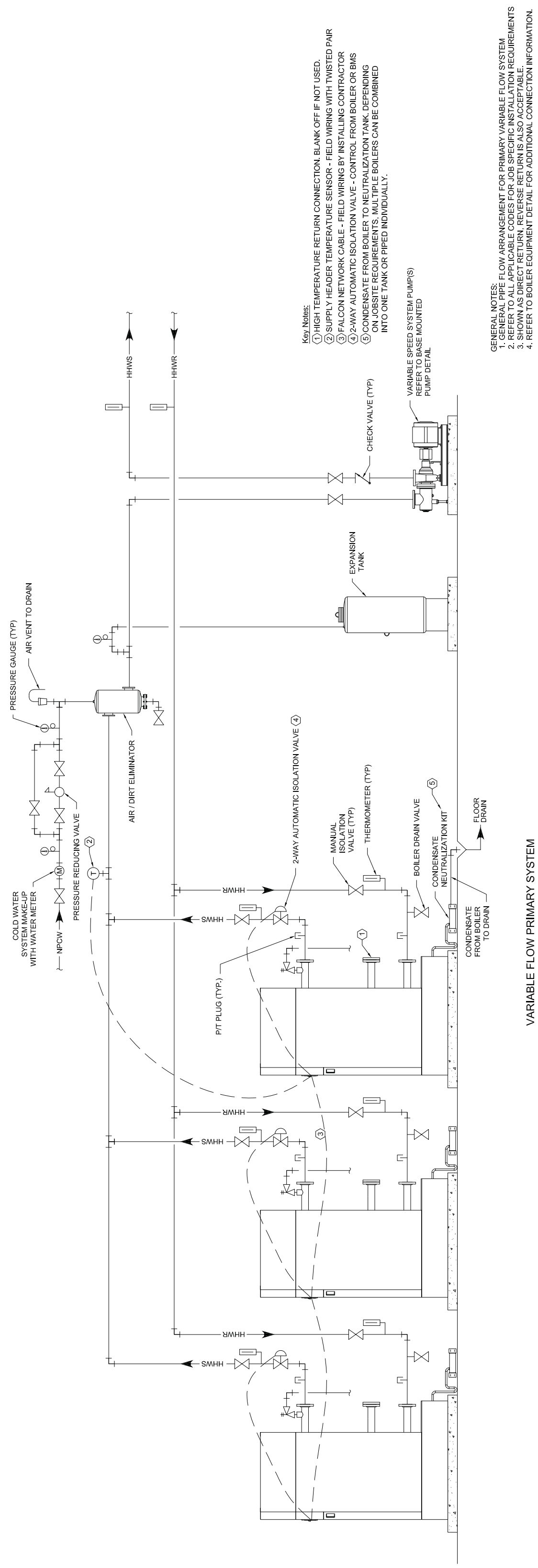


Figure 44. Primary Variable Flow, Single Boiler with Heat Exchanger

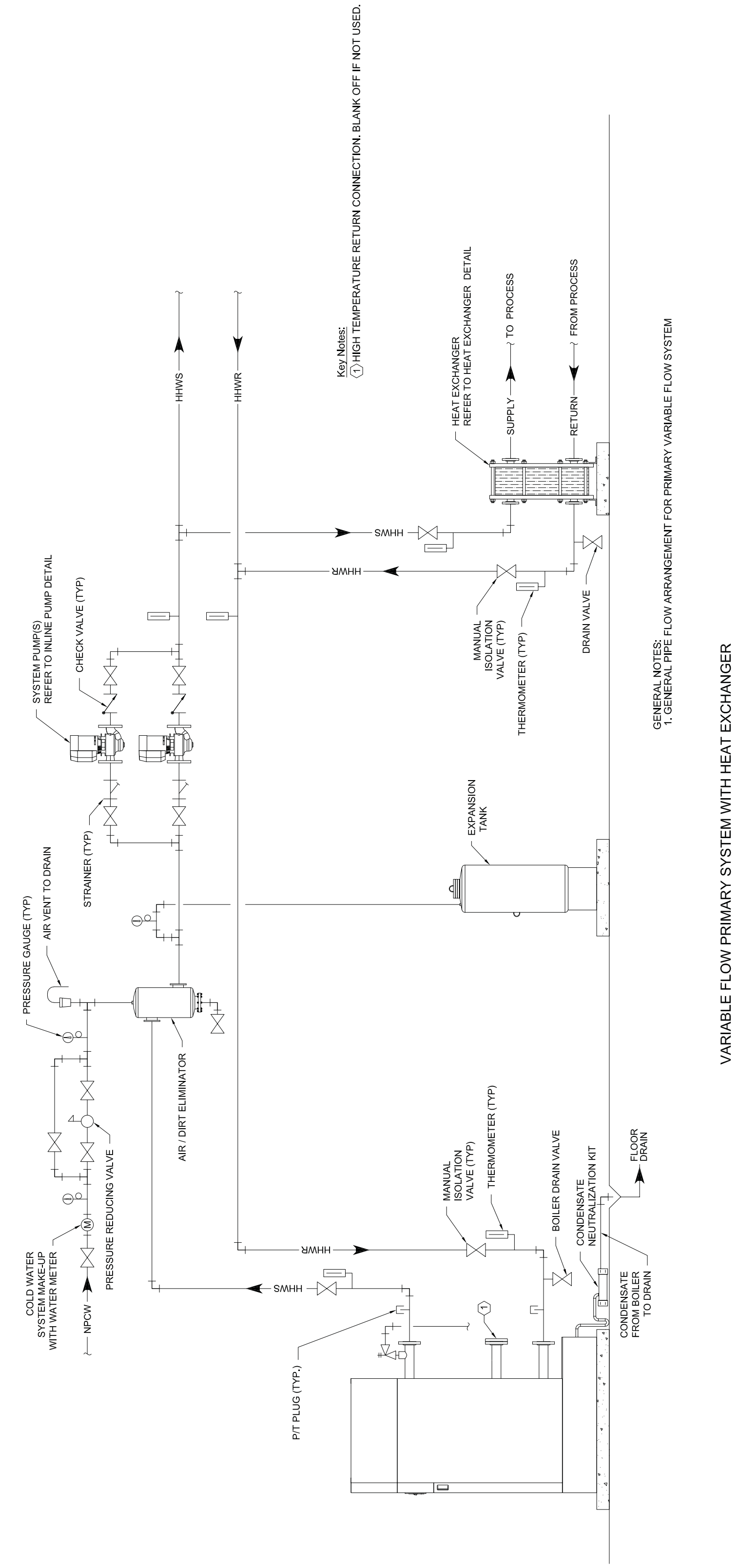
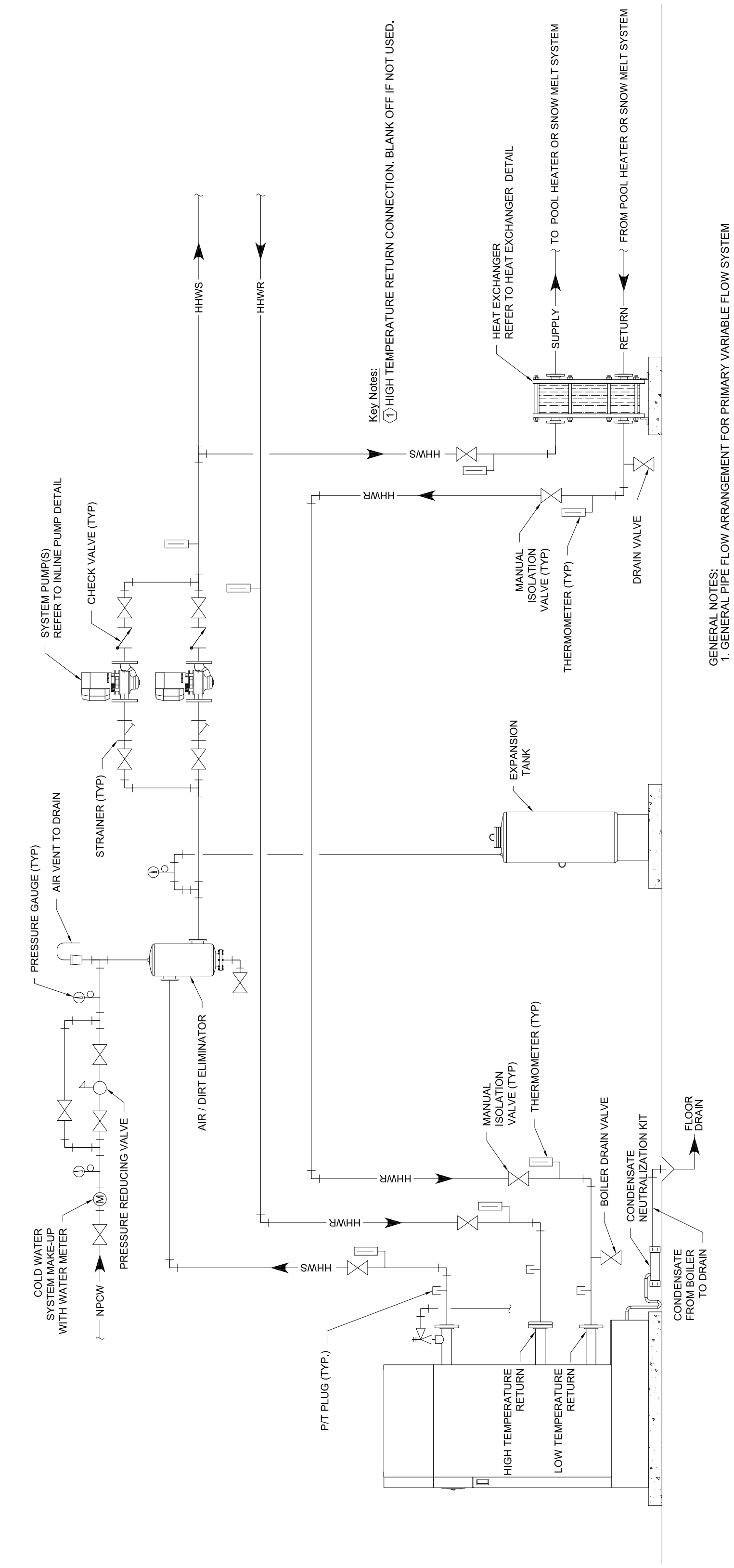


Figure 45. Primary Variable Flow, Single Boiler with Heat Exchanger and Dual Return



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